



Nineveh Fire Protection District Board of Trustees

Nineveh Fire Station 101
S Nineveh Rd
Nineveh, Indiana 46164

studioAXIS Project #2025013

PROJECT MANUAL VOLUME 2 SPECIFICATION SECTIONS 22-28

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SECTION 22 05 01 - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. The requirements of the General Conditions, General Requirements, Special Conditions, Instructions to Bidders, Contract Documents and other information bound herewith form a part of and shall govern all work performed under these specifications.
- B. The accompanying plumbing drawings are issued as part of this specification. Any requirements shown thereon are equally affective as if included in this specification. Any omissions in the specification or on the drawings are not to be a basis for failure on the part of the Contractor, from installing components required by the systems to operate in the intended manner. Should any work be called for on the drawings, specifications or in the codes, in such a manner that the Contractor cannot, in his judgement, comply with the requirements, then the Contractor shall bring the matter to the attention of the Engineer before proceeding with the work.
- C. The drawings depict the systems' components and distribution method. Every attempt is made to complete the distribution piping; however, discrepancies may develop in the process. The Contractor, within reason, is required to prepare his bid and construct the project that the result is fully developed, complete and operable systems. (This includes obvious omitted piping connections). In the event of discrepancies in pipe sizes from drawing to drawing, the Contractor shall include the cost for the larger size.
- D. Should any work be called for on the drawings, specifications or in the codes, in such a manner that the Contractor cannot, in his judgement, comply with the requirements, then the Contractor shall bring the matter to the attention of the Engineer before proceeding with the work.
- E. Work includes the installation of equipment, piping, and components necessary for complete and operable systems.
- F. The plumbing work on this project includes the following systems:
 - 1. Domestic water systems
 - 2. Sanitary sewer system
 - 3. Sanitary waste and vent systems
 - 4. Condensate drain piping system
 - 5. Natural gas system

1.02 DEFINITIONS AND TERMS USED IN THE DIVISION 22 SPECIFICATIONS AND PLUMBING DRAWINGS

- A. The word "Owner" shall mean the party mentioned in the prime contract agreement, or any representative of his party duly authorized to act in his behalf in the execution of the work.
- B. The word "Construction Manager" shall mean the person, firm or corporation entering into a contract with the Owner to manage construction operations.
- C. The word "Contractor" shall mean the person, firm or corporation entering into a contract to construct and complete the work as described herein.
- D. The word "Engineer" shall mean Circle Design Group and their representatives assigned to this project.
- E. The word "Architect" shall mean Studio Axis and their representatives acting as the Owner's appointed agent.
- F. The words "Commissioning Agent or Engineer" shall mean the Owner's Agent and their representatives, hired to commission, or verify performance of all or portions of the work included in the contract documents.
- G. The words "furnish", or "supply" shall mean to purchase and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar subsequent requirements.
- H. The word "install" shall mean operations at the project site, including unloading, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar requirements.
- I. The word "provide" shall mean to furnish and install complete and ready for intended use.

1.03 CODES, FEES AND MISCELLANEOUS COSTS

- A. All materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards and utility company regulations.
- B. In cases of difference between building codes, specifications, state laws, local ordinances, industry standards and utility company regulations and the Contract documents, the most stringent shall govern. The Contractor shall promptly notify the Engineer in writing of any such differences.
- C. Non-Compliance: Should the Contractor perform any work that does not comply with requirements of applicable building codes, states laws, local ordinances, industry standards and utility company regulations, he shall bear all costs arising for correction of non-complying items.

- D. Applicable Codes and Standards shall include all state laws, local ordinances, utility company regulations and applicable requirements of the following nationally accepted laws, codes, and standards. These requirements are to be considered minimum and are to be exceeded when so indicated on the drawings or herein specified.
1. Governing Agencies
 - a. Fire Prevention and Building Safety Commission
 - b. Indiana Department of Health
 2. Applicable Codes
 - a. Indiana Building Code (IBC), 2014, consisting of:
 - (1) International Building Code, 2012
 - (2) Indiana Amendments
 - b. Indiana Electrical Code (IEC), 2009, consisting of:
 - (1) NFPA 70, National Electrical Code, 2008
 - (2) Indiana Amendments
 - c. Indiana Safety Code for Health Care Facilities, 1991, consisting of:
 - (1) NFPA 99 Standard for Health Care Facilities 1992
 - (2) Indiana Amendments
 - d. Indiana Mechanical Code (IMC) 2014 consisting of:
 - (1) International Mechanical Code 2012
 - (2) Indiana Amendments
 - e. Indiana Plumbing Code (IPC), 2012 Edition, consisting of:
 - (1) International Plumbing Code 2006 Second Printing
 - (2) Indiana Amendments
 - f. Indiana Swimming Pool Code (ISPC 20) 2011
 - g. Indiana Energy Conservation Code (IECC) 2010, consisting of:
 - (1) American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. Standard 90.1, 2007 Edition
 - (2) Indiana Amendments
 - h. Indiana Elevator Safety Code 2011 Edition 675 IAC21-3 (ANSI ASME A17.1, 2007 Edition)
 - i. Indiana Fire Code (IFC), 2014, consisting of:
 - (1) International Fire Code, 2012
 - (2) Indiana Amendments
 - j. Indiana Rules for Boilers and Pressure Vessels and excerpts from Indiana Statue (IC22-12) governing licensing and regulation
 - k. Indiana Fuel Gas Code 2014 Edition Consisting of:
 - (1) International Fuel Gas Code 2012
 - (2) Indiana Amendments
 3. Standards
 - a. ASPE: American Society of Plumbing Engineers
 - b. ASTM: American Society of Testing Materials

- c. ANSI: American National Standards Institute
- d. ASME: American Society of Mechanical Engineers
- e. NEC: National Electric Code
- f. NEMA: National Electrical Manufacturers Association
- g. NFPA: National Fire Protection Association
- h. NFPA: National Fire Protection Association
- i. OSHA: Occupational Safety and Health Act
- j. UL: Underwriters Laboratories
- k. ADAAG: Americans with Disabilities Act Accessibility Guidelines
- l. Ten State Standards
- m. NFPA 101: Life Safety Code
- n. AGA: American Gas Association
- o. ASCI: American Standard Code for Information Exchange
- p. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. 90.1 – 2013

- E. The Contractor shall be responsible for obtaining all permits, payment of all fees, necessary drawings and arranging and paying for all inspections, tests, etc. which may be required by any governing authority or utility company in connection with the furnishing or installation of any of his work.

1.04 WORK AND WORKMANSHIP

- A. All materials and equipment shall be of the highest quality in every respect. All materials and equipment shall be new and of the latest design and free of defects.
- B. Workmanship shall be by skilled workmen of highest standard in strict accordance with all applicable manufacturers' printed specifications (which, by reference, are made completely a part of these specifications as though herein repeated), performed under supervision of competent foremen at all times.
- C. The Owner has full power to condemn or reject any work, materials or equipment not in accordance with these specifications and construction drawings or not in conformance with the manufacturers' specifications or drawings which were approved by the Owner or Engineer.
- D. 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 Engineer.
- E. Such decisions that the Owner or Engineer may make with respect to questions concerning the quality, fitness of materials, equipment and workmanship shall be binding upon the parties thereto.
- F. 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.

1.05 DEVIATIONS FROM DRAWINGS

- A. Plumbing drawings show the intended arrangement and routing of all piping, equipment, and appurtenances. They shall be followed as closely as actual building construction and work of other trades will permit.
- B. The Contractor shall investigate structural and finish conditions affecting his work and shall provide any fittings, offsets and accessories required to accommodate said conditions.
- C. The Contractor shall coordinate with other trades and provide any fittings, offsets and accessories required to obtain the coordinated installation, in addition adjustment shall be made for reasons to improve the installation or performance, etc., made upon receiving the approval of the Engineer. The Contractor shall document that adjustments have been coordinated with all parties concerned.

1.06 OCCUPATIONAL SAFETY AND HEALTH ACT

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

1.07 COORDINATION BETWEEN CONTRACTORS

- A. The Contractor and his Subcontractors shall study all drawings and specifications for this project so that complete coordination between trades will be obtained. Special attention shall be given to points where piping crosses ducts, other piping, or conduit, where lights fit into ceilings and where pipes pass through walls and structural elements.
- B. It is the responsibility of the Contractor and his Subcontractors to leave necessary room for other trades. No extra compensation will be allowed to cover the cost of relocating piping or equipment found encroaching on space required by the other trades.
- C. The Contractor shall review the electrical requirements of the final equipment selections with the Electrical Contractor to ensure such items receive proper electrical services or connections.
- D. The Contractor shall provide complete information and cooperation to the other Contractors and trades pertaining to his work to accomplish coordination for the complete project.
- E. The Contractor shall provide the necessary sleeved openings, excavations, etc. Cutting and patching shall be held to a minimum.
- F. The Contractor and his Subcontractors shall be required to attend the periodic progress meetings to accomplish coordination with the Owner, Architect and Engineer.

- G. Assure a minimum of 30" clear access at the front for all equipment requiring maintenance access.

1.08 INSPECTION

- A. At the appropriate intervals of the mechanical installation, the Contractor shall inform the local and state authorities to arrange inspections of his work. Provide Certificate of Inspection when completed.

1.09 REPORTS AND FINAL SUBMISSIONS

- A. The Contractor shall submit, for attachment to the Substantial Completion Certificate, a letter certifying that the plumbing systems are in accordance with the Indiana Mechanical Code, Indiana Plumbing Code and Indiana Fire Code as amended by the State of Indiana.
- B. Submit all other test reports, as hereinafter specified.

1.10 COORDINATION WITH COMMISSIONING

- A. The purpose of the commissioning process is to provide the Owner of the facility with a high level of assurance that the mechanical and electrical systems have been installed in the prescribed manner and operate within the performance guidelines set in the Construction Documents.
- B. Each trade Contractor shall review the procedures in the specification sections and include the necessary cooperation and coordination.

PART 2 - PRODUCTS

2.01 PRODUCT AND MATERIAL APPROVAL

- A. When Manufacturer's model numbers are listed, they are for reference only and are not to be considered a basis of design. The model numbers listed are the best information made available to the designer by the manufacturer and not intended to supplant or be inclusive of the criteria defined in the specifications and drawings. The Contractor/Manufacturer shall review the complete construction documents to ensure the products proposed are appropriate and meet the system design criteria.
- B. The performance requirements listed in the specifications or shown on the drawings are the basis of design and will be the benchmark used for submittal review and approval as well as determining if work is accepted or rejected.
- C. A specification followed by one or more manufacturers is limited to those manufacturers. Names of other proposed manufacturers may be submitted for approval to the Engineer a minimum of ten (10) days prior to receiving bids. Approval will be granted only if issued by Addendum (no exceptions).

- D. A specification followed by one or more manufacturers and "or approved equal" is open to equal products or materials. However, the Contractor shall supply one of the listed manufacturers at no additional cost if Engineer determines substituted product unsatisfactory.
- E. Any substituted equipment offered for consideration shall be stated as a separate item with the bid. State any additive or deductive cost.
- F. If changes in piping, equipment, layout, or electrical service are brought about by the use of equipment which is not compatible with the layout shown on the drawings, the Contractor shall include the cost of the necessary changes in his bid.

2.02 SUBCONTRACTORS AND MATERIAL LIST

- A. The Contractor shall submit, with his bid, a completed list of Subcontractors, manufacturers and suppliers of each item listed. No substitutions will be allowed, by the Contractor, after award of contract.
- B. Failure to submit a fully completed list within the stated time may be cause to reject the bid.
- C. Remove or copy the following list and attach it to the bid form.

2.03 LIST FOR PLUMBING CONTRACTOR:

(The Contractor)

A. Sub-Contractors SUBCONTRACTORS AND MATERIALS

1. Insulation Subcontractor _____

B. Material and Suppliers List

<u>SECTION</u>	<u>MATERIAL</u>	<u>MANUFACTURER</u>	<u>SUPPLIER</u>
22 05 19	Meters and gauges	_____	_____
22 05 29	Pipe hangers and Supports	_____	_____
22 05 53	Equipment and pipe Identification	_____	_____
22 05 76	Cleanouts	_____	_____
22 07 19	Pipe Insulation	_____	_____
22 11 16	Domestic water piping	_____	_____
22 11 19	Backflow preventers	_____	_____
22 11 19	Water hammer arresters	_____	_____
22 11 22	Domestic water booster pumps	_____	_____
22 11 23	Water circulating pumps	_____	_____
22 13 16	Sanitary waste piping and fittings	_____	_____
22 13 19	Sanitary floor drains and floor sinks	_____	_____
22 13 23	Interceptors	_____	_____
22 31 00	Water softeners	_____	_____
22 34 00	Water heaters	_____	_____
22 34 05	Thermostatic mixing valves	_____	_____
22 42 00	Water closets, urinals and lavatories	_____	_____
22 42 00	Electric water coolers	_____	_____
22 42 00	Sinks	_____	_____
22 42 00	Mop basins	_____	_____
22 42 00	Showers	_____	_____
22 42 00	Bathtubs	_____	_____
22 42 00	Valve boxes	_____	_____
22 42 00	Clothes washer boxes	_____	_____
22 42 00	Faucets	_____	_____
22 42 00	Flush valves	_____	_____

2.04 EQUIPMENT DELIVERY SCHEDULE

- A. Submit a schedule listing equipment and materials required for complete installation, quantity ordered, date of placing order and the promised delivery dates.
- B. Any and all probable delivery delays shall be identified at the pre-construction meeting.

2.05 SUBMITTALS

- A. The Contractor shall submit shop drawings, fabrication drawings, and specific product literature for all products specified and shown on the drawings.
- B. Approval of submittals does not relieve the Contractor of the responsibility for ordering proper quantities and miscellaneous appurtenances required for operation and/or installation of the respective material or equipment.
- C. The following general information is required with each submittal as applicable:
 - 1. The full manufacturer's model number of each item
 - 2. Identification of each item's performance, physical size, and construction data.
 - 3. Identification of finishes. Furnish two (2) chips for each color for items requiring color/finish selections.
 - 4. Indicate any modifications made to manufacturers' standard design which are required by these specifications.
 - 5. Location of connection points for external piping or electrical connections.
 - 6. Rough-in, foundation and support point dimensions.
 - 7. Complete wiring diagrams and connection identifications, specific to this project.
 - 8. Contractor's stamp, signature and date shall be affixed to the submittal with indication of his review and approval.
- D. When manufacturer's information contains multiple model numbers and capacities on the same data sheet, specific equipment to be provided shall be identified by highlighting or clouding relevant data or striking non-relevant data.
- E. Unit equipment designations from the plans and schedules (unit tags) shall be identified for each piece of equipment.
- F. In addition, submit any detailed or specific information as stated in the respective specification sections.

2.06 RECORD DRAWINGS

- A. The Contractor shall submit record drawings as stated in the General Conditions, and as specified herein.

- B. During construction, maintain a complete and legible set of drawings, at the job site showing changes and deviations between actual construction and Engineer's drawings.
- C. Submit to Engineer for review at the 25%, 50%, 75% and 100% completion of the work a complete, accurate and neat set of marked-up blueline drawings showing the complete "as built" construction.
- D. This marked-up set shall be returned to the Contractor as many times as necessary in order to obtain desired results.

2.07 MAINTENANCE MANUALS

- A. The Contractor shall submit maintenance manuals as stated in the General Conditions and as described in further detail herein.
- B. Maintenance manuals are to include all information relative to maintenance and operating instructions for all new plumbing products.
- C. Maintenance manuals shall be assembled in the following sections:
 - 1. Section 1
 - a. Title of project
 - b. Name and addresses of:
 - (1) Owner
 - (2) Engineer
 - (3) Contractor
 - 2. Section 2: Index of complete contents
 - 3. Section 3:
 - a. List of all equipment with model number and serial number
 - b. Warranty of each piece of equipment with start and completion dates.
 - 4. Section 4: valve tag chart
 - 5. Section 5: Products
 - a. Incorporate data sheets, operating instructions, maintenance instructions, parts list, installation instruction and performance characteristics on each piece of equipment or system in individually tabbed subsections.
 - b. Label and assemble tabbed sections in numerical order by corresponding specification section number.
- D. Each section shall be separated by a pasteboard tabbed divider. Each section tab shall identify equipment by same name as listed in the index. Tabs shall extend outside of sheet size.
- E. All information shall be arranged in a three-ring (3" D configuration) vinyl coated notebook.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle equipment and components carefully to prevent damaging, breaking, denting, and scoring. Do not install damaged equipment or components; replace them with new ones.
- B. Store equipment and components in clean dry place. Protect from weather, theft, dirt, fumes, water, construction debris and physical damage at all times.

3.02 UTILITY START-UPS

- A. Contractor shall facilitate the startup of new utility services for this project and ensure the proper operation of utility metering for billing and energy management.

END OF SECTION

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SECTION 22 05 02 - ASSIGNMENT OF MISCELLANEOUS WORK

PART 1 - GENERAL

1.01 PAINTING

- A. Painting of exposed plumbing system in public areas shall be by General Contractor.
- B. Painting of piping systems in mechanical rooms and fan rooms (color coded) shall be by Plumbing Contractor.
- C. Painting of all interior and exterior non-galvanized metal supports, stands and miscellaneous metal for plumbing equipment and piping shall be by the Plumbing Contractor.
- D. Painting of patched and new ceiling and wall surfaces shall be by Mechanical Contractor.
- E. Painting of all exterior piping shall be by Plumbing Contractor.

1.02 WALL OPENINGS

- A. Wall openings for plumbing work shall be arranged for and provided by the Plumbing Contractor.
- B. Lintels for wall openings required by plumbing work will be furnished and installed by the Contractor constructing the wall. Plumbing Contractor is responsible for notifying that Contractor of locations and sizes of openings requiring lintels prior to wall construction. Openings not coordinated and provided shall be arranged for and provided by the Plumbing Contractor.
- C. Final sizes and locations of plumbing penetrations in walls are the responsibility of the Plumbing Contractor.
- D. Provide approved fire stops for fire rated wall openings.
- E. Provide acoustical seals for sound proofing in wall openings.

1.03 ROOF AND FLOOR OPENINGS

- A. Roof and floor openings for plumbing work shall be provided by Plumbing Contractor. Miscellaneous framing required, shall be furnished, and installed by the Contractors constructing the roof or floor structure. Plumbing Contractor is responsible for notifying those Contractors of exact locations and sizes prior to construction of the framing. Openings not coordinated and provided shall be arranged and paid for by the Plumbing Contractor.
- B. Final sizes and locations of plumbing penetrations through the roof and floor structures are the responsibility of the Plumbing Contractor.

- C. All post-tensioned slab penetrations shall be sleeved. Sleeves shall be provided by the Plumbing Contractor and coordinated with the General Contractor.
- D. Roof curbs and supports for plumbing work shall be provided by the Plumbing Contractor requiring same.
- E. Counterflashing shall be provided by the Plumbing Contractor. Roof flashing shall be provided by the Roofing Contractor.
- F. All roofing work required on the existing building (openings, flashing, etc.) shall be performed by the Roofing Contractor maintaining the warranty.
- G. Provide fire retardant plywood sheets when roof areas are completed during operations for walkways and work areas. The Contractors working on the completed new roof shall be responsible for roof protection and assuring the warranty on the roof system is maintained.

1.04 WALL AND CEILING ACCESS PANELS

- A. Wall and ceiling panels for access to concealed valves, etc. shall be furnished by the Plumbing Contractor.
- B. Plumbing Contractor is responsible for coordinating and assisting in locating all access panels with the General Contractor prior to his wall or ceiling construction, to obtain access to valves, etc.
- C. Access panels are required in inaccessible (non lay-in) ceilings and walls for all valves, plumbing water hammer arrestors or other components requiring periodic maintenance. Panels shall be located to be accessible without causing damage to final finishes. Coordinate items requiring access including with other trades so that the quantity of access panels is kept to a minimum.
- D. The panel locations shall also be coordinated with, and receive the approval of, the Architect and Engineer.

1.05 CONCRETE PADS

- A. Concrete pads for plumbing equipment shall be provided by the Plumbing Contractor in accordance with Specifications Section 22 05 05, Concrete Pads and Curbs.
- B. Concrete pad removals and floor patching by Plumbing Contractor.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.01 PLATFORMS AND SUPPORT STANDS

- A. Platforms and supporting stands for plumbing equipment shall be provided by the Contractor.
- B. Each piece of equipment or apparatus suspended from ceiling or mounted above floor level shall be provided with suitable structural support, platform or carrier constructed in accordance with best recognized practice in a neat and workmanlike manner.
- C. Contractor shall exercise extreme care that structural members of building are not overloaded by such equipment. In all cases, details of such hangers, platforms and supports together with total weights of mounted equipment shall be approved by Structural Engineer.

3.02 ATTACHING TO BUILDING CONSTRUCTION

- A. Equipment and piping supports shall be attached to structural members (beams, joists, etc.) rather than to floor or roof slabs.
- B. Where equipment is suspended from concrete or masonry construction, use expansion shields to attach supports to construction. Expansion shield bolt diameter shall be the same size as support rod diameter, hereinafter specified.
- C. 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 Architect and/or Engineer.
- D. Where supports are attached to structural members coated with fireproofing, the Contractor shall clean the fireproofing, attach the support, and patch the fireproofing with like material.

3.03 ELECTRICAL CONNECTIONS TO EQUIPMENT

- A. In the event that equipment furnished requires a larger starter or disconnect than that which is indicated on the documents, the Contractor supplying the larger equipment shall reimburse the Electrical Contractor supplying the larger starter or disconnect for the difference in labor and material cost.
- B. Detailed diagrams and instructions shall be provided by Contractor supplying equipment. If connections are different from those shown on the drawings, the Contractor shall notify the Electrical Contractor prior to start of his related work.

- C. Relays, switches, contactors, etc. which may be required in addition to those specified or indicated on the electrical drawings shall be furnished by the supplying Contractor for installation by the Electrical Contractor. These devices shall be mounted by the Electrical Contractor at the apparatus to be installed and the Contractor supplying these additional devices shall reimburse the Electrical Contractor for his labor and material costs.
- D. In the event that several pieces of plumbing equipment from different suppliers are combined into one system, Contractor shall furnish complete interface wiring and control diagram to enable the Electrical Contractor to make proper connections. Diagrams shall be submitted to the Engineer for approval prior to actual wiring.
- E. Contractor shall furnish to Electrical Contractor written notice of approval and acceptance of all control wiring which was installed by the Electrical Contractor for his system(s). Such approval shall be given within thirty (30) days of completion of all such control wiring. The letter shall be copied to the Engineer.

END OF SECTION

SECTION 22 05 03 - COMPLETION AND STARTUP

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish material and labor required to perform startup of plumbing equipment and systems installed in this project and provide operating and maintenance instructions to the Owner.
- B. Coordinate, schedule and perform this work with the Commissioning Engineer.
- C. Furnish labor and material required to inspect the installed piping systems and correct deficiencies as specified herein.
- D. Furnish labor and equipment required to maintain clean work areas throughout the project and to perform final cleanup.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Assignment of Miscellaneous Work: Section 22 05 02
- C. Testing, Adjusting and Balancing: Section 23 05 93

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.01 GENERAL COMPLETION REQUIREMENTS

- A. Adhere strictly to the following procedures in completing plumbing systems.
 - 1. Pumps:
 - a. Check pump packing glands or mechanical seals for cleanliness and adjustment before running pump. Inspect shaft sleeves for scoring and proper placement of packing, replace if necessary. Inspect mechanical faces, chambers and seal rings and replace if necessary. Make sure piping system is free of dirt and scale before circulating liquid through pumps.
 - b. 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.
 - c. Tighten unions and flanges in piping systems after system has been placed in operation. Replace gaskets in flanges that show any signs of leakage after tightening.

2. Piping:
 - a. 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.
 - b. Clean dirt pockets, orifices, valve seats and headers in all fluid systems after system has been placed in operation to assure, they are free from foreign material.
 - c. Adjust pipe hangers and supports for correct pitch and alignment.
 - d. Inspect valves, clean bonnets and stems, tighten packing glands to assure no leakage but permit valve stems to operate without galling. Replace packing in valves that require same to retain maximum adjustment after system is judged complete. Replace entire packing in any valve that continues to leak after adjustment, remove and repair bonnets that leak, coat packing gland threads and valve stems with surface preparation after cleaning.
 - e. Inspect each pressure gauge and thermometer for calibration and replace those that are defaced, broken or read incorrectly.
 3. General:
 - a. Remove rust, scale and foreign materials from equipment and renew any defaced surfaces. If equipment is badly marred, Engineer shall have authority to request that new materials be provided.
 - b. Repair pipe insulation that may have been damaged during construction period.
- B. Complete all applicable startup procedures described in preceding paragraphs and in the associated articles for particular systems prior to occupancy of spaces served.
- C. Provide such continuing adjustment services as necessary to ensure proper functioning of all plumbing systems after building occupancy and during warranty period.

3.02 STARTUP

- A. Perform a startup of each system installed in this project in strict accordance with manufacturer's printed procedure.
- B. Check for proper rotation of all pumps.
- C. Check for proper electrical services and usage during the startup procedure.

3.03 TEMPORARY USE OF NEW EQUIPMENT

- A. The warranty on the equipment will not begin until the date of Owner's final acceptance at the completion of the project.

- B. Should the Owner elect to receive beneficial operation of the equipment prior to project's final acceptance, he may do so. The warranty period may begin then upon the Contractor receiving written approval from the Owner accepting the equipment with conditions of any incomplete portions of the work.

3.04 TOUCH-UP

- A. All plumbing equipment, cabinets, control panels and other enclosures shall be cleaned, and 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 by the installing Contractor to match original finish or shall be replaced before final acceptance.

3.05 CLEANING

- A. Maintain a clean project site throughout the construction period. Provide personnel to regularly remove debris and unused materials. Coordinate this cleaning effort with your Subcontractors.
- B. Remove all debris and unused materials from job site created by plumbing work.
- C. Clean all plumbing equipment to a "like new" condition prior to systems startup, prior to balancing and in preparation of final inspection. Vacuum clean all internal components.
- D. Clean all mechanical rooms and/or areas of debris and unused material. Vacuum clean mechanical room floors.
- E. Clean the exterior surfaces of all piping systems. Vacuum clean if appropriate. Damp/wet clean with soap (chemical if necessary) and water where required or directed by Owner/Engineer.

3.06 RAISED FLOOR PLENUM CLEANING

- A. Maintain a clean raised floor plenum throughout the entire construction period. Provide personnel to perform daily cleaning of activities on the base floor of the plenum.
- B. Provide periodic vacuum cleaning of the plenum.
- C. Do not operate the air system unless the plenum has been cleaned.

END OF SECTION

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SECTION 22 05 05 - CONCRETE PADS AND CURBS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install cast-in-place concrete pads and curbs for equipment where shown on the drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Assignment of Miscellaneous Work: Section 22 05 02

1.03 SUBMITTALS

- A. Submit complete shop and setting drawings in accordance with Specifications Section 22 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 CONCRETE FORMWORK

- A. Design criteria: conform to tables for form design in APA Form V345, including strength.
- B. Lumber: construction standard grade.
- C. Plywood: exterior type softwood plywood, PS 1.
- D. Ties: carbon steel, snap ties, 1" breakback, 1/4" maximum diameter.
- E. Form Coatings: non staining
- F. Form Joint Tape: closed cell foam.

2.02 CONCRETE REINFORCEMENT

- A. Materials
 - 1. Bars: deformed billet steel: ASTM A615, Grade 40.
 - 2. Wire:
 - a. Cold drawn steel: ASTM A82
 - b. Deformed steel: ASTM A496
 - 3. Tie Wire: FS-QQ-W-461, annealed steel, black 16 gauge, min.
 - 4. Welding Electrodes: AWS A5.1, low hydrogen, E70 Series.
 - 5. Splice Devices: sized to develop 125% of yield strength of bar

6. Bar Supports: Conform to "Bar Support Specifications", CRSI Manual of Standard Practice, Chapter 3.
 7. Wire Fabric: welded steel, ASTM A195
- B. Placement: Set reinforcing accurately and tie all items securely.
- C. Pin all interior pads and curbs to floor slabs with dowels or bars.

2.03 EXPANSION AND CONTRACTION JOINTS

- A. Joint Filler: Pre-molded, treated, non-bituminous, non-extruding wood fiber in concrete color and compatible with specified sealants. Filler shall conform to the performance requirements of ASTM D1752, Type 1.
- B. Acceptable Manufacturers
1. Everlastic
 2. Rescor
 3. Homex 300
 4. Sponge Rubber
 5. Williams Products
 6. W. R. Meadows
 7. Homasote
 8. Construction Gaskets

2.04 CAST-IN-PLACE CONCRETE

- A. Interior: 4000 PSI, ready mix, to conform to ASTM C94
- B. Exterior and Below Grade: 4000 PSI with 4% - 6% air entrainment.
- C. Slump: 5 inch maximum, tolerance, zero plus or minus 2 inches.
- D. Concrete shall be thoroughly consolidated without honeycombed finish surface.
- E. All top, side and vertical edges of concrete pads and curbs shall have 3/4" chamfer.

2.05 CONCRETE FINISHING

- A. Interior Pads and Curbs
1. Provide smooth (floated) sides and top.
 2. Grind smooth all chamfered edges
- B. Exterior Pads
1. Provide smooth (floated) sides
 2. Provide broom finish top
 3. Grind smooth all chamfered edges

2.06 CONCRETE CURING

- A. Apply concrete curing compound only at exposed slab.
- B. Acceptable Manufacturers
 - 1. Curetox - Toch Brothers
 - 2. Sealtight AR-30C - W.R. Meadows
 - 3. Promulsion 100 - Protex

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide 3-1/2" (nominal 4") concrete housekeeping pads under all interior floor mounted Plumbing Equipment.
- B. All housekeeping pads shall include welded steel wire fabricated reinforcement.
- C. Provide concrete pads around all exterior ground mounted cleanouts and manholes.
- D. Coordinate location and size of pads and curbs with other Contractors.
- E. Coordinate pad location with floor drains.
- F. Expansion joints will not be permitted to cross limits of a piece of equipment.
- G. Concrete pads shall extend 6" past all sides of equipment. Determine size of equipment from manufacturer's shop drawings prior to forming pad. Do not scale from design drawings.

END OF SECTION

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SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide totally enclosed fan cooled or open drip-proof motors for plumbing equipment of the type and efficiency as specified herein.
- B. This section is applicable to motors for:
 - 1. Domestic hot water circulating pumps

1.02 QUALITY ASSURANCE

- A. All motors shall be designed, selected and applied in accordance with the latest applicable standards of NEMA, IEEE, ANSI, and the current edition of the National Electric Code.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Domestic Water Pumps: Section 22 11 23

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Section 22 05 01, General Provisions.
- B. Submit shop drawing of motor with each applicable piece of equipment as stated in Item 1.01B above.
- C. Submittal shall indicate full load efficiencies and minimum power factor.

PART 2 - PRODUCTS

2.01 SINGLE PHASE MOTORS (THRU 0.5 HP)

- A. Single Phase Motors shall have the highest energy efficiency available, permanent split-capacitor where possible or as approved. Provide capacitor start or two-capacitor type motor for high torque applications. Provide automatic resetting in-built thermal protection unless otherwise specified.

2.02 THREE PHASE MOTORS (3/4 HP AND ABOVE)

- A. Motors three quarter horsepower and larger shall be three phase unless specifically noted otherwise on the drawings. Motors may be open drip proof or totally enclosed fan cooled.
- B. Motors shall be designed for Premium Efficiency and tested in accordance with IEEE 112, Test Method B. The Guaranteed Minimum Efficiency values shall be equal to or greater than the qualifying levels listed in Table M1.
- C. Motors shall have a service factor of not less than 1.15.
- D. Motors shall be T-Frame unless otherwise specified.
- E. Motors shall not exceed 1800 RPM as standard whenever possible unless otherwise specified.
- F. Motors shall be constructed using Class "F" Insulation.
- G. Motors shall be designed with a Class "B" temperature rise over an Ambient temperature of 40°C.
- H. Motors shall utilize greaseable bearings.
- I. Motors shall utilize NEMA Design B as standard whenever possible. NEMA Designs C and D may be used when appropriate for special applications. Motors shall not utilize NEMA Design A unless specifically approved by the specifying engineer.
- J. Specialty motors shall be of the highest efficiency available. The motor construction, i.e. design, type, frame, RPM, etc., shall be as appropriate for the application in question while providing reliability and long life expectancy.
- K. Motor nameplate voltage shall match the Nominal System Voltage as closely as possible.
- L. Motors over 5 horsepower shall have grounded rotors where used with variable frequency drives.

M. Efficiencies: Motors shall have efficiencies meeting or exceeding the following:

OPEN DRIP PROOF (ODP) 3 HP AND ABOVE

1800 RPM

MOTOR SIZE	GUAR.	NOMIN
3	86.5	88.5
5	87.5	89.5
7.5	88.5	90.2
10	89.5	91.0
15	91.0	92.4
20	91.0	92.4
25	91.7	93.0
30	92.4	93.6
40	93.0	94.1
50	93.0	94.1
60	93.6	94.5
75	94.1	95.0
100	94.1	95.0
125	94.5	95.4
150	94.5	95.4
200	95.6	95.4

TOTALLY ENCLOSED FAN COOLED (TEFC) 7-1/2 HP AND ABOVE)

1800 RPM

MOTOR SIZE	GUAR.	NOMIN
7.5	89.5	91.0
10	89.5	91.0
15	91.0	92.4
20	91.0	92.4
25	92.4	93.6
30	92.4	93.6
40	93.0	94.1
50	93.0	94.1
60	93.6	94.5
75	94.1	95.0
100	94.5	95.4
125	94.7	95.6
150	95.0	95.8
200	95.0	95.8

N. Manufacturers

1. Baldor Super E
2. General Electric Energy Saving CI
3. Louis-Allis Spartan
4. Reliance Duty Master E-2000 or XE
5. Marathon Blue Chip XRI
6. Siemens PE 21+
7. Toshiba EOP

PART 3 - EXECUTION

3.01 MOTOR SIZING

- A. Motors shall be rated for 1.15 service factor but shall be selected for operation within their full load rating without applying the service factor.

END OF SECTION

SECTION 22 05 19 - METERS AND GAUGES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide thermometers and pressure gauges in the piping systems where shown on the drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Domestic Water Piping System: Section 22 11 16
- C. Domestic Water Pumps: Section 22 11 23

1.03 SUBMITTALS

- A. Submit shop drawings on each gauge and thermometer type to be used on this project in accordance with Specifications Section 22 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES - STANDARD

- A. Dial size: 4"
- B. Case: open front style, phenol or stainless steel
- C. Bourdon tube: bronze
- D. Connection: lower or back as required
- E. Accuracy: within 1% of scale range
- F. Range: refer to Application - Part 3: Execution
- G. Manufacturers
 - 1. Ashcroft
 - 2. Viking
 - 3. Weiss Instruments
 - 4. Weksler
 - 5. Terice

2.02 PUMP PRESSURE GAUGES - GLYCERIN FILLED

- A. Dial size: 4"
- B. Case: open front style, stainless steel
- C. Ring: stainless steel, bayonet type
- D. Mounting: stem
- E. Bourdon tube: stainless steel
- F. Connection: lower or back as required
- G. Window: glass
- H. Dial: acrylic coated, white aluminum
- I. Pointer: micrometer adjustable; black aluminum
- J. Movement: stainless steel
- K. "O" Ring: Buna-N Sealant: RTV
- L. Accuracy: $\pm 1\%$ of scale range
- M. Range: refer to Application - Part 3: Execution
- N. Manufacturers:
 - 1. Ashcroft
 - 2. Weiss Instruments Inc.
 - 3. Weksler
 - 4. Terice

2.03 THERMOMETERS

- A. Dial Size: 5"
- B. Case: Open front style; black; phenol or stainless steel
- C. Coil: Bi-metal
- D. Separable sockets: brass with extension neck
- E. Stem: 3/4" to 1" NPT
- F. Stem Length: Maximum allowable for pipe size up to 6" immersion
- G. Tube and capillary: silicone filled
- H. Accuracy: within 1% of scale range

- I. Range: Refer to Application - Part 3: Execution
- J. Manufacturers
 - 1. American
 - 2. Trerice
 - 3. Weiss Instruments Inc.
 - 4. Weksler
 - 5. Weston

2.04 THERMOMETERS

- A. Solar powered, digital readout thermometer with 1% accuracy; 3/8" LCD digits; adjustable mounting for ease of visibility.
 - 1. High impact ABS case
 - 2. -40°F to 300°F range
 - 3. 1/10° resolution between -19.9°F to 199.9°F.
 - 4. Internal potentiometer recalibration
 - 5. 10 LUX (1 foot candle) rating
 - 6. Readout updates every 10 seconds
 - 7. Ambient operating range of -30°F to 140°F at up to 100% relative humidity with zero error.
 - 8. Glass passivated thermistor sensing element
 - 9. Bulb-in-well stem assembly
- B. Manufacturers
 - 1. Miljoco CDX93585
 - 2. Trerice
 - 3. Trend Instruments
 - 4. Weiss Instruments
 - 5. Weksler

2.05 THERMOMETERS

- A. Thermometer: V-shape design, 9" adjustable, blue spirit filled magnifying lens and reading tube.
- B. Mounting at 12'-1" AFF and above, use 12" scale
- C. Stem: 3/4" to 1" NPT
- D. Stem Length: maximum allowable for pipe size up to 6" immersion
- E. Accuracy: within 1% of scale range
- F. Range: Refer to Application - Part 3: Execution

- G. Manufacturers
 - 1. Ashcroft
 - 2. Miljoco 5X935B
 - 3. Terice
 - 4. Weiss Instruments

PART 3 - EXECUTION

3.01 PRESSURE GAUGES - INSTALLATION/APPLICATION

- A. Connection in piping: provide a 1/4" ball valve ahead of each gauge. Mount gauges for maximum visibility.
- B. Scale range for domestic cold water system: 0-100 psig.

3.02 THERMOMETERS - INSTALLATION/APPLICATION

- A. Connection in domestic hot water system piping: brass well with male threaded NPT connection and lagging extension neck. Mount wells in vertical up position to facilitate their being filled. Use glycerin filled for test purposes only.
- B. Scale range for domestic hot water system: 20°F - 240°F.

3.03 LOCATION REQUIREMENTS

- A. Provide glycerin filled pressure gauges at inlet and outlet of pumps.
- B. Provide standard pressure gauges at all locations shown on drawings.
- C. Provide ancillary thermometers where shown on drawings.
- D. Provide thermometer on domestic water heater inlet and outlet pipes.
- E. Provide thermometer on inlet and outlet pipes of domestic water at thermostatic mixing valve.
- F. Provide thermometer on the inlet side of the domestic hot water circulation pump(s).
- G. Provide pressure gauge on outlet side of domestic water service backflow preventers.
- H. Provide pressure gauge on air compressor discharge piping.
- I. Provide pressure gauge in compressed air piping at one representative location in each room containing distribution outlets. Consult with Designer.

END OF SECTION

SECTION 22 05 29 - BASIC PIPING REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Pipe Hangers and Supports
- B. Sleeves and Plates
- C. Installation of Piping Systems
- D. Fire Stop Sealants

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Identification of Piping and Equipment: Section 22 05 53
- D. Plumbing Pipe and Equipment Insulation: Section 22 07 19
- E. Domestic Water Piping System: Section 22 11 16
- F. Sanitary Waste and Vent Piping: Section 22 13 16
- G. Natural Gas Piping System: Section 22 70 16

1.03 COORDINATION DRAWINGS

- A. Coordination Drawings are required on this project.
 - 1. Piping systems coordination drawings as defined below are used to obtain complete coordination with all other trades.
 - 2. Prepare coordination drawings of all piping systems, and above. Drawings to reflect all offsets and routing adjustment required as a result of coordination with structural, ductwork and other trades. Note bottom of pipe elevations above finish floor.

B. Drawings:

1. Submit drawings for Engineer's approval prior to installation. Refer to Specifications Section 22 05 01, General Provisions and Division 1 for submission requirements.
 - a. Drawings shall be prepared utilizing AutoCAD or Revit. Contact the Architect to obtain generic floor plans. Engineers' drawings are not intended for use as coordination drawings.
 - b. Drawings shall be minimum scale of $1/4" = 1'-0"$ for floor plans. Include sections and elevations of all pipe offsets or risers.
 - c. Coordinate the routing with all other trades and the structural/architectural drawings during drawing development period. Detail all areas requiring close or critical coordination points on the drawings.
2. Thoroughly review all construction documents to verify all routings, heights, and locations of all piping. Visit the job site and field verify all routings, heights, and locations. Notify the Engineer of any conflicts and proposed coordinated solutions.
3. For remodeled areas the Contractor shall visit the job site and field verify all routings, heights, and locations of all piping. Notify the Engineer of any conflicts.
4. Completed drawings shall be submitted to General Contractor, Mechanical Contractor, Sprinkler Contractor, Sheet Metal Contractor, Temperature Control Contractor, and Electrical Contractor for their coordination and impact to the final layouts. Prepare any drawing corrections required to obtain a coordinated layout. Provide sufficient sets of drawings for distribution.
5. No pay requests for installed work will be honored until fully coordinated drawings are accepted by the Owner.

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Section 22 05 01, General Provisions for all products in this section including pipe hangers and supports, fire stops, etc.
- B. Submit shop drawings which indicate complete material data, a list of materials proposed for this project.

1.05 GENERAL PIPE SYSTEM INSTALLATION REQUIREMENTS

- A. Fabricate and install all pressure piping systems in accordance with the procedures established in the ANSI B31 Code. Materials and fittings shall be as defined by the applicable standards of ANSI, ASHRAE, ASME, AWWA, API, NPC, Plumbing Code, etc.

- B. Provide fittings in accordance with the ANSI B16 Code for all changes in direction, elevation or size. No mitered joints or pipe bends will be permitted. Reduction of pipe size shall be by reducing fittings or couplings. Bushings will not be permitted.
- C. Each length of pipe, fitting and item shall be marked with the manufacturer's name and material identification.
- D. Install all piping to present a neat and orderly appearance. Run all lines parallel with building walls and construction. Keep piping free from contact with structure or equipment to prevent noise transmission, allowing clearance for expansion and contraction. Offset piping, in approved manner, where required to avoid interference with other work, to increase headroom under piping or to improve appearance of the work.
- E. Anchor piping as required to prevent undesirable movements.
- F. Provide ample space between piping and construction for proper insulation covering thickness.
- G. Provide adequate protection for piping and equipment against freezing.
- H. Provide eccentric reducing couplings in all cases where air or water pockets would occur due to a reduction in pipe size. Do not use bushings.
- I. Use dielectric couplings or waterway fittings when joining dissimilar piping materials.
- J. Pipes passing through exposed construction shall be provided with escutcheons or other seals as described herein. Exposed escutcheons in finished areas shall have a chrome finish.
- K. Penetrations of fire rated walls, floors, roofs and ceilings are to be made with rated fire stops equal/exceeding the fire rating of the building separation being penetrated.
- L. The installation of exposed polyvinylchloride pipe (PVC) materials shall not be permitted for use in plenums and shafts serving supply or return air streams of the building's ventilation system. Where PVC is approved for use elsewhere in specifications, and PVC is used in return air plenums and shaft, PVC piping must be wrapped with 3-M plenum wrap material.

1.06 PIPING SYSTEMS WARRANTY

- A. Maintain integrity of all piping systems through warranty period, repairing all leaks.
- B. Warranty work shall include repair/replacement of building materials and finishes damaged by leak(s).

- C. All damage resulting from leaking pipes shall be paid for by the installing Contractor.

1.07 CLEARANCE FROM ELECTRICAL EQUIPMENT

- A. Piping is prohibited in electric and telephone rooms and closets, elevator machine rooms, and for installations over or within 6 ft. of transformers, substations, switchboards, motor control centers, standby power plants, and motors.
- B. Branch piping to equipment is acceptable when installed over or within 6 ft. of motors.

1.08 DRIP PANS

- A. Provide drip pans under piping when installation is over or within 6 ft. of electrical apparatus is unavoidable, or in rooms containing electrical equipment, or under drainage piping at ceilings of food preparation areas. Pans shall be reinforced, properly supported and made watertight. Provide enclosed type pans for pressure piping. Extend 1-1/2 in. drainpipe from pans to spill over nearest floor drain or as indicated.

PART 2 - PRODUCTS

2.01 PIPING SYSTEM MATERIALS

- A. All pipe hangers and supports shall conform to the latest requirements of ANSI Code for Pressure Piping B 31.1

2.02 PIPE HANGERS (UNINSULATED PIPE)

- A. Hangers: Steel and cast iron pipe
 - 1. 2" and smaller: adjustable clevis, light weight
 - a. Anvil Fig. 65
 - b. PHD Fig. 440
 - 2. Larger than 2": adjustable clevis
 - a. Anvil Fig. 260
 - b. PHD Fig. 450
- B. Hangers: Copper pipe
 - 1. 2" and smaller: copper plated adjustable split ring
 - a. Anvil Fig. CT-109
 - b. PHD Fig. 502

2. Larger than 2": copper plated adjustable clevis
 - a. Anvil Fig. CT-65
 - b. PHD Fig. 502
- C. Riser clamps: Steel and cast iron pipe
 1. Anvil Fig. 261
 2. PHD Fig. 550
- D. Riser clamps: Copper pipe
 1. Anvil Fig. CT-121
 2. PHD Fig. 552
- E. Floor supports: Steel and cast iron pipe
 1. 2" and smaller: U-bolt on structural steel channel secured to floor with angle clips
 - a. Anvil Fig. 137
 - b. PHD Fig. 90
 2. Larger than 2": Adjustable pipe saddle
 - a. Anvil Fig. 264
 - b. PHD Fig. 875
- F. Floor supports: Copper pipe, 2" and smaller: U-bolt on structural steel channel secured to floor with angle clips
 1. Anvil Fig. 120
 2. PHD Fig. 95
- G. Roof supports: Steel and cast iron pipe
 1. 2" and smaller: U-bolt on structural steel channel secured to prefabricated roof supports
 - a. Miro #3-RAH-7
 - b. PHD Fig. 90
 - c. Rooftop Blox #RTB-01
 2. larger than 2": Adjustable pipe saddle
 - a. Miro #3-RAH-7
 - b. Rooftop Blox #RTB-01
- H. Roof supports: Copper pipe, 2" and smaller: U-bolt on structural steel channel secured to prefabricated roof support.
 1. Miro #3-RAH-7
 2. Rooftop Blox #RTB-01

- I. Supports at walls or columns: Cast iron or steel brackets properly selected to support weight suspended.
1. Anvil Fig. 194, 195, 199, 202
 2. PHD Fig. 850, 855, 860
- J. Trapeze hangers: Where parallel pipes may be grouped at approximately the same elevation, supports of unistrut, structural steel angles or channels with rods of sufficient strength to support weight can be used. Provide double nuts on support rods, angles, and channels. Review weights with the Structural Engineer on this project.
1. Secure individual pipes on trapeze with U-bolts specified above.
 2. Uninsulated pipes shall be isolated from the trapeze support with cradles.
 3. After final height is established, trim all excess thread rod supports under trapeze hangers to not exceed $\frac{1}{2}$ " length.
 4. MSS SP-69, Type 59, shop, or field-fabricated assemblies constructed of structural steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.
- K. Roller supports: Provide adjustable type roll hangers properly braced to prevent hanger movement of roll stands as applicable.
1. Roller hangers
 - a. Anvil Fig. 181
 - b. PHD Fig 470
 2. Roller stands
 - a. Anvil Fig. 177
 - b. PHD Fig. 480
- L. Rods: Galvanized steel, all threaded hanger rods; threaded both ends

<u>PIPE SIZES</u>	<u>ROD DIAMETER</u>
2" and smaller	3/8"
2.5" to 3.5"	1/2"
4" and 5"	5/8"
6" and 8"	3/4"
10" and 12"	7/8"
14" and 18"	1"
20" and larger	1-1/4"

- M. Turnbuckles: where required to adjust pipe elevation.

N. Beam Clamps

1. To 400 pounds loading, hardened steel point set screw; 6" pipe malleable iron clamp
 - a. Anvil Fig. 86
 - b. PHD Fig. 270
 - c. Anvil Fig. 87 (clamp with retaining clip)
2. To 1,300 pounds loading, malleable iron jaw, steel tie rod, center load.
 - a. Anvil Fig. 218 (FM listed)
 - b. PHD Fig. 630
3. To 11,000 pounds loading, forged steel: Anvil Fig. 292 Observe Manufacturer's stress limits.

O. Pipe Rollers

1. Non adjustable roller stand, cast iron
 - a. 2-12 inch pipe
 - (1) Anvil Fig. 175
 - (2) PHD Fig. 460
 - b. 14-42 inch pipe: Anvil Fig. 271
2. Adjustable roll support, cast iron roll on steel rod, 1 to 30 inch pipe.
 - a. Anvil Fig. 177
 - b. PHD Fig. 480

2.03 PIPE HANGERS (INSULATED PIPE)

- A. Provide hanger and support materials as specified for uninsulated pipe but with the following exceptions:
1. Size hanger ring to fit outside insulation
 2. Copper plated rings are not required
 3. Pipe insulation is to extend uninterrupted at hangers.
 4. Provide pipe insulation shields at each hanger.
- B. Insulation cradles:
1. Provide hard wood cradles on all insulated domestic water pipe services sized for the insulation thickness.
 2. Provide hard wood (oak, etc.) cradles on all insulated waste and storm water pipe sized for the insulation thickness. The insulation vapor barrier is to encompass the wood block. Wood cradles shall be 6" in length.

2.04 ANCHORS AND GUIDES

- A. Provide anchors and guides as required and/or where shown on the drawings.

- B. Guides shall be Flexonics Flexon pipe alignment guide or approved equal.

2.05 SLEEVES AND PLATES (ESCUTCHEONS)

- A. Schedule of Sleeve Usage
 - 1. All sleeves through concrete walls shall be Schedule 40 PVC pipe.
 - 2. All sleeves through wall board, drywall, plasterboard or wall panels shall be 20 gauge galvanized steel.
 - 3. All sleeves through masonry walls, metal roof deck, concrete floors on grade and metal deck shall be Schedule 40 galvanized steel pipe.
- B. Special sleeves and sealing as shown on drawings.
- C. Plates shall be chromium plated for finished areas and plain cast iron elsewhere.

2.06 FIRE STOP SEALANTS

- A. Penetration Sealants
 - 1. Dow Corning "Firestop Foam" and "Firestop Sealant"
 - 2. Insta-Foam Products, Inc. "Insta-Foam Seal Silicone RTV Foam"
 - 3. 3M Brand "Fire Barrier" Caulk
 - 4. 3M Brand Moldable Putty "Pads" and Moldable Putty "Stix"
- B. Intumescent sealants for use in openings and sleeves involving plastic pipe, insulated pipe or flexible cable:
 - 1. Dow Corning "Firestop Intumescent Wrap Strip"
 - 2. Fox Coupling, Inc. "Cast-In-Place Firestop Coupling"
 - 3. 3M Brand "Fire Barrier" Caulk with FS-195 wrap strip and CS-195 composite sheet.

2.07 PEX PIPE HANGERS

- A. Single pipe horizontal hangers shall be nylon pex tubing suspension clip with dual anchor points.
- B. Multi-pipe horizontal hangers shall be nylon pex tubing suspension clips with dual anchor points mounted on trapeze channel.
- C. Single pipe vertical hangers shall be metal economy pex tubing clamp.

2.08 PIPE SHIELD PLATES

- A. Provide protective pipe shield plates of minimum 16 gauge steel.
- B. Pipe shield plates are required where concealed piping, other than cast iron or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1.5 inches (38 mm) from nearest edge of member.

- C. Shield plates shall cover the area where pipe passes through frame member and extend 2 inches beyond in each direction.
- D. Manufacturers:
 - 1. Concord Carpenter
 - 2. Simpson
 - 3. Or approved equal

PART 3 - EXECUTION

3.01 HANGERS AND SUPPORTS

- A. General
 - 1. Furnish and install supports, guides, anchors and sway braces required for proper installation and support of pipelines.
 - 2. Pipe suspensions shall prevent excessive stress and excessive variation in supporting force. Fabrication and installation of supports for pipelines shall not constrain piping to cause excessive 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. Piping systems where flexibility is not desired shall be supported by rigid hangers.
- B. Vibration and Noise Transfer Control
 - 1. 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 supports themselves or through addition of flexible piping connectors or auxiliary equipment.
- C. Pipe Hanger and Supports
 - 1. The following piping must be suspended by individual pipe hangers, rather than being suspended with other piping on trapeze type supports.
 - a. All sanitary waste and vent piping
 - b. All storm water piping
 - c. All relief piping terminating over indirect waste
 - 2. Piping, other than as specified above, may be suspended by individual pipe hangers or where two or more pipes are paralleling each other at same elevation, Contractor may at his option support them on common trapeze bars. Construct of structural steel angles or channels with rods of sufficient strength to support weight and of design satisfactory to the Owner. Use U-bolts for securing individual pipes in trapeze. Under no circumstances shall piping be supported from other piping.
 - 3. Where smaller piping must be suspended closer to overhead construction than is possible with single rod hangers, use double rod supports.

4. Spacing

a. All pipe hanger spacing specified below are also applicable to trapeze hangers. Spacing shall be determined by smallest pipe among pipes carried on trapeze.

b. Spacing of hangers or supports for steel pipe as scheduled below.

PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
Thru 1"	6'-0"	10'-0"
1-1/4" thru 2"	10'-0"	15'-0"
2-1/2" and above	12'-0"	15'-0"

c. Spacing of hangers or supports for cross-linked polyethylene (PEX) pipe.

PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
1/2" thru 2"	2'-8"	5'-0"
2-1/2" and above	2'-8"	10'-0"

d. Spacing of hangers or supports for CPVC pipe or tubing.

PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
1/2" thru 1"	3'-0"	5'-0"
1-1/4" thru 2"	4'-0"	5'-0"
2-1/2" and above	4'-0"	10'-0"

e. Spacing of hangers or supports for copper pipe as scheduled below.

PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
Thru 3/4"	5'-0"	5'-0"
1" and 1-1/4"	7'-0"	10'-0"
1-1/2" to 3"	9'-0"	10'-0"
4" to 8"	12'-0"	10'-0"

f. Spacing of hangers or supports for cast iron pipe as scheduled below. Place hanger close to joint.

PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
1-1/2" and above	5'-0"	15'-0"

4" and above in 10'-0" length	10'-0"	15'-0"

- g. Spacing of hangers or supports for polypropylene (PP) pipe or tubing as scheduled below.

PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
1/2" thru 1"	2'-8"	5'-0"
1-1/4" thru 2"	4'-0"	5'-0"
2-1/2" and above	4'-0"	10'-0"

- h. Spacing of hangers and support for PVC piping as scheduled below.

PIPE SIZE	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
1/2" thru 2"	4'-0"	5'-0"
2-1/2" and above	4'-0"	10'-0"

- i. Provide hanger or support at all valves, tees and elbows.
 j. Avoid binding or cramping pipe in racks or spaces that would limit natural flexing of CPVC, PEX, PP or PVC pipe.

D. Securing Hangers and Supports at Building Construction

1. Provide as required steel or malleable iron inserts in poured concrete construction. Maximum load which may be applied to any one foot length of continuous insert shall not exceed 1000 pounds.
2. Where piping is suspended from masonry construction, use expansion shields to attach pipe supports to construction. Expansion shield bolt diameter the same size as the support rod diameter specified.
3. 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 beam clamps made of heavy steel forged to fit structural member (I-beam, angle, channel) and securely fastened in place. No building member to be drilled, welded, cut or otherwise deformed in attaching pipe supports unless approved by the Engineer.
4. Where existing masonry is not suitable to receive and hold expansion shields or where other means of attachment is advantageous, the Contractor shall submit alternate method for approval to Engineer.
5. Do not suspend hangers from deck. Suspend from structural framing members in an approved and workmanlike manner.
6. Provide additional bracing and support wherever needed, in opinion of the Engineer. Install structural steel members, attached to building framing, where required, to provide additional points of support. Drill building structural and miscellaneous steel only as directed by the Engineer.

E. Vertical Pipe Hangers

1. Support vertical runs under 10'-0" long with hanger adjacent to elbows and at any floor penetration.
2. Support vertical runs over 10'-0" long with riser clamps. Weld clamps to pipe and support on pipe sleeve or building structure. Space clamps at every floor.
3. Provide supports at the bottom of risers 8" and larger with structural steel supports of a Structural Engineer approved design. Secure to floor with angle clips.

3.02 PIPE SLEEVES

- A. Furnish, locate and set pipe sleeves where piping passes through floors, walls and other concrete or masonry structural materials except where tunnels, chases or shafts are provided in the construction.
- B. Wall Sleeves
1. Below Grade
 - a. Sleeves set in walls below finished grade, in which one side is open to a space within the building, shall be provided with a water stop/collar which will seal against the passage of water between the sleeve and concrete. Sleeves shall be sized to finish flush with face of wall. Manufacturer "Century Line Sleeves" or approved equal.
 - b. Sleeves shall be installed where pipes pass under or through footings, grade beams or other structural bearing walls existing or new.
 2. Above Grade: Sleeves set in walls above grade shall be sized to finish flush with face of walls and shall be constructed of material which is equal to or greater than the fire rating of the wall.
- C. Floor Sleeves: Floor sleeves shall extend 1-1/2" above finished floor in chases and mechanical spaces. Sleeves shall extend to 3" above finished floors in areas such as kitchens, food preparation, dishwashing and laboratory areas. Sleeves shall be flush with finish floor in occupied spaces.
- D. Sleeves shall be in accordance with the following schedule unless otherwise specified.

SLEEVE SCHEDULE

<u>PIPE SIZE</u>	<u>UNINSUL.</u>	<u>1" INSUL.</u>	<u>1-1/2" INSUL.</u>	<u>2" INSUL.</u>
1"	2"	4"	6"	6"
1-1/2"	3"	4"	6"	8"
2"	3"	6"	8"	8"
3"	4"	6"	8"	10"
4"	6"	8"	10"	10"

6" 8" 10" 12" 12"

- E. The void between the sleeve and wall, and the pipe or insulation jacket shall be neatly filled with an approved fire stop material.

3.03 PIPE SHIELD PLATES

- A. In concealed locations where piping, other than cast-iron or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1.5 inches (38 mm) from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 0.062 inch-thick (1.6mm) steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches (51 mm) above sole plates and below top plates.

3.04 UNION AND FLANGES

- A. Provide at intervals and locations where they will facilitate disconnection and removal of piping at all valves, at connections to equipment and elsewhere as shown.
- B. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

3.05 APPLICATION OF FIRE STOP SEALANTS

- A. Prepare and apply preparation sealing system in accordance with manufacturer's printed instructions.
- B. Employ installation techniques which will ensure that fire-stopping is deposited to fill and seal holes and openings.
 - 1. Provide flame (F) rating minimum one-hour, but not less than fire resistance rating of the assembly in which it is installed, per ASTM E-814.
 - 2. Ensure effective smoke seal.
- C. Tool exposed surfaces of applied sealant smooth.

3.06 VALVE INSTALLATION

- A. Furnish and install valves as specified in domestic water specification.
- B. Unless specifically otherwise indicated, provide valves in accordance with the following:
 - 1. Shut-off valves shall be provided at each piece of equipment
 - 2. Valves same size as lines in which they are installed.
 - 3. Valves in each service branch at point where it leaves main.
 - 4. All valves 2" and smaller shall be threaded.
 - 5. Install a union just downstream of all threaded valves.

- 6. Provide valve stem extensions on all insulated valves.
- 7. Install a line size valve on both sides of balance valves.
- C. Install valves with stems vertical where possible but in no case lower than horizontal position.
- D. Where locations of valves are not shown in detail, install valves in accessible positions arranged for easy access.
- E. Provide chain wheels with guides, and extension stem hand-wheels, for convenient operation of frequently used valves located above 7 feet from floor in mechanical room(s).
- F. Where mixing faucet assemblies with shutoff control located downstream of the mixer are furnished by others (i.e.: hose spray assemblies). Contractor shall coordinate and provide necessary check valves with unions and appurtenances required.

END OF SECTION

SECTION 22 05 40 - TRENCHING, BACKFILLING AND COMPACTING (EXTERIOR)

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Domestic Water Piping System: Section 22 11 16
- C. Sanitary Waste and Vent Piping: Section 22 13 16

1.02 SCOPE

- A. Work in this section pertains to that located outside the building and to a coordinated point (5'-0") outside the exterior wall.

1.03 REFERENCES

- A. The latest issues of the following American Society of Testing Materials' documents form a part of this specification to the extent hereinafter.
 - 1. D698 Standard Proctor Maximum Dry Density
 - 2. D1556-64 Density of Soil in Place by the Sand Cone Method
 - 3. D2167-66 Density of Soil in Place by the Rubber Balloon Method

1.04 DELIVERY, STORAGE AND HANDLING

- A. Imported materials shall be stockpiled on site where directed if not ready for installation. Maintain segregation of differing materials.
- B. Do not deliver materials until ready for incorporation into the permanent work. Storage space is not available.

1.05 TRENCH CONDITIONS

- A. Protection of trench surrounding structures, surfaces, and equipment:
 - 1. Embankments and excavations shall be kept shaped and drained.
 - 2. Ditches and drains along the subgrade shall be maintained in such a manner as to drain effectively at all times.
 - 3. Operate pumping equipment as required to keep the excavation free of water, firm and undisturbed until approval of the permanent work has been received from the Owner/Engineer.
 - 4. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped if required and recompact prior to the placing of surfacing.
 - 5. The storage or stockpiling of materials on a finished subgrade will not be permitted.

6. Erosion control shall be performed by this Contractor until the installation of permanent vegetation, structures, and erosion control devices.
7. Provide adequate shoring and brace excavations as necessary to prevent cave-ins and excessive settlement
8. Do not use mechanical excavation equipment within two feet of existing piping, appurtenances, structural columns, footings, and grade beams.
9. Damage of piping, structures or surfaces as mentioned above shall be repaired or replaced by the appropriate trades at the expense of the Contractor.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Select Aggregate: No. 14-2 sand (required where PVC or CPVC is used).
- B. #12 crushed stone with fines

PART 3 - EXECUTION

3.01 INSPECTION

- A. Before commencement of work, verify the following with the documents associated with all work below grade.
 1. Verify installation of fences.
 2. Protective fencing for trees and plants has been installed as specified.
 3. Existing structural conditions near trenches.
 4. Demolition of miscellaneous structures (i.e. manholes).
 5. Clearing and grubbing.
 6. Stripping and disposal of sod and stripping and stockpiling of topsoil.
 7. Means, methods, and routing of transporting materials.

3.02 PREPARATION

- A. Layout the various lines on the floor with a washout type paint in areas subject to traffic or a chalk line where not subject to traffic.
- B. Do not proceed with excavation until layout is approved.
- C. Set line and grade stakes as required or specified in the various sections covering the installation of piping.

3.03 TRENCHING

- A. General: All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified.

- B. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the edge of the floor cut. All slab and excavated materials not required or suitable for backfill shall be removed. Sheeting and shoring shall be placed as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if the pipe can be safely and properly installed and backfill can be properly compacted in such tunnel sections. Where specifically allowed, tunneled pipe shall be in accordance with the Uniform Plumbing Code.
- C. Trench Excavation: Trenches shall be of the necessary width for proper laying of pipe. The banks of pipe trenches shall be as nearly vertical as practical. Care shall be taken not to over-excavate unless the trench bottom is of a non-compressible material (i.e. rock, etc.), refer to over-excavation described below when required. The bottom of the trenches shall be accurately graded to provide a uniform surface for the type of bedding specified. Stones shall be removed as necessary to avoid point bearing. Except as hereinafter specified for wet or otherwise unstable material, over-depths shall be backfilled with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such material shall be over-excavated to a depth to allow for construction of a stable pipe bedding. Bedding shall be a minimum of 6" deep.
- D. Special requirements for specific systems.
 - 1. Storm, waste and vent piping: The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not exceed eight inches on either side of the pipe. The width of the trench above that level shall be as wide as necessary for the proper performance of the work. The bottom of the trench shall be rounded so that at least the bottom quadrant of the pipe shall rest firmly on undisturbed soil for as near the full length of the barrel as proper jointing operations will permit. This part of the excavation shall be done manually, only a few feet in advance of the pipe laying.
 - 2. Water Lines: Unless otherwise indicated, trenches shall be graded to avoid high points which necessitate placing vacuum and relief valves in the lines. Maintain minimum vertical and horizontal distances between water and sewer piping as required by local code.
 - 3. Excavation for Appurtenances: Excavation for pits, tanks and similar structures shall be sufficient to leave at least 12" clear space between the outer surface of structure and the bank or timber that may be used to hold and protect the banks. Any over-depth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with sand, gravel or concrete as directed at no additional cost to the Owner.

3.04 PAVEMENT REMOVAL AND REPLACEMENT

- A. Where construction requires cutting and replacing of flexible pavement, cutting shall be so accomplished that the remaining exposed edges shall conform vertically and horizontally to a straight line. Width of the section of pavement removed shall be of necessary width for proper laying of pipe or duct. After the pavement is removed to its full depth, the surface course shall be cut back one foot on both sides of the trench with a concrete saw to provide a true joint in the surface courses. Pavement removed shall be replaced to the same section, materials, and compaction as the original pavement. Waste materials shall be disposed of by the Contractor offsite at his responsibility.
- B. Where construction requires removal and replacement of rigid pavement, the cutting shall be accomplished by a concrete saw, minimum depth of vertical cut shall be one inch. The remaining depth of section may be broken out in any approved manner. Width of section removed shall be such that no area of pavement removed or replaced and no adjacent slab or portion of slab which remains in the pavement abutting the replacement slab shall have length or width between joints of less than 10 feet. Pavement removed shall be replaced to the same section using Class E concrete. Concrete rubble resulting from the above operations shall be disposed of offsite at the Contractor's responsibility.

3.05 BACKFILLING

- A. General: After bedding, the trenches shall not be backfilled until all required pressure tests are performed. Where damage is likely to result from withdrawing sheeting, the sheeting will be approved to be left in place and the contract price will be adjusted accordingly. Except as otherwise specified for special conditions of over-depths, trenches shall be backfilled to the ground surface with selected material as hereinafter specified. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified or the condition shall be restored to its original condition as near as practical and as hereinafter specified.
- B. Backfilling of trench: Backfill material shall be deposited in 6" maximum thickness layers and compacted with suitable tampers to the specified density as described in Specifications, Division I. If any portion of the cover in the lower portion of the trench is in the depth of special compaction and materials requirements under pavement, the special requirements shall control. Special care shall be taken not to damage the coating or wrapping of pipes.
- C. Backfilling remainder of trench: Except for special materials for pavements, the remainder of the trench shall be backfilled with excavated material that is free of stones larger than three inches or one half the layered thickness, whichever is smaller, in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified hereinafter and each layer shall be compacted to the minimum density specified hereinafter as applicable to the particular area.

- D. Backfilling under Roadways, Parking Areas and Walks: Six inch layers, at least 95% of maximum density at moisture contents ranging from 1% below to 4% above optimum up to the elevations at which the requirements for pavement subgrade materials and compaction control.
- E. Under sodded or seeded areas: Twelve inch layers, at least 88% of maximum density at moisture contents ranging from 1% below to 4% above optimum up to the elevation at which topsoil requirements control.
- F. Topsoil placement: Placement and depth as indicated on the drawings or described herein. Contractor shall overfill by 20% to allow for settlement.

3.06 TESTS

- A. Tests for and Control of Density: Tests for determination of maximum density and optimum moisture shall be performed by the Testing Agency in accordance with the requirements of ASTM D698 Standard Proctor maximum dry density. Samples shall be representative of the materials to be placed. An optimum moisture density curve shall be obtained for each principle type of material or combination of materials encountered or utilized. Results of these tests shall be the basis of control for compaction. The above testing shall include Atterberg limits, grain size determinations and specific gravity.
- B. Test for Density Control: The Testing Agency will control the density of the backfill by test made in accordance with ASTM Standard D1556. A density test shall be made for each foot of fill for each 200 lineal feet or less of trench. The Contractor shall make as many additional tests as he requires to obtain the specified density at all points.

END OF SECTION

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SECTION 22 05 41 - TRENCHING, BACKFILLING AND COMPACTING (INTERIOR)

PART 1 - GENERAL

1.01 RELATED WORK

- A. General Provisions: Section 22 05 01
- B. Domestic Water Piping System: Section 22 11 16
- C. Sanitary Waste and Vent System: Section 22 13 16

1.02 SCOPE

- A. Work in this section pertains to that located within the building and to a coordinated point beyond the exterior wall.

1.03 REFERENCES

- A. The latest issues of the following American Society of Testing Materials' documents form a part of this specification to the extent hereinafter.
 - 1. D698 Standard Proctor Maximum Dry Density
 - 2. D1556-64 Density of Soil in Place by the Sand Cone Method
 - 3. D2167-66 Density of Soil in Place by the Rubber Balloon Method

1.04 DELIVERY, STORAGE AND HANDLING

- A. Imported materials shall be stockpiled on site where directed if not ready for installation. Maintain segregation of differing materials.
- B. Do not deliver materials until ready for incorporation into the permanent work. Storage space is not available.

1.05 TRENCH CONDITIONS

- A. Protection of trench surrounding structures, surfaces and equipment:
 - 1. Embankments and excavations shall be kept shaped and drained.
 - 2. Operate pumping equipment as required to keep the excavation free of water, firm and undisturbed until approval of the permanent work has been received from the Engineer.
 - 3. Provide adequate shoring and brace excavations as necessary to prevent cave-ins and excessive settlement
 - 4. Do not use mechanical excavation equipment within two feet of existing piping, appurtenances, structural columns, footings and grade beams.
 - 5. Damage of piping, structures or surfaces as mentioned above shall be repaired or replaced by the appropriate trades at the expense of this contractor.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Select Aggregate: No. 14-2 sand (required where PVC or CPVC pipe is used)
- B. #12 crushed stone with fines

PART 3 - EXECUTION

3.01 INSPECTION

- A. Before commencement of work, verify the following with the documents associated with all work below grade.
 - 1. Type of existing floor and wall finishes.
 - 2. Existing structural conditions near trenches (i.e. load bearing walls, columns. etc.).
 - 3. Demolition of miscellaneous structures (i.e. manholes inside the building).
 - 4. Means, methods and routing of transporting materials in and out of building.

3.02 PREPARATION

- A. Lay out the various lines on the floor with a washout type paint in areas subject to traffic or a chalk line where not subject to traffic. Lay out lines must not be applied on carpet unless approval is given by the Owner.
- B. Do not proceed with excavation until layout is approved.
- C. Set line and grade stakes as required or specified in the various sections covering the installation of piping.

3.03 TRENCHING

- A. General: All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified.
- B. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the edge of the floor cut. All slab and excavated materials not required or suitable for backfill shall be removed. Sheet piling and shoring shall be placed as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if the pipe can be safely and properly installed and backfill can be properly compacted in such tunnel sections. Where specifically allowed, tunneled or directional bore pipe shall be in accordance with the Local Code.

- C. Trench Excavation: Trenches shall be of the necessary width for proper laying of pipe. The banks of pipe trenches shall be as nearly vertical as practical. Care shall be taken not to overexcavate unless the trench bottom is of a non-compressible material (i.e. rock, etc.), refer to overexcavation described below when required. The bottom of the trenches shall be accurately graded to provide a uniform surface for the type of bedding specified. Stones shall be removed as necessary to avoid point bearing. Except as hereinafter specified for wet or otherwise unstable material, overdepths shall be backfilled with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such material shall be overexcavated to a depth to allow for construction of a stable pipe bedding. Bedding shall be a minimum of 6" deep.
- D. Special requirements for specific systems.
1. Storm, waste and vent piping: The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not exceed eight inches on either side of the pipe. The width of the trench above that level shall be as wide as necessary for the proper performance of the work. The bottom of the trench shall be rounded so that at least the bottom quadrant of the pipe shall rest firmly on undisturbed soil for as near the full length of the barrel as proper jointing operations will permit. This part of the excavation shall be done manually, only a few feet in advance of the pipe laying.
 2. Water Lines: Unless otherwise indicated, trenches shall be graded to avoid high points which necessitate placing vacuum and relief valves in the lines. Maintain minimum vertical and horizontal distances between water and sewer piping as required by local code.
 3. Excavation for Appurtenances: Excavation for pits, tanks and similar structures shall be sufficient to leave at least 12" clear space between the outer surface of structure and the bank or timber that may be used to hold and protect the banks. Any overdepth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with sand, gravel or concrete as directed at no additional cost to the Owner.

3.04 CONCRETE FLOOR SLAB REMOVAL AND REPLACEMENT

- A. Where construction requires removal and replacement of concrete floor slab, the cutting shall be accomplished by a concrete saw, minimum depth of vertical cut shall be one inch. The remaining depth of section may be broken out in an approved manner. Concrete rubble resulting from the above operations shall be disposed of offsite at the Contractor's expense and responsibility. Width of slab removed shall not be less than two feet or more than four feet. Slab removed shall be replaced to the same section using Class E concrete (4000 psi strength, 4" slump, 6% air entrained containing water-reducing admixtures). Reinforcement of the replacement slab shall be accomplished by setting dowelled #4 steel rods at 24" center to center. Rods are to be set horizontally into drilled holes to a minimum depth of 6" and epoxy set into place.

3.05 BACKFILLING

- A. General: After bedding, the trenches shall not be backfilled until all required pressure tests are performed. Where damage is likely to result from withdrawing sheeting, the sheeting will be approved to be left in place and the contract price will be adjusted accordingly. Except as otherwise specified for special conditions of overdepths, trenches shall be backfilled to the ground surface with selected material as hereinafter specified. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified or the condition shall be restored to its original condition as near as practical and as hereinafter specified.
- B. Backfilling of trench: Backfill material shall be deposited in 6" maximum thickness layers and compacted with suitable tampers to the specified density as described in Specifications, Division I. If any portion of the cover in the lower portion of the trench is in the depth of special compaction and materials requirements under pavement, the special requirements shall control. Special care shall be taken not to damage the coating or wrapping of pipes.

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION OF PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Label all mechanical equipment furnished and/or installed in this project.
- B. Label all electrical equipment furnished under this project.
- C. Label all piping systems installed in this project.
- D. Provide valve tags and chart.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Basic Piping Requirements: Section 22 05 29
- C. Plumbing Pipe and Equipment Insulation: Section 22 07 19
- D. Domestic Water Piping System: Section 22 11 16
- E. Sanitary Waste and Vent Piping; Section 22 13 16
- F. Natural Gas Piping System: Section 22 70 16

1.03 SUBMITTALS

- A. In accordance with Specifications Section 22 05 01, General Provisions, submit manufacturer's data on labels. Include a listing of labels ordered with name of equipment or control device.
- B. Submit manufacturer's data on valve tags including a list of all valves to be tagged on the project.

PART 2 - PRODUCTS

2.01 PLUMBING EQUIPMENT LABELS

- A. Labels shall be engraved, laminated plastic plates. Height of letters shall be as scheduled herein.
- B. Letters shall be black; plates shall be white.
- C. System shall meet ANSI A13.1-1975 specification.

- D. Manufacturers:
 - 1. Brady
 - 2. Seton Nameplate Corporation
 - 3. Or approved equal

2.02 PLUMBING EQUIPMENT CONTROL LABELS

- A. Labels shall be engraved, laminated plastic plates. Height of letters shall be as scheduled herein.
- B. Letters shall be black; plates shall be white
- C. System shall meet ANSI A13.1-1975 specification.
- D. Manufacturers:
 - 1. Brady
 - 2. Seton Nameplate Corporation
 - 3. Or approved equal

2.03 VALVE TAGS

- A. Valve tags shall be consecutively numbered, brass tags (1-1/2" round).
- B. Where valves are located above ceilings, provide a location marker on the ceiling grid, as specified under 2.05, of same general description as brass tags.
- C. All main valves shall include text on the tag to read "Main Shutoff Valve". Tag size shall be increased to include text and valve number.
- D. System shall meet ANSI A13.1-1975 specification.
- E. Manufacturers:
 - 1. Brady
 - 2. Seton Nameplate Corporation
 - 3. Or approved equal

2.04 VALVE TAG CHART

- A. Prepare a computer generated chart listing all valves tagged on this project. List the valve number, service and normal position (closed or open). Submit file disk of chart to Owner at project completion.
- B. Chart shall be mounted in a suitably sized frame with shatterproof glass front and installed on the wall of the main mechanical room.

2.05 CONCEALED EQUIPMENT AND VALVE LOCATION MARKERS

- A. Furnish white plastic marker with engraved black numbers and letters, 1/4" high to attach to ceiling grids. Confirm width of ceiling grids with Ceiling Contractor and match the size. Numbers and letters shall match the equipment label wording as scheduled.
- B. Manufacturers:
 - 1. Brady
 - 2. Seton Nameplate Corporation, Style No. M5300
 - 3. Or approved equal

2.06 PIPE LABELS

- A. Furnish snap-around type markers through 5" pipe sizes. Furnish strap-around type markers with nylon ties for 6" pipe sizes and larger.
- B. Letter height shall vary with pipe size as follows:
 - 1. Thru 1-1/4" insulated pipe: 1/2"
 - 2. Thru 2" insulated pipe: 3/4"
 - 3. Thru 6" insulated pipe: 1-1/4"
 - 4. 8" and above insulated pipe: 2-1/2"
- C. Include directional flow arrows.
- D. System shall meet ANSI A13.1-1975/OSHA designated color and specification.
- E. Manufacturers:
 - 1. Brady
 - 2. Seton Identification Products, "Setmark" system
 - 3. Or approved equal meeting ANSI specifications

PART 3 - EXECUTION

3.01 MECHANICAL EQUIPMENT LABEL INSTALLATION

- A. Schedule of Mechanical Equipment Labels (List is not necessarily inclusive of all equipment on this project to be labeled).

<u>Equipment</u> <u>Wording</u>	<u>Example</u> <u>Height</u>	<u>Letter</u>
Water Softeners	WATER SOFTENER	1"
Water Heaters	WATER HEATER-1	1"
Domestic Water Circulating Pumps	HWRP-1	1"
Backflow Preventers	BFP-1	1"

- B. Labels shall be secured to the equipment in a readily apparent location with a

minimum of four (4) screws for 1" size labels and two (2) screws for 1/2" and smaller. (Glue shall not be used.) Drill holes for screw openings. Cracked labels shall be replaced.

- C. Equipment which is not suitable to receive the above fastening method shall be labeled on an adjacent wall, chain hung from the ceiling, or on a readily sighted disconnect switch, at the direction of the Designer.

3.02 ELECTRICAL AND CONTROL EQUIPMENT LABEL INSTALLATION

- A. Items to be labeled include:
 - 1. Motor starters: 1/2" high
 - 2. Motors which cannot be readily identified by their starter label when observer is standing by the motor: 1/2" high
- B. 1/2" and 1" letter size labels shall be secured to the devices with appropriately sized screws or rivets. (Glue shall not be used.) Screw holes shall be drilled. Cracked labels shall be replaced.
- C. 1/4" and 1/8" letter size labels shall be glued to the device.

3.03 VALVE TAG INSTALLATION

- A. Install tags on each operating valve installed in this contract, i.e. main or branch line shutoff valves.
- B. Use scheduled abbreviations for service indication.
- C. Attach tags with nickel plated brass bead chain.

3.04 PIPE LABEL INSTALLATION

- A. Install pipe identification labels on each piping system where required to provide easy identification of the system and flow.
- B. Minimum requirements include the following:
 - 1. At both sides of all wall penetrations, concealed and exposed, throughout the building.
 - 2. At an accessible location for every exposed 25 lineal feet of piping.
 - 3. At each piece of equipment.
- C. Do not install labels until pipe has been insulated and painted.

3.05 CONCEALED EQUIPMENT AND VALVE LOCATION MARKER INSTALLATION

- A. Install plates directly on to exposed bottom of ceiling T-bar, with glue.
- B. Locate plate adjacent to ceiling tile which accesses the equipment or valve above.
- C. Install plates directly on to access panels in drywall ceilings.

END OF SECTION

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SECTION 22 05 76 - DRAINAGE PIPING CLEANOUTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install all piping specialty items as described herein or as shown on the drawings.
- B. Cleanouts shall be required on all soil, waste, and storm water piping as described in the latest Indiana approved edition of the Plumbing Code and as described herein.
- C. Cleanouts are to be installed at intervals not to exceed 100 feet on horizontal runs of pipe.
- D. Cleanouts are to be installed inside the building near connection between the building drain and building sewer or installed outside the building and extend up to finish grade where shown on the drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Basic Piping Requirements: Section 22 05 29
- D. Sanitary Waste and Vent Piping System: Section 22 13 16

PART 2 - PRODUCTS

2.01 FLOOR CLEANOUTS (FINISHED AREAS) (REFER TO ARCHITECTURAL FINISH SCHEDULE FOR APPLICABLE FINISHES)

- A. For carpeted floors, medium duty use:
 - 1. Cast iron cleanout body with round adjustable scoriated secured nickel bronze top. Bronze inner plug, flange, and gasket seal. Adjustable nickel bronze carpet clamping frame to be installed after the carpet is set in place.
 - 2. Manufacturers: J.R. Smith Fig. 4021S-X-F or equivalent Josam, Wade or Zurn.

- B. For concrete floor finished and unfinished surfaces, medium duty use:
 - 1. Cast iron cleanout body with round adjustable scoriated secured nickel bronze top. Bronze inner plug, flange, and gasket seal.
 - 2. Manufacturers: J.R. Smith Fig. 4021S-F or equivalent Josam, Wade or Zurn.
- C. For concrete floor finished and unfinished surfaces, heavy duty use:
 - 1. Cast iron cleanout body with round adjustable scoriated secured nickel bronze top. Bronze inner plug, flange, and gasket seal.
 - 2. Manufacturers: J.R. Smith Fig. 4101S-F or equivalent Josam, Wade or Zurn.
- D. For floor areas covered with vinyl tile and linoleum surfaces:
 - 1. Cast iron cleanout body with round adjustable scoriated secured nickel bronze top with 1/8" recess. Bronze inner plug, flange, and gasket seal.
 - 2. Manufacturers: J.R. Smith Fig. 4141S-F or equivalent Josam, Wade or Zurn.
- E. For floor areas with terrazzo and similar tile floor surfaces:
 - 1. Cast iron cleanout body with round adjustable scoriated secured nickel bronze top with 1/2" recess. Bronze inner plug, flange, and gasket seal.
 - 2. Manufacturers: J.R. Smith Fig. 4181S-F or equivalent Josam, Wade or Zurn.

2.02 FLOOR CLEANOUTS (UNFINISHED AREAS)

- A. For use in unfinished areas such as equipment rooms, storage rooms, closets, etc.
 - 1. Heavy duty cast iron cleanout with round adjustable scoriated secured cast iron top. Bronze inner plug, flange, and gasket seal.
 - 2. Manufacturers: J.R. Smith Fig. 4221S-F or equivalent Josam, Wade or Zurn.

2.03 CLEANOUTS (UNPAVED AREAS)

- A. Cleanout housing shall be completely independent of pipe, eliminating undesired load transmission to cleanout branch pipe.
 - 1. Cast iron cleanout and double flanged housing with heavy duty secured scoriated cast iron cover and lifting device. Bronze inner plug with gasket seal.
 - 2. Provide a square, concrete pad around cleanout body.
 - 3. Manufacturers: J.R. Smith Fig. 4251S-CI or equivalent Josam, Wade or Zurn.

2.04 CLEANOUTS (PAVED AREAS)

- A. Cleanout housing shall be completely independent of pipe, eliminating undesired load transmission to cleanout branch pipe.
 - 1. Cast iron cleanout and double flanged housing with heavy duty secured scoriated cast iron cover and lifting device. Bronze inner plug with gasket seal.
 - 2. Provide a square, concrete pad around cleanout body.
 - 3. Manufacturers: J.R. Smith Fig. 4251S-CI or equivalent Josam, Wade or Zurn.

2.05 WALL CLEANOUTS (TEE AND COVER) (FINISHED AREAS)

- A. For concealed piping where cleanout is desired in wall in lieu of floor such as base of storm, soil, and waste stacks.
 - 1. Cast iron cleanout tee for hub and spigot or no-hub pipe as specified. Threaded bronze cleanout plug. Nickel-bronze frame stainless steel cover, vandal proof screws.
 - 2. Manufacturers: J.R. Smith Fig. 4551S-U or equivalent Josam, Wade or Zurn.

2.06 SUSPENDED PIPE CLEANOUT

- A. Cleanout with threaded airtight plug.
- B. Manufacturer: J.R. Smith, Josam, Wade or Zurn

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide cleanout branches throughout the entire building soil, waste, storm water and condensate drain piping systems. Install at every change of direction greater than 45 degrees, intervals not more than 100 feet apart, base of each stack, as indicated on drawings, and as required by Plumbing Code.
- B. All cleanouts above ceilings are to be coordinated with other trades for accessibility.
- C. All floor and wall cleanouts are to be installed flush and true to finished surfaces.

END OF SECTION

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SECTION 22 07 19 - PLUMBING PIPE AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work shall include all labor, equipment, accessories, materials, and services required to furnish and install all insulation, fittings and finishes for the following piping systems:
 - 1. Domestic water piping
 - 2. Storm water piping
 - 3. Sanitary waste piping

1.02 QUALITY ASSURANCE

- A. Insulation shall be installed by skilled workmen regularly engaged in this type of work.
- B. Reference Standards:
 - 1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
 - a. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.
 - b. Exception: Mechanical insulation installed outdoors may have flame spread index of 75 and smoke developed index of 150.
 - 2. National Commercial & Industrial Insulation Standards – Latest Edition
 - 3. International Energy Conservation Code.
- C. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Assignment of Miscellaneous Work: Section 22 05 02
- D. Basic Piping Requirements: Section 22 05 29
- E. Domestic Water Piping System: Section 22 11 16
- F. Sanitary Waste and Vent Piping System: Section 22 13 16

G. Domestic Water Pumps: Section 22 11 23

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Sections 22 05 01, General Provisions.
- B. Product Data:
 - 1. Submit manufacturer's technical product data and installation instructions for each type of insulation.
 - 2. Submit schedule showing manufacturer's product number, k-value, thickness, density in lbs./cu. ft., and furnished accessories for each system requiring insulation.
- C. Where specified herein, submit manufacturer's sample of each piping and equipment insulation type required. Affix label to sample which completely describes product sample.
- D. Submit maintenance manuals in accordance with Division 1 specification requirements:
 - 1. Maintenance manuals shall include the following:
 - a. Maintenance data
 - b. Replacement material lists for each type of mechanical insulation provided.

1.05 JOB CONDITIONS

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation, or insulation that has been previously wetted and dried out; remove from project site.
- C. Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.06 SCHEDULING

- A. Work shall be scheduled by the Contractor.
- B. Maintain communication with the Contractor throughout construction period to assure coordination of the insulation installation with the progress of the piping systems.

1.07 DEFINITION OF TERMS

- A. Concealed: shall mean hidden from sight and/or access such as in trenches, chases, furred spaces, pipe shafts, or above suspended ceilings.
- B. Exposed: shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas or unfinished rooms are to be considered as "exposed".
- C. Accessible: shall mean above suspended lay-in type ceilings.
- D. Inaccessible: shall mean above suspended ceilings not readily accessed from most areas.

1.08 COLD SERVICE AND NON-POTABLE - PIPE INSULATION

- A. Service for domestic cold water and non-potable; all locations
 - 1. Exposed: Type 1
 - 2. Concealed: Type 1 or 2
 - 3. Accessible: Type 1
- B.

Materials	<u>Type (1)</u>	<u>Type (2)</u>
1. Insulation	Fiberglass	Elastomeric foam
2. Jacket	Factory ASJ	(Not required)
3. Insulation thickness for pipe:		
1/2" thru 1"	1"	1/2"
1-1/4" thru 5"	1"	3/4"
6" and above	1"	Use Type 1

1.09 HOT SERVICE - PIPE INSULATION

- A. Service for domestic hot and hot water return; all locations
 - 1. Exposed: Type 1
 - 2. Concealed: Type 1 or 2
 - 3. Accessible: Type 1 or 2
- B.

Materials	<u>Type (1)</u>	<u>Type (2)</u>
1. Insulation	Fiberglass	Elastomeric foam
2. Jacket	Factory ASJ	(Not required)
3. Insulation thickness for pipe:		
1/2" thru 2"	1"	1"
2-1/2" and above	1-1/2"	Use Type 1

4. Insulation Thickness for heat traced piping:
- | | |
|----------------|--------|
| 1/2" thru 1" | 1" |
| 1-1/4" thru 2" | 1-1/2" |
| 2-1/2" thru 4" | 2" |

1.10 DRAINAGE SERVICE - PIPE INSULATION

A. Service

1. For all horizontal storm water piping, including sump pan and drain body:
2. All vertical storm where PVC or CPVC pipe material is used and exposed in occupied spaces or adjacent to sound sensitive spaces (i.e.: meeting rooms, sleeping quarters, etc.)
 - a. Concealed: Type 1 or 2
 - b. Exposed: Type 1
 - c. Accessible: Type 1 or 2
3. For above ground sanitary waste lines receiving condensate drains from cooling coils or ice machines or electric water coolers. Insulate to stack or conjunction with tempered waste branch.
 - a. Concealed: Type 1 or 2
 - b. Exposed: Type 1
 - c. Accessible: Type 1 or 2
4. For condensate drains from cooling coils:
 - a. Concealed: Type 1 or 2
 - b. Accessible: Type 1 or 2
 - c. Exposed: Not required if in conditioned space. Type 1 if in unconditioned space.

B.	Materials	<u>Type (1)</u>	<u>Type (2)</u>
1.	Insulation	Heavy density	Elastomeric fiberglass foam
2.	Jacket	Factory ASJ	(Not required)
3.	Insulation thickness for pipe:		
	Thru 2-1/2"	1"	3 /4"
	3" and above	1"	Use Type 1

1.11 EQUIPMENT

A. Service - Insulate the following equipment surfaces:

1. Domestic water heaters: Type 1
2. Domestic water storage or preheat tanks: Type 1
3. Steam water heaters: Type 2

B. Materials	<u>Type 1</u>	<u>Type 2</u>
1. Insulation	Heavy density	Foamglass fiberglass
2. Jacket	8 oz glass cloth	
3. Insulation thickness	2"	3-1/2"

PART 2 - PRODUCTS

2.01 GENERAL

- A. All pipe insulation and coverings on pipe shall have a flame spread rating not exceeding twenty five (25) and a smoke developed rating not exceeding fifty (50).
- B. Pipe insulation coverings and adhesives on pipes used in chases, shafts or other concealed spaces shall have a flame spread rating not exceeding twenty five (25) and a smoke developed rating not exceeding one hundred fifty (150).
- C. Pipe insulation and coverings on pipe used in plenums and shafts serving as supply or return air ducts or exposed in finished areas shall have a flame spread rating not exceeding twenty five (25) and a smoke developed rating not exceeding fifty (50).

2.02 INSULATING MATERIALS: PIPING AND EQUIPMENT

- A. Fiberglass
1. Cold piping: a fine inorganic fibrous glass insulation with factory applied vapor barrier jacket, molded to conform to piping, "K" value at 75°F, maximum 0.24 btu inch/sq.ft./°F/hour.
 2. Hot piping: a fine inorganic fibrous glass insulation with factory applied general purpose jacket, molded to conform to piping, "K" value at 75°F, maximum 0.25 btu inch/sq.ft./°F/hour.
- B. Elastomeric foam: a closed cellular material, odorless, self-extinguishing, UL approved, maximum water vapor transmission of 0.20 perms; "K" value at 75°F, maximum 0.27 btu inch/sq.ft./°F/hour. All exterior elastomeric foam insulation shall include a UV protective coating or covering.
- C. Calcium silicate: rigid molded hydrous calcium silicate insulating pipe covering for use up to 1200°F. Density shall be 11# per cubic foot.

- D. Foamglass: a cellular glass insulation, resistant to water, non-corrosive, non-combustible and dimensionally stable. 0.00 permeability perm-inch. Absorption 0.2% by volume, flame spread 0, smoke develop 0 meeting ASTM E84. 0.29 BTU-inch /sq.ft./°F/hour @ 75°F thermal conductivity. Hot piping (ambient to 400°F) shall be Pittsburg Corning "Foamglass".

2.03 MISCELLANEOUS JACKET MATERIALS

- A. Aluminum jacket: embossed aluminum with factory attached 30-9-30 duplex waterproof asphalt laminated paper as manufactured by Childers (0.010" thickness); Childers Ell-Jacs for fittings.
- B. Reinforced foil and paper: FSK (foil-scrim-kraft) aluminum foil reinforced with fiberglass yard mesh and laminated to 40# chemically treated, fire resistant kraft; UL listed.

2.04 ACCEPTABLE INSULATION MANUFACTURERS

- A. Owens-Corning
- B. Johns-Manville
- C. Armstrong
- D. Knauf

2.05 ACCEPTABLE INSULATION SUNDRIES/ADHESIVES MANUFACTURERS

- A. Benjamin Foster
- B. Childers
- C. Vimasco

PART 3 - EXECUTION

3.01 GENERAL

- A. Application of insulation materials to piping shall be done in accordance with manufacturers' written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use.

3.02 PREPARATION

- A. Apply insulation only after piping and equipment have been tested and cleaned.
- B. Protect furniture, equipment, ducts, pipes, etc. with tarpaulins. Keep premises clean.

- C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating condition.

3.03 GENERAL INSTALLATION

- A. All insulation shall be continuous through wall and ceiling openings and sleeves. All covered pipe is to be located a sufficient distance from walls, other pipes, ductwork, and other obstacles to permit the application of the full thickness of insulation specified. (If necessary, extra fittings and pipe are to be used.)
- B. Vapor barrier jackets shall be applied with a continuous, unbroken vapor seal.
- C. Pipe hangers shall be sized large enough to be installed over the outer surface of the insulation. Load distributing corrosion resistant #14 USG metal shields shall be installed around the lower one-third circumference of the insulation. Shields shall be 12 gauge for smaller sizes. Length of the shield shall be 12" and up through 6"; 16" for 6" through 12"; and 20" over 12" IPS.

3.04 APPLICATION OF PIPE INSULATION

- A. All pipe insulation shall be installed with joints butted firmly together.
- B. Seal all punctures in vapor barrier jacket with vapor barrier adhesive on cold piping.
- C. Apply insulation jackets on all piping, as follows:
 - 1. In public and occupied areas where pipe is subjected to damage from normal traffic.
 - 2. All insulated pipe installed outdoors.
 - 3. All exposed vertical and horizontal piping below 6'-0" AFF in mechanical rooms or occupied non-finished rooms, such as storage, work rooms, etc. This includes elbows and fittings. Not included are valves or strainers.
 - 4. The metal jacket shall be retained with rivets or other suitable method that does not puncture the insulation.
- D. Jackets on pipe insulation shall be vapor sealed using self-sealing lap, lap-seal tape gun or adhesive such as 520.
- E. All fiberglass insulation ends are to be tapered at 45° and sealed.
- F. Insulation of valves and fittings
 - 1. Valves and fittings
 - a. Provide mitered sections of fiberglass insulation of same thickness and density as adjoining pipe insulation or provide insulating type cement equal to adjoining pipe insulation thickness.
 - b. Cover insulation with vapor tight jacket of same jacket as adjoining pipe insulation.

2. Elbows

- a. Insulate elbows with fiberglass insulation of same thickness and density as adjoining pipe insulation.
- b. A flexible fiberglass type insulation is not acceptable.
- c. Cover insulated elbows with pre-molded PVC elbow covers.
 - (1) PVC covers shall be rated for 25 fire/50 smoke develop maximum.
 - (2) Manufacturer: Zeston; or approved equal

3. Mechanical couplings (Mechanical Contractor's option): Insulate all mechanical couplings in systems utilizing same (as determined by Mechanical Contractor) with manufacturer's molded fiberglass insulation sections. Insulation thickness shall be of same density, jacket, and thickness as adjoining pipe insulation.

3.05 APPLICATION OF EQUIPMENT INSULATION

- A. General: Insulate all manholes, removable heads, and access doors so they may be removed.
- B. Round equipment: Secure insulation with 1/2" wide metal bands, 12" on center, or with mechanical pins welded to equipment 12" on center.
- C. Flat or irregular equipment (metal partitions, plenums, etc.): Secure insulation with mechanical pins welded to equipment 12" on center each way.

END OF SECTION

SECTION 22 11 16 - DOMESTIC WATER PIPING SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install domestic cold, hot, and hot water return pipe and fittings to plumbing fixtures and equipment as shown on the plumbing drawings or herein specified.
- B. All piping shall be installed in compliance with the latest local approved Plumbing Code and as recommended by the International Code Council (ICC).
- C. Where non-potable water is indicated on plans. The pipe material shall match domestic cold water.
- D. All pipe, fittings, valves, equipment, and pipe joining material used for potable domestic water systems shall be LEAD-FREE in accordance with state and federal regulations.
- E. This Section specifies the water distribution piping system, including potable cold, hot, and recirculated hot water piping, fittings, and specialties within the building to a coordinated point 5'-0" outside the building.
- F. Products installed but not furnished under this Section include water meter(s) which will be provided by the Utility Company, to the site, ready for installation per Water Company requirements.
- G. All work specified in this section includes domestic water piping and valves within the building.

1.02 QUALITY ASSURANCE:

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators
 - 3. NSF/ANSI Standard 61 "Drinking Water System Components".
 - 4. Indiana Plumbing Code.
- B. Potable water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."
- C. Potable water piping and components shall comply with NSF-372, "Drinking Water System Components – Lead Content".

- D. All grooved coupling, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for couplings, housings, fittings or valve and specialty bodies shall be date stamped for quality assurance and traceability.
- E. Installer Qualifications: Use an installer possessing documentation proving successful completion of PEX plumbing installation training by the PEX tubing manufacturer.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Concrete Pads and Curbs: Section 22 05 05.
- D. Meters and Gauges: Section 22 05 19
- E. Basic Piping Requirements: Section 22 05 29
- F. Trenching, Backfilling and Compacting (Exterior): Section 22 05 40
- G. Trenching, Backfilling and Compacting (Interior): Section 22 05 41
- H. Identification for Piping and Equipment: Section 22 05 53
- I. Pipe and Equipment Insulation: Section 22 07 19
- J. Plumbing Fixtures and Trim: 22 42 00

1.04 SUBMITTALS:

- A. Product data for each piping type and valve specified.
 - 1. Submittals and shop drawings shall include the following data:
 - a. Manufacturer's technical data including valve performance and capacity.
 - b. Accessories furnished.
 - c. Manufacturer's recommended installation methods.
 - 2. Grooved joint couplings and fittings shall be referred to on drawings and product submittals, and be identified by the manufacturer's listed model or series designation.
- B. Maintenance data for each valve specified for inclusion in Operation and Maintenance Manual.

- C. Welder's certificates certifying that welders comply with requirements specified in Quality Assurance below.
- D. Certification of Compliance with ASME and UL fabrication requirements specified below.
- E. Test reports specified in Part 3 of this Section.

1.05 DEFINITIONS:

- A. Water Distribution Piping: A pipe within the building, or on the premises, which conveys water from the water service pipe, or water meter, to the points of usage.
- B. Water Service Piping: The pipe from the water main, or other source of potable water supply, to the water distributing system of the building served.
- C. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Store pipe in a manner to prevent sagging and bending.
- B. Store CPVC, PVC, PB or PEX pipe and fittings protected from direct sunlight.

1.07 SEQUENCING AND SCHEDULING:

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete reinforcement and formwork requirements are specified in Section 22 05 05.
- B. Coordinate the installation of pipe sleeves for foundation wall penetrations.
- C. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING (ABOVE GROUND)

- A. Maximum Design: pressure 125 psig, temperature 200°F.

B. Piping System Notes

1. Domestic cold water, hot water and hot water return piping for above ground and exposed installation.
2. Fabricate piping system in strict accordance with the materials specified herein and per the following restrictions.
3. Grooved and coupled piping systems are acceptable only in fully accessible locations, no exceptions.
4. Coupled system products are not acceptable for valves, strainers, etc.
5. Saddle type fittings are prohibited.

C. Pipe and Fitting Material

1. 1/2" thru 4": Type L, hard drawn, seamless copper pipe and fittings, ASTM B-88, 95-5 soldered joints.
2. 1/2" thru 4"; Type L, hard drawn, seamless copper pipe with press fittings:
 - a. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press end shall have SC (Smart Connect) feature design (leakage path). Smart Connect™ (SC Feature) in Pro-Press 1/2" to 2" dimensions the Smart Connect Feature assures leakage of liquids and/or gasses from inside the system past the sealing element of a unpressed connection. The function of this feature is to provide the installer with quick and easy identification of connections which have not been pressed prior to putting the system into operation.
 - b. Manufacturer:
 - (1) Viega
 - (2) Or approved equal
3. 2" thru 8" and above: Type L, hard drawn, seamless copper pipe, and fittings. ASTM B-88, roll grooved for copper or 2" through 12" with Schedule 40 stainless steel.
 - a. Fittings:
 - (1) ASME B16.22 wrought copper or ASME B16.18 cast bronze, manufactured to copper tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.) Basis of Design: Victaulic Copper Connection.
 - (2) ASTM A403 wrought stainless steel, ASTM A351 Grade CF8M cast stainless steel, or factory-manufactured from ASTM A312 stainless steel pipe. Basis of Design: Victaulic Company.

- b. Couplings: Installation-Ready, for direct stab installation without field disassembly, with Grade P Fluoroelastomer center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth, and ASTM A449 compliant bolts and nuts.
 - (1) Two ductile iron housings cast with off setting angle-pattern bolt pads. Basis of Design: Victaulic Style 607
 - (2) Two ductile iron housings coated with blue enamel. Basis of Design: Victaulic Style 807N or 889 (rigid) and 877N (flexible).
- 4. 1/2" thru 4" CPVC: Schedule 40 pipe and fittings shall be manufactured from a Type IV, Grade I Chlorinated Polyvinyl Chloride (CPVC) compound with a minimum Cell Classification of 23447 per ASTM D1784. The pipe and fittings shall be manufactured in strict compliance to ASTM F441, consistently meeting the Quality Assurance test requirements of this standard regarding material, workmanship, burst pressure, flattening, and extrusion quality. The pipe and fittings shall be produced in the USA using domestic materials, by an ISO 9001 certified manufacturer, and shall be stored indoors after production, at the manufacturing site, until shipped from factory. This pipe and fittings shall carry the National Sanitation Foundation (NSF) seal of approval for potable water applications. The pipe and fittings shall have a Flame Spread rating less than 25 and a Smoke Development rating less than 50 when tested and listed for Surface Burning Characteristics in accordance with CAN/ULC-S102-2-M88 or equivalent. Solvent cements for joining piping and tubing to meet ASTM F493.
 - a. The Victaulic Company PGS-300 CPVC Piping system may be used on water services 2" through 12" where IPS size Schedule 40 and 80 CPVC pipe is approved for use. Pipe and fittings shall be cut grooved to Victaulic's PGS-300 groove specification. Schedule 80 CPVC pipe shall meet the requirements of ASTM F441 and ASTM D1784 – minimum cell classification 23447 Pipe.
 - (1) Couplings for CPVC/PVC Pipe: Victaulic Style 857 and Style 856 Coupling; Installation ready coupling for direct stab installation without field disassembly; or Style 858 reducing coupling.
 - (2) PGS-300 fittings meet the requirements for ASTM F439, modified for grooved ends. Fittings are supplied either directly molded to size with integral groove profiled or are fabricated from socket fittings with factory solvent cemented grooved tangents. Classified in accordance with NSF-PW SE for potable water service.
- 5. PEX piping and fittings:
 - a. 1" diameter or less, Type L copper manifold comprised with 3/4" inlet with shut-off ball valve, spun closed end and 1/2" PEX crimp outlets, the 1/2" copper PEX outlets are brazed to the header. Zurn copper manifold - QCM43 or Nibco manufacturer.

- b. Pipe shall be rolled tubing made of cross-linked high density polyethylene, produced using the silane method of cross linking (PEX-b) or PEX-a and meeting the performance specifications of ASTM F876/F877 and CSA B137.5. Pipe shall also comply with NSF 61 and 14 as suitable for use with potable water. Temperature and pressure ratings shall be 160 psi at 73°F, 100 psi at 180°F, and 80 psi at 200° F. Pipe shall have UV stabilization additives to protect it from UV exposure. Pipe shall be chlorine resistant utilizing the ASTM F2023 testing standards.
- c. PEX crimp fittings shall employ stainless steel clamping system. All terminations at fixture rough-ins shall have drop ear elbows with rigid 90 degree connection and 1/2" threaded female outlet.

2.02 PIPING (BELOW GROUND)

- A. Maximum Design: pressure 125 psig; temperature 200°F.
- B. Pipe and Fittings Material
 - 1. 1/2" thru 4"; Type K, hard drawn, seamless copper pipe and fittings ASTM B-88, 95-5/' soldered joints.
 - 2. 4" and larger shall be ductile iron AWWA C151/A21.51 with a minimum thickness class of 51. Pipe shall be of the push-on or mechanical joint retainer glands as required herein. Fittings shall conform to AWWA 110/A2 1.10 and have a pressure rating at least equivalent to that of the pipe. Pipe and fittings shall be cement lined. (For water service outside of building to flanged connection 12" above finished floor.)

2.03 TRANSITIONS FITTINGS:

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compliance with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufactures: Subject to compliance with requirements, provide products by the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.: Piping Specialties Products.
 - c. Ford Meter Box Company, Inc.
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc.: a Sensus Company.
 - g. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Charlotte Pipe and Foundry Company
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
2. Descriptions:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO Inc.
 - c. Spears Manufacturing Company.
2. Description:
 - a. CPVC four-part union.
 - b. Brass threaded end.
 - c. Solvent-cement-joint plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

F. PEX-to-Metal Transition Fittings:

1. One-piece fitting with threaded brass or copper sweat end and ASTM F 1960, or compression fitting end to match PEX fitting type.

2.04 DIELECTRIC FITTINGS:

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International.
 - e. Matco-Norca.

- f. McDonald, A. Y. Mfg. Co.
- g. Watts; a division of Watts Water Technologies, Inc.
- h. Wilkins; a Zurn Company.

- 2. Standard: ASSE 1079.
- 3. Pressure Rating: 125 psig minimum at 180 deg F
- 4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn Company.
- 2. Standard: ASSE 1079.
- 3. Factory-fabricated, bolted, companion-flange assembly.
- 4. Pressure Rating: 125 psig minimum at 180 deg F
- 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
- 2. Non-conducting materials for field assembly of companion flanges.
- 3. Pressure Rating: 150 psig.
- 4. Gasket: Neoprene or phenolic.
- 5. Bolt Sleeves: Phenolic or polyethylene.
- 6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

F. Dielectric Waterway:

1. Copper-silicon casting conforming to UNS C87850 with grooved and/or threaded ends. UL classified in accordance with ANSI /NSF-61 for portable water service. Basis of Design: Victaulic Style 647.

2.05 UNIONS AND CONNECTORS:

- A. Unions: ANSI B16.39, malleable iron, Class 150, hexagonal stock, with ball- and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.
1. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.
- B. Dielectric Unions: Threaded or soldered end connections as required to suit application; constructed to isolate copper from galvanized pipe, prevent galvanic action, and prevent corrosion.
- C. Flexible Connectors: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250° F operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of 3/4 inch misalignment.

2.06 ENCASEMENT FOR PIPING:

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: **Sheet**
- C. Color: **Black**

2.07 VALVES

- A. Manufacturers:
1. Conbraco (Apollo)
 2. Crane
 3. Hammond
 4. Jomar
 5. Keystone
 6. Milwaukee
 7. Nibco
 8. Red-White

9. Spears
10. Stockham
11. Victaulic

B. Shutoff Valves

1. Ball Valves (1/2" thru 2"): Lead free compliant, bronze body with brass ball, **brass extension stem**; steel handle with vinyl cover, lever operated, threaded, 600 psig, lead free.
2. Butterfly Valves (2-1/2" and larger): NSF 372 Lead free compliant MSS SP-67; rated at 200 psi;
 - a. Cast-iron body conforming to ASTM A 126, Class B lead free. Provide valves with field replaceable EPDM sleeve, **provide valves with extended neck**, nickel plated ductile iron disc stainless steel stem, and EPDM O-ring stem seals.
 - b. 2-1/2" – 6", 300 psi (2065 kPa) maximum pressure rating, with copper tubing sized grooved ends. Cast brass body to UNS C8785, Aluminum bronze disc to UNS C95500, with pressure responsive Grade P Fluoroelastomer seat. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating. Victaulic Series 608N.
 - c. 2" - 12 ", 300 psi (2065 kPa CWP) maximum pressure rating, with grooved ends, stainless steel body and disc. Grade CF8M, conforming to ASTM A351, with blow-out proof 17-4PH stainless steel stems to ASTM A564, with pressure responsive Grade P Fluoroelastomer seat. Stem shall be offset from the disc centerline to provide complete 360 degree circumferential seating. Victaulic Series 861 Vic-300 MasterSeal Valve.
 - d. Provide lever operators with locks for sizes 2 through 6 inches and gear operators with position indicator for sizes 8 through 24 inches. Provide lug type as indicated. Specify chain wheel operators for valves installed above 8 foot above finished floor. Valves shall be suitable for bi-directional dead end service without the need for a downstream flange.
3. CPVC Ball Valves (1/2" thru 2"): Pressure rating 250 psi at 73°F water non-shock full-port; maximum service temperature 210°F, full port, EPDM O-rings.
4. CPVC Ball Valves (2 1/2" thru 4"): Valve pressure rating 150 psi at 73°F water non-shock full-port; maximum service temperature of 210°F full port; FKM O-rings; female NPT threaded end connections; orange handle; ASTM F1970, NSF/ANSI Standard 14, NSF/ANSI Standard 61 G.
5. Gate Valves (1-1/2" thru 2"): Lead free compliant, bronze body with bronze disc, rising stem. (Use only where required by Water Utility Company)

6. Gate Valves (2 1/2" and larger); Lead free MSS-SP-139, iron body, bronze trim, solid wedge disc, bolted bonnet, outside screw and yoke, renewable seats, rising stem, flange. (Use only where required by Water Utility Company)

C. Check Valves

1. Horizontal Swing Check (1/2" thru 2")
 - a. (2-1/2" and smaller): Lead free compliant MSS-SP-139, MSS SP-80; Class 125, cast-bronze body and cap conforming to ASTM B62; with horizontal swing. Y-pattern, and bronze disc; and having threaded or solder ends. Provide valves capable of being reground while the valve remains in the line. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires or where Class 125 is not available.
 - b. (2-1/2" and larger): Lead free compliant MSS SP-71; Class 125, cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal swing, and bronze disc or cast iron disc with bronze disc ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line.
2. CPVC Check Valves:
 - a. (1/2" thru 2"): Schedule 80, CPVC check valve: valve pressure rating 150 psi at 73°F water non-shock; maximum service temperature of 210°F full port, EPDM O-rings; both socket and female NPT threaded end connections; ASTM F1970, NSF/ANSI Standard 14, NSF/ANSI Standard 61 G.
 - b. (3" thru 4"): Schedule 80, CPVC check valve: valve pressure rating 150 psi at 73°F water non-shock; maximum service temperature of 210°F; EPDM O-rings; female NPT threaded end connections; ASTM F1970, NSF/ANSI Standard 14, NSF/ANSI Standard 61 G.
 - c. Stainless Steel Check Valves: 2" – 12", 300 psi (2065 kPa CWP), grooved end Grade CF8M stainless steel body and disc, 17-4PH stainless steel shaft, with 17-4PH or 316 stainless steel spring, and Grade P Fluoroelastomer seat. Suitable for vertical or horizontal installation. Victaulic Series 816.

D. Balance Valve

1. (1/2" thru 1"): lead free compliant manual balance valve made of forged brass 600 WOG, 325°F; bi-directional modified venturi. Female pipe threads or sweat body with integral test ports. Includes two pressure taps and PT test plugs. (Balance valve station shall also include two ball valves and one check valve.)
2. See Flow Data on drawings.

3. Valve kits for potable water services providing flow-limiting recirculation balancing and control, positive shut-off, inline check to eliminate reverse flow, integrated union for installation and maintenance with sweat or copper press ends in sizes $\frac{1}{2}$ " and $\frac{3}{4}$ " (15 and 20mm). All domestic water kit components are ANSI/NSF 61 certified for domestic hot water service +140 degree F/+60 degree C and ANSI/NSF 372.
 - a. Victaulic Series 7WB: Quarter-turn balancing with measuring ports for pressure and temperature, rated to 300-psi (2068-kPa).
 - b. Victaulic Series 7WT: Temperature-limiting with shut-off when fluid temperature reaches set point with measuring ports for pressure and temperature, thermometer or PT port options, rated to 230-psi (1600-kPa).
 - c. Victaulic Series 7W9; Globe style balancing with measuring ports for pressure and temperature, rated to 300-psi (2068-kPa).
 - d. Victaulic Series 7WX: Automatic balancing control, rated to 300-psi (2068-kPa).
 4. Manufacturers:
 - a. Bell & Gossett
 - b. Hays
 - c. Nexus: Ultra MB Model MBNL
 - d. Taco
 - e. Victaulic
 - f. Or approved equal
- E. Pressure Regulating Valves:
1. Single seated, direct operated type: having bronze body with integral strainer and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and inlet and outlet pressures indicated. Cla-Val 990 series.
 2. Hydraulically pilot operated single diaphragm actuated type: having ductile iron body and cover, FDA approved diaphragm resilient synthetic rubber disc; restriction fitting, pressure reducing control, strainers, isolation valves. Select proper size for maximum flow rate and inlet and outlet pressures indicated. Cla-Val 90-01 series.
- F. Relief Valves: Provide proper size relief valve, in accordance with ASME Boiler and Pressure Vessel Codes, for indicated capacity of the appliance for which installed.
- G. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 °F, and pressure relief at 150 psig.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Branch connections shall be made from the side or bottom of the main to facilitate drainage.
- D. Install exposed piping, at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- E. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications. Provide pipe supports per manufacturers' requirements.
- F. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- G. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building.
- H. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- I. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- J. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.
- K. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inches shall be steel: pipe sleeves 6 inch and larger shall be sheet metal.
- L. Fire Barrier Penetrations: Where pipes pass through time rated fire resistive construction including fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division-7 for special sealers and materials.
- M. Install piping level with no pitch.
- N. Insulate buried (below ground) water piping with 1" thick polyurethane insulation. Cover polyurethane with a field installed PVC jacket. Seal joints watertight

following manufacturer's instructions.

- O. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- P. CPVC and PEX water piping shall be installed level and plumb, parallel, and perpendicular to other building systems and components, and in a professional manner.
- Q. Install PEX or PEX-a piping in accordance with manufacturer's installation instructions.
- R. Furnish and install expansion loops on domestic water piping mains in corridors per piping manufacturer's requirements.
- S. Install drainage-type, trap-seal primers from lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- T. Install supply type, trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.
- U. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- V. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.
- W. Do not proceed until unsatisfactory conditions have been corrected.
- X. Where domestic service enters the building from below grade, the pipe shall have a minimum bury depth of 6" below local frost line.
- Y. Reaction anchors: Use concrete thrust blocking where solid undisturbed earth is available. Use joint harnesses in other places. If lack of undisturbed earth is the result of improper trench excavation, provide joint harness at no additional cost. Coat underground metal surfaces not encased in concrete with two coats of Koppers Bitumastic type 50. Bitumastic shall be applied to clean dry surfaces only. Allow first coat to dry before applying second coat.
- Z. Press Connections: Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

- AA. General Application: Use gate, ball, and butterfly valves for shut-off duty; ball and butterfly for throttling duty. Ball valves shall not be used for steam service. Refer to piping system specification sections for specific valve applications and arrangements.
- BB. Locate valves for easy access and provide separate support where necessary.
- CC. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- DD. Install three-valve bypass around each pressure-reducing valve using throttling-type valves.
- EE. Install valves in horizontal piping with stem at or above the center of the pipe.
- FF. Install valves in a position to allow full stem movement.
- GG. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.
 - 2. Wafer Check Valves: Horizontal or vertical position, between flanges.
 - 3. Lift Check Valve: With stem upright and plumb.
- HH. When soldering, use paste fluxes that are approved by the manufacturer for use with Lead Free Alloys.
- II. Whether shown on the drawings or not all branch lines serving the following fixtures shall include an isolation valve followed by a check valve:
 - 1. Mop Basins
 - 2. Food Service Pre-Rinse Stations
 - 3. Food Service Three-Compartment Sinks
- JJ. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representatives shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

3.02 TESTING

- A. Cap all plumbing fixture rough-ins and apply hydrostatic pressure to 1-1/2 times the normal operating pressure of the system but not less than 75 psig. System must be able to hold test pressure for thirty minutes. If system fails test, Contractor will drain system, repair leaks and retest until system hold the rated hydrostatic test pressure.
- B. After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.03 DISINFECTING

- A. The domestic cold, hot and hot water return systems used for potable water shall be disinfected in accordance with Owner requirements, AWWA C601, and local Department of Health requirements.
- B. Provide a "Water Sample Report" supplied from the local Department of Health. Submit test results to Owner and Engineer. The sample is to be taken from faucets selected by the Engineer. The Contractor shall be responsible for any costs incurred for water analysis.

3.04 ADJUSTING AND CLEANING:

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

3.05 COMMISSIONING:

- A. Fill the system.
- B. Check compression tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
 - 1. Open valves to fully open position. Close drain valves, hydrants, and hose bibbs.
 - 2. Remove and clean strainers.
 - 3. Check pump for proper direction of rotation. Correct improper wiring.
 - 4. Lubricate pump motors and bearings.

END OF SECTION

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Backflow preventer shall be designed and manufactured for the purpose of prevention of backflow from non-potable water system to the potable/municipal water system.
- B. All equipment and pipe joining material used for potable domestic water systems shall be LEAD-FREE in accordance with state and federal regulations.
- C. Water hammer arresters shall be sized in accordance with the Plumbing and Drainage Institute (PDI) recommendations.

1.02 QUALITY ASSURANCE:

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators
 - 2. NSF/ANSI Standard 61 "Drinking Water System Components".
 - 3. Indiana Plumbing Code.
 - 4. Indiana State Board of Health
- B. Reference Standards:
 - 1. Americans with Disabilities Act (ADA) Accessibility Guidelines

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Basic Piping Requirements: Section 22 05 29
- D. Domestic Water Piping System: Section 22 11 16

1.04 SUBMITTALS

- A. Submit shop drawings for each type of backflow preventer, water hammer arrestor and accessories specified or furnished in accordance with Specification Section 22 05 01, General Provisions.
- B. Submit final backflow preventer test report on each unit into the Operator's Maintenance Manuals.

1.05 AGENCY APPROVAL

- A. Installation of backflow preventer(s) shall comply with state and local codes and local water utility requirements.
- B. Compliance shall be in accordance with the following standards:
 - 1. ASSE Standard 1013, 1022, 1056
 - 2. AWWA Standard C-511-92
 - 3. CSA B64.4
 - 4. USC Manual Section 10
 - 5. IAPMO and IPC approved
 - 6. Foundation for Cross-Control and Hydraulic Research of USC, Manual Section 10

1.06 EXTRA STOCK:

- A. Maintenance Stock: Furnish one valve key for each key operated wall hydrant, hose bibb or faucet installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basket Strainers:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Josam Mfg. Co.
 - 3. Metraflex Co.
 - 4. Mueller
 - 5. Spirax Sarco
- C. Hose Bibbs and Faucets:
 - 1. Chicago Faucet Co.
 - 2. Jay R. Smith Mfg. Co.
 - 3. Josam Mfg. Co.
 - 4. MIFAB, Inc.
 - 5. Prier Products, Inc.
 - 6. Wade/Tyler Pipe; Sub. of Tyler Corp.
 - 7. Watts Drainage Products
 - 8. Woodford Mfg. Co.
 - 9. Zurn Industries Inc., Hydromechanics Div.
- D. Wall, Roof and Yard Hydrants:
 - 1. Chicago Faucet Co.
 - 2. Jay R. Smith Mfg. Co.

3. Josam Mfg. Co.
4. MIFAB, Inc.
5. Prier Products, Inc.
6. Wade/Tyler Pipe; Sub. of Tyler Corp.
7. Watts Drainage Products
8. Woodford Mfg. Co.
9. Zurn Industries Inc., Hydromechanics Div.

E. Backflow Preventers:

1. Febco Sales, Inc.: Subs. of Charles M. Bailey Co., Inc.
2. Hersey Products, Inc.
3. ITT Lawler; Fluid Handling Div.
4. Watts Regulator Co.
5. Zurn Industries, Inc.; Wilkins-Regulator Div.
6. Beeco

F. Vacuum Breakers

1. Cash (A. W.) Valve Mfg. Corp.
2. Conbraco Industries, Inc.
3. Febco Sales, Inc.; Subs. of Charles M. Bailey Co., Inc.
4. Watts Regulator Co.
5. Zurn Industries, Inc.; Wilkins-Regulator Div.

G. Water Meters:

1. Badger Meter, Inc.
2. Hersey Products Inc.
3. Neptune Water Meter Co.: Subs. Neptune Int'l.
4. Sensus
5. Rockwell Int'l. Municipal & Utility Div.
6. Zurn Industries Inc.; Hays Fluid Controls Div.

H. Water Hammer Arresters:

1. Jay R. Smith Mfg. Co.
2. Josam Manufacturing Co.
3. MIFAB
4. Precision Plumbing Products, Inc.
5. Sioux Chief Manufacturing
6. Wade/Tyler Pipe; Sub. of Tyler Corp.
7. Watts Drainage Products
8. Zurn Industries, Inc.; Hydromechanics Div.

I. Dielectric Unions:

1. Perfection Corp.
2. Watts Regulator Co.
3. Victaulic Company

J. Y-Pattern Strainers:

1. Armstrong Machine Works
2. Hoffman Specialty ITT: Fluid Handling Div.
3. Metraflex Co.
4. Mueller
5. Spirax Sarco
6. Watts Regulator Co.

2.02 BACKFLOW PREVENTERS

- A. Refer to Plumbing Equipment Schedule for characteristics of valves.
- B. Refer to plans for backflow preventers at Kitchen related equipment.
- C. Domestic water system backflow preventer(s) shall operate on the reduced pressure principle. It shall be a complete assembly consisting of tight closing shutoff valves before and after the backflow device and protected by a strainer. An additional shut off isolation valve shall be located ahead of the strainer.
1. Reduced pressure principle devices shall be designed to include test cocks, a pressure differential relief valve located between two positive seating check valves and have renewable seats. The relief valve shall discharge to an air gap drain funnel assembly (ASSE 1013).
 2. Double check principle devices shall be designed to include test cocks and two positive seating check valves with renewable seats (ASSE 1015).

2.03 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER

- A. Valve Assembly (1/4" thru 2" size):
1. Bronze body construction, stainless steel and brass internal parts, screwed connection, inlet strainer (union body connections 3/4" and 1" only).
 2. Maximum design: 175 psi; temperature 140°F.
 3. Shut-off valves: quarter-turn ball valves
 4. Check valves: double seated with removable seats
 5. Test Cocks: ball valves
 6. Exact size and flow rate as noted on the drawings.

B. Valve Assembly (2-1/2" thru 3" size):

1. Bronze body construction with internal waterways epoxy coated. Stainless steel and brass internal parts and flanged connection; inlet strainer
2. Air inlet, water outlet discharge ports
3. Maximum design: 175 psi; temperature 110°F
4. Shutoff valves: NRS gate valves
5. Check valves: double seated with removable seats
6. Test cocks: ball valves
7. Air gap drain funnel assembly
8. Exact size and flow rate as noted on the drawings.

C. Valve Assembly (4" and larger):

1. Stainless steel construction; epoxy coated gate valves; flanged connection; inlet strainer
2. Air inlet, water outlet discharge ports
3. Maximum design: 175 psi; working pressure temperature 110°F
4. Shutoff valves: NRS gate valves (Waterous Series 500) (2) independently operating.
5. Check valves: spring loaded cam-checks; rubber faced discs with replaceable seats
6. Test cocks: ball valves
7. Air gap drain funnel assembly
8. Exact size and flow rate as noted on the drawings.

2.04 DOUBLE CHECK PRINCIPLE BACKFLOW PREVENTER

A. Valve Assembly (1/2" thru 2"):

1. Cast bronze body, modular construction
2. Replaceable seats and seat discs
3. Maximum design: 175 psi working pressure; 180°F temperature
4. Shut-off valves: quarter-turn ball valves
5. Check valves: captured spring assisted disc with rubber seat discs.
6. Test cocks: ball valves
7. Exact size and flow rate as noted on the drawings.

B. Valve Assembly (2-1/2" thru 3"):

1. Epoxy coated cast iron body, modular construction
2. Replaceable seats and seat discs
3. Maximum design: 175 psi working pressure; 110°F continuous to 140°F intermittent temperature.
4. Shut-off valves: non-rising stem gate valves
5. Check valves: captured spring assisted disc with rubber seat discs.
6. Test cocks: ball valves
7. Exact size and flow rate as noted on the drawings.

2.05 PRESSURE TYPE VACUUM BREAKER

- A. Vacuum Breaker:
 - 1. Certified under FCCCHR of USC Section 10, ASSE Standard 1020.
 - 2. Listed on the State Board of Health approved list.
 - 3. Exact size as noted on the drawings.

2.06 WATER METER:

- A. Water meter: Compound (Turbine) type, conforming to AWWA Standards. Size meter and arrange piping and specialties to comply with Utility Company requirements.
- B. Water meter: Sealed register displacement type, magnetic drive meter conforming to AWWA Standards. Arrange piping and specialties to comply with Utility Company requirements. Registration shall be in cubic feet of water.

2.07 WATER HAMMER ARRESTERS:

- A. Water Hammer Arresters: Water hammer arresters shall be sized, tested, and certified in accordance with PDI Standard WH-201, A.S.S.E.-1010 and A.N.S.I.-A112.26.1.
 - 1. Spun closed, one-piece, seamless type 'L' copper tube and factory charged, with acetal piston, three EPDM O-rings, pressure-lubricated with Dow Corning III silicone compound, FDA approved. Unit shall be pressure rated for 250 psi, designed to keep waterline at 150 psi working pressure during pressure surges following quick valve closure. Working temperature from 33° F to 250° F
 - 2. Constructed of all stainless steel and with internal heavy duty balanced expansion bellows, pre-charged suitable for operation in temperature range of minus 100 to 300 degrees F and maximum 250 psig working pressure.
- B. Type 'K'
 - 1. Hard drawn copper barrel with internal free floating piston with double "O-ring" seals. Seal lubricant to be approved for use in potable water systems.

2.08 HOSE BIBBS AND HYDRANTS:

- A. Hose Bibbs (HB-1): Bronze body, rough brass finish, wheel handle, 3/4 inch MPT inlet, 3/4 inch hose outlet, anti-siphon protection. Similar to Woodford Model 19.
- B. Hose Bibbs (HB-2): Cold and Hot water, horizontal mount, bronze body, rough brass finish, wheel handles, 3/4 inch MPT inlet, 3/4 inch hose outlet, anti-siphon protection, pressure relief valves, Woodford Model 22.

- C. Recessed Non-Freeze Wall Hydrant (WH-1): stainless steel hydrant, Matte Black finish, acetal polymer connector, vacuum breaker, hinged cover, 3/4 inch inlet and hose outlet. Similar to Aquor water systems SKU: VBHP002-TI-CG.

2.09 REACTION ANCHORS:

- A. Provide concrete thrust blocking or joint harness for all pressure piping in accordance with NFPA 24.
- B. Thrust blocking: Sufficient mass of concrete, bearing on solid undisturbed earth, to resist hydraulic thrust at maximum pressure to which pipe will be subjected, 150 psi minimum.
- C. Joint harness: Steel straps and rods across joints, securely anchored on pipe or other adequate anchorage to resist hydraulic thrust at maximum pressure to which pipe will be subjected, 150 psi minimum.
 - 1. Coal tar coating: Koppers Bitumastic type 50.
 - 2. Clamps, straps, and washers: steel, ASTM A506.
 - 3. Rods: Steel, ASTM A575
 - 4. Rod coupling: Malleable iron
 - 5. Bolts: Steel, ASTM A307
 - 6. Cast iron washers: Gray iron ASTM A126

PART 3 - EXECUTION

3.01 GENERAL

- A. Pipe relief lines required to nearest drain or as shown/indicated.
- B. Prior to substantial completion and occupancy by the Owner, all strainer assemblies shall be removed and cleaned.
- C. Backflow preventer shall be tested, and all defective devices repaired or replaced prior to acceptance.
- D. Equipment shall be installed in accordance with the drawings and all applicable state and local codes.

- E. Install backflow preventers at each connection to mechanical equipment and systems, and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Pipe relief outlet without valves, to nearest floor drain. RPZ backflow preventers are required only on specific services, per State of Indiana Administrative Rules, Section 327 IAC 8-10-4 "Cross Connection Hazards" and Section 327 IAC 8-10-8 "Inspection of Devices; Time Limits".
- F. Size and Locate Water Hammer Arresters as shown on the schedule and drawings on quick-closing valves as per the requirements of Standard PDI-WH 201 current edition, whether shown or not shown on the drawings.

END OF SECTION

SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install circulating pump(s) for the domestic hot water system(s) as shown on the drawings and herein specified.

1.02 QUALITY ASSURANCE:

- A. Reference Standards:
 - 1. UL Standard 778: "Motor Operated Water Pumps". All plumbing pumps shall be listed and labeled by UL or another nationally recognized testing laboratory (NRTL) to UL Standard 778.
 - 2. Hydraulic Institute: "Centrifugal Pumps - Instructions for Installation, Operation, and Maintenance."
 - 3. ASME Section VIII: Fabricate and stamp expansion tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
 - 4. IAC 8-10-3 Title 327 Indiana Department of Environmental Management; effective July 19, 1985. Each pump shall be provided with controls to prevent the operation of pressure booster pumps when the pump suction pressure drops below 20 psig.
- B. Provide electric motors and components which are NEMA listed and labeled.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Meter and Gauges: Section 22 05 19
- D. Basic Piping Requirements: Section 22 05 29
- E. Domestic Water Piping System: Section 22 11 16
- F. Identification for Piping and Equipment: Section 22 05 53
- G. Electrical: Division 26

1.04 SUBMITTALS

- A. Submit descriptive product literature and shop drawings in accordance with Division 1.
 - 1. Submittals and shop drawings shall include the following data:
 - a. Manufacturer's technical data including certified performance curves and rated capacity. Operating points shall be indicated on the performance curves.
 - b. Wiring schematics including ladder type diagrams which differentiate between factory installed and field installed portions.
 - c. Dimensional data including weights and required clearances.
 - d. Accessories furnished.
 - e. Manufacturer's installation requirements.
- B. Submit maintenance manuals in accordance with Division 1
 - 1. Maintenance manuals shall include the following:
 - a. Parts lists for each type and size of pump or system
 - b. Published installation instructions.
 - c. Troubleshooting maintenance guide for each type of pump or system.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. All pumps shall be stored in a dry location.
- B. Retain shipping flange protective covers and protective coatings during storage.
- C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- D. Comply with manufacturer's rigging instructions for handling.

1.06 DESIGN BASE AND COORDINATION

- A. The construction drawings indicate a system based on the information available to Engineer by a selected manufacturer of equipment. Electrical services, size, configuration and space allocations are consistent with that manufacturer's information.
- B. This manufacturer and other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the manufacturer for any different services, space, clearances, etc.

- C. Provide coordination with the project hydronic systems Balance Contractor for final balance of the pumps.
 - 1. Pump impeller sizing and pump performance: the pressure differential (head) required for each hydronic system has been estimated and noted in the pump schedule. The initial impeller size shall be selected based on this estimated head.
 - 2. The actual amount of head to overcome will vary above or below this estimate. The mechanical contractor shall change the impeller as required to suit actual job conditions at no additional cost to the Owner. Impeller sizing shall be coordinated with the Balancing Contractor and pump manufacturer.
 - 3. Refer to Section 23 05 93 Testing, Adjusting and Balancing for further conditions.

PART 2 - PRODUCTS

2.01 HOT WATER CIRCULATING PUMP

- A. Manufacturers:
 - 1. Amtrol, Inc.
 - 2. Armstrong Pumps, Inc.
 - 3. Grundfos Pumps Corp.
 - 4. ITT Bell & Gossett
 - 5. Peerless Pumps
 - 6. Pentair Aurora Pumps
 - 7. Taco, Inc.
- B. Refer to Plumbing Equipment Schedule on the drawings for pump characteristics.
- C. Pump shall be horizontal centrifugal type for inline installation.
- D. The pump shall be of the horizontal, oil lubricated type, specifically designed and guaranteed for quiet operation; suitable for 125 psig working pressure.
- E. The pump shall have a ground and polished steel shaft with integral thrust collar. The shaft shall be supported by two horizontal sleeve bearings designed to circulate oil. The pumps shall be equipped with a watertight seal to prevent leakage. Mechanical seal faces to be carbon on ceramic.
- F. Motors:
 - 1. Motors shall meet requirements of Section 22 05 13, Common Motor Requirements.
 - 2. The motor shall be non-overloading at any point on the pump curve.
- G. Furnish vibration isolation as specified in Section 22 05 48, Vibration and Seismic Controls for Piping and Equipment.

2.02 AQUASTAT (120 DEGREE F)

- A. Provide a temperature sensing switch to regulate the return water temperature by automatically turning the domestic hot water circulating pump on and off.
 - 1. Limited adjustable dead band at mid-range of 30°F.
 - 2. Adjustable operating range of 50°F to 160°F.
 - 3. Unit shall be set to turn pump on at 110°F and off at 120°F.
 - 4. Adjustable snap action switch.
 - 5. General purpose enclosure with direct mount transducer.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Comply with the manufacturer's instructions for installation.
- B. Install pumps at locations indicated on the drawings, providing access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Suspend in-line pumps with all-thread hanger rod and vibration isolation hangers of sufficient size to support the weight of the pump independent from the piping.
- D. Provide a flexible connection between the suction and discharge header of each booster pump package and the building system piping.

3.02 CONNECTIONS:

- A. All piping shall be brought to the pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the pump connections or piping.
- B. Each pump used for domestic hot water return shall be installed with a shut-off valve and strainer installed in the suction side of the pump and a check valve, a balancing valve, and a shut-off valve in the discharge. Valves shall be the same size as the piping connecting the pump.

3.03 TRAINING:

- A. Manufacturer's representative shall instruct the Owner's maintenance personnel on the operation and proper care of the domestic booster pump equipment and a report shall be submitted to the Architect/Engineer.

3.04 WARRANTY

- A. The pump shall be warranted in writing against defects in materials or workmanship under normal use and service for a period of one year after date of original operation.

END OF SECTION

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install all sanitary, waste and vent piping from plumbing fixtures, drainage fittings and specialty items as shown on the plumbing drawings or herein specified.
- B. All piping shall be installed in compliance with the latest local approved Plumbing Code and as recommended by the International Code Council (ICC).
- C. All work specified under this section includes sanitary waste and vent system piping and fittings to a coordinated point 5'-0" outside the building.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Basic Piping Requirements: Section 22 05 29
- D. Trenching, Backfilling and Compacting (Interior): Section 22 05 41
- E. Drainage Piping Cleanouts: Section 22 05 76
- F. Identification for Piping and Equipment: Section 22 05 53
- G. Plumbing Pipe and Equipment Insulation: Section 22 07 19
- H. Sanitary Drains: Section 22 13 19
- I. Plumbing Fixtures and Trim: Section 22 42 00

1.03 SUBMITTALS:

- A. Product data for each piping type specified.
 - 1. Submittals and shop drawings shall include the following data:
 - a. Manufacturer's recommended installation methods.
- B. Certification of Compliance with ASME and UL fabrication requirements specified below.
- C. Test reports specified in Part 3 of this Section.

1.04 SEQUENCING AND SCHEDULING:

- A. Coordinate the installation of pipe sleeves for foundation wall penetrations.
- B. Coordinate with installation of sanitary sewer systems as necessary to interface building drains with drainage piping systems.
- C. Interruption of Existing Sanitary Service: Do not interrupt sanitary services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary services.
 - 2. Do not interrupt sanitary services without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING SYSTEM MATERIALS

- A. Sanitary Waste Pipe and Fittings - (Underground):
 - 1. 2" thru 12": DWV, ASTM A74, service weight cast iron soil pipe; bell and spigot; one piece DuPont neoprene compression gasket, ASTM Standard C564 and ASTM 1563.
 - 2. 2" thru 12": DWV, service weight hubless cast iron soil pipe; plain cut ends; conforming to CISPI Standard 301 and ASTM A888; 2" thru 4" no-hub coupling to be medium duty with (4) adjustable stainless steel bands and stainless steel screws per coupling, as conforming to CISPI 310 and ASTM C1540 with neoprene gasket to meet ASTM C564 Standards; 5" thru 12" no-hub coupling to be heavy duty with (6) adjustable stainless steel bands and stainless steel screws per coupling.
 - a. Medium Duty:
 - (1) Anaco-Husky (HD 2000)
 - (2) Charlotte/Ideal (MD)
 - (3) Mission (Heavyweight)
 - (4) Tyler Pipe (Wide-Body)
 - b. Heavy Duty:
 - (1) Anaco-Husky (SD 4000)
 - (2) Charlotte/Ideal (HD)
 - (3) Mission (Heavyweight)
 - (4) Tyler Pipe (Wide-Body)

3. 2" thru 12": DWV, Schedule 40 PVC, bell ends/couplings; ASTM D2564; solvent weld joints; ASTM A-2665; ASTM F656; ASTM D2855.
- B. Sanitary Waste Pipe and Fittings – (Aboveground):
1. 1-1/2" thru 12": DWV, ASTM A74, service weight cast iron soil pipe; bell and spigot; one piece DuPont neoprene compression gasket, ASTM Standard C564 and ASTM 1563.
 2. 1-1/2" thru 12": DWV, service weight hubless cast iron soil pipe; plain cut ends; conforming to CISPI 301 and ASTM A888. 1-1/2" thru 4" no-hub coupling to be medium duty with (4) adjustable stainless-steel bands and stainless-steel screws per coupling, as conforming to CISPI 310 and ASTM C1540 with neoprene gasket to meet ASTM C564 Standards; 5" thru 12" no-hub coupling to be heavy duty with (6) adjustable stainless steel bands and stainless steel screws per coupling.
 - a. Medium Duty:
 - (1) Anaco-Husky (HD 2000)
 - (2) Charlotte/Ideal (MD)
 - (3) Mission (Heavyweight)
 - (4) Tyler Pipe (Wide-Body)
 - b. Heavy Duty:
 - (1) Anaco-Husky (SD 4000)
 - (2) Charlotte (HD)
 - (3) Mission (Heavyweight)
 - (4) Tyler Pipe (Wide-Body)
 3. 1-1/2" thru 12": DWV, Schedule 40 PVC, bell ends/couplings; ASTM D2564; solvent weld joints; ASTM A-2665; ASTM F656; ASTM D2855.
 4. 1-1/4" thru 6": DWV, hard drawn seamless copper tube and fittings 50-50 soldered joints; ASTM-306. (NOT TO BE USED ON URINAL WASTE)
- C. Sanitary Vent Pipe and Fittings – (Underground):
1. 2" thru 12": DWV, ASTM A74, service weight cast iron soil pipe; bell and spigot; one piece DuPont neoprene compression gasket, ASTM Standard C564 and ASTM 1563.
 2. 2" thru 12": DWV, service weight hubless cast iron soil pipe; plain cut ends; conforming to CISPI 301 and ASTM A888. 1-1/2" thru 4" no-hub coupling to be medium duty with (4) adjustable stainless steel bands and stainless steel screws per coupling, as conforming to CISPI 310 and ASTM C1540 with neoprene gasket to meet ASTM C564 Standards; 5" thru 12" no-hub coupling to be heavy duty with (6) adjustable stainless steel bands and stainless steel screws per coupling.
 - a. Medium Duty:
 - (1) Anaco-Husky (HD 2000)
 - (2) Charlotte/Ideal (MD)
 - (3) Mission (Heavyweight)
 - (4) Tyler Pipe (Wide-Body)

- b. Heavy Duty:
 - (1) Anaco-Husky (SD 4000)
 - (2) Charlotte/Ideal (HD)
 - (3) Mission (Heavyweight)
 - (4) Tyler Pipe (Wide-Body)
 - 3. 2" thru 12": DWV, Schedule 40 PVC, bell ends/couplings; ASTM A-2665; solvent weld joints; ASTM D 2564; ASTM F656; ASTM D2855.
- D. Sanitary Vent Pipe and Fittings – (Aboveground):
- 1. 1-1/2" thru 12": DWV, ASTM A74, service weight cast iron soil pipe; bell and spigot; one piece DuPont neoprene compression gasket, ASTM Standard C564 and ASTM 1563.
 - 2. 1-1/2" thru 12": DWV, service weight hubless cast iron soil pipe; plain cut ends; conforming to CISPI 301 and ASTM A888. 1-1/2" thru 4" no-hub coupling to be medium duty with (4) adjustable stainless-steel bands and stainless steel screws per coupling, as conforming to CISPI 310 and ASTM C1540 with neoprene gasket to meet ASTM C564 Standards; 5" thru 12" no-hub coupling to be heavy duty with (6) adjustable stainless steel bands and stainless steel screws per coupling.
 - a. Medium Duty:
 - (1) Anaco-Husky (HD 2000)
 - (2) Charlotte/Ideal (MD)
 - (3) Mission (Heavyweight)
 - (4) Tyler Pipe (Wide-Body)
 - b. Heavy Duty:
 - (1) Anaco-Husky (SD 4000)
 - (2) Charlotte/Ideal (HD)
 - (3) Mission (heavyweight)
 - (4) Tyler Pipe (Wide-Body)
 - 3. 1-1/4" thru 12": DWV, Schedule 40 PVC, bell ends/couplings; ASTM A-2665; solvent weld joints; ASTM D 2564; ASTM F656; ASTM D2855.
 - 4. 1-1/4" thru 6": DWV, hard drawn seamless copper tube and fittings 50-50 soldered joints; ASTM-306/ASME B16.32 or ASME B16.29; ASTM B32.
- E. Pumped Waste Discharge Pipe and Fittings – (Underground):
- 1. 2" - 4" DWV galvanized steel pipe, screwed or victaulic fittings. ASTM A53, ASTM A120 teflon tape for screwed joints.
 - a. Victaulic Couplings: Installation-Ready, for direct slab installation without field disassembly, including a center-leg gasket with pipe stop to ensure proper groove engagement alignment, and pipe insertion depth. Victaulic Style 107N (rigid) and 177N (flexible).
 - 2. 2" thru 12": DWV, Schedule 40 PVC, bell ends/couplings; ASTM A-2665; solvent weld joints; ASTM D 2564; ASTM F656; ASTM D2855.

- F. Pumped Waste Discharge Pipe and Fittings – (Aboveground):
 - 1. 1-1/2" - 4" DWV galvanized steel pipe, screwed or victaulic fittings. ASTM A53, ASTM A120 teflon tape for screwed joints.
 - a. Victaulic Couplings: Installation-Ready, for direct slab installation without field disassembly, including a center-leg gasket with pipe stop to ensure proper groove engagement alignment, and pipe insertion depth. Victaulic Style 107N (rigid) and 177N (flexible).
 - 2. 1-1/4" thru 12": DWV, Schedule 40 PVC, bell ends/couplings; ASTM A-2665; solvent weld joints; ASTM D 2564; ASTM F656; ASTM D2855.
- G. Sanitary Waste and Vent Pipe Fitting exposed in Kitchen/Dishwashing/Food Preparation Areas (1-1/4" through 6"): DWV copper, seamless tube/brass fittings, ASTM B306; 50-50 soldered joints; ASME B16.23; ASME B16.29; ASTM B32.
- H. Plenum Shield Blanket or Wrap
 - 1. All plastic piping installed within fire rated return air plenums shall be wrapped with a high temperature insulation blanket or wrap meeting the flame spread and smoke developed rating of the Building Code. Product shall be 1/2" thick foil faced with a density of 6 pcf. Product shall be suitable for operation at temperatures up to 2300 deg. F.
- I. Air-Admittance Valves:
 - 1. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
 - 2. Housing: Plastic.
 - 3. Operation: Mechanical sealing diaphragm.
 - 4. Size: Same size as connected fixture of branch vent piping.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Wherever polyvinylchloride (PVC) pipe is installed within a fire rated plenum, it shall be wrapped with Plenum Shield Blanket. Each pipe shall be individually wrapped. Verify location with HVAC plans. Wrap to be installed with stainless steel banding with crimp clips at maximum 10" on center as recommended by the manufacturer.

3.02 EXAMINATION:

- A. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.
- B. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.

- C. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.03 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS:

- A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.
- B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated invert elevation.
- C. Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

3.04 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into account many design considerations. So far as practical, install piping as indicated.
- B. All horizontal waste drainage piping shall be installed with the minimum required pitch unless otherwise shown or specified. Slope as follows: 1-1/4" to 2-1/2" pipe slope at 1/4" per foot. 3" and larger pipe slope at 1/8" per foot. No piping is to be sloped less than 1/8" per foot.
- C. Use fittings for all changes in direction and all branch connections.
- D. Install expansion joints on vertical risers as indicated, and as required by the plumbing code.
- E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- F. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- G. Horizontal pipe and fittings 5 inches and larger must be suitably braced to prevent horizontal movement, at every branch opening or change of direction by use of braces, blocks, rodding or other approved method, to prevent movement or joint separation.
- H. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

- I. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Allow sufficient space above removable ceiling panels to allow for panel removal.
- J. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals.
- K. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 7 for special sealers and materials. All piping penetrations through fire rated walls shall be cast iron.
- L. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited. Double wye, sanitary tee fittings or double combination wye and 1/8 bend fittings are not permitted in the horizontal position.
- M. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- N. Extend building drain to connect to sewer piping, of size and in location indicated for service entrance to building. Sewer piping is specified in a separate section of Division 33.
- O. All joints for bell and spigot cast iron drainage pipe, buried or inaccessible, shall be made watertight.
- P. All cast iron pipe buried in the ground shall have a firm bearing along the entire length of undisturbed earth or engineered bedding.
- Q. The bell of all horizontal pipe shall not rest upon the earth but have free area for caulking.
- R. Cleanout fitting/adaptors shall be of the same manufacturer as the pipe manufacturer.

- S. Horizontal and vertical pipe cleanouts shall be installed in accessible locations with clearances as required by the Plumbing Code. Countersunk cleanout plugs shall be installed where raised heads may cause a hazard.
- T. Cleanout plugs shall be threaded type; gas and watertight without the use of gasket or packing material.
- U. All openings for connections must be closed with screw plugs until used and all hand holes must be closed at once and the sewer kept clean (any earth or foreign matter that may get into the sewer must be removed by this trade).
- V. Furnish all required plumbing vents from soil and waste pipes. All vents are to extend 12" above the roof line and be provided with regular roof connections to receive flashing made for this purpose.
- W. Provide on each vent pipe, a seamless lead or neoprene rubber flashing specifically manufactured for vent size penetrating roof.
- X. Rough-in piping shall be stubbed three inches from the finished building surfaces. Temporarily plug and cap piping until equipment is ready for final installation.
- Y. Obtain dimensioned rough-in shop drawings from equipment suppliers.
- Z. Any suspended drain line serving fixtures on floors above shall be suspended from the floor as high as possible.
- AA. The installation of polyvinylchloride (PVC) pipe or fittings shall not be permitted on waste lines from kitchen equipment receiving more than 120 degree F hot water. Cast iron pipe to be used.
- BB. Install air-admittance valves on drain piping as indicated on drawings.
- CC. Install air-admittance valves in recessed wall boxes as indicated on drawings

3.05 FIELD QUALITY CONTROL:

- A. Inspections:
 - 1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

- b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
 - 3. Re-inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection by the plumbing official.
 - 4. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Piping System Test drainage and vent system as follows:
- 1. Test for leaks and defects in all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 - 2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
 - 3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water column shall be maintained for 4 hours with no leaks. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
 - a. During cold weather construction periods and only with prior approval of the engineer, an air pressure test of minimum 5 PSIG shall be maintained for a period of 1 hours with no drop in pressure.
 - 4. Finished Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Plug the stack openings on the roof and building drain where it leaves the building and introduce air into the system equal to a pressure of 1" water column. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without the introduction of additional air throughout the period of inspection. Inspect all plumbing fixture connections for gas and water leaks.
 - 5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for all tests and required corrective action.

3.06 ADJUSTING AND CLEANING:

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris as work progresses.

- C. Clean interior of all existing waste drain piping systems under slab to a termination point outside the building with a water jet drain cleaning system. Cleaning process involves pumping of water through a sewer hose at a high pressure to a jetter nozzle attachment to the end of a hose. The nozzle is to disburse the water at multiple angles while traveling through the entire drainage piping to remove build up from the interior pipe surfaces of the existing drainage piping systems to be free of clogs and to provide free flow of liquids. Verify with Owner for As-Built drawings indicating the sizes, locations and flow directions of all existing under slab waste drain piping. Work to be performed by Commercial Sewer Cleaning Company or approved equal.

3.07 PROTECTION:

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- C. Exposed ABS or PVC Piping: Protect plumbing vents exposed to sunlight with 2 coats of a water-based latex paint.

END OF SECTION

SECTION 22 13 19 - SANITARY DRAINS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install sanitary drains and fittings as shown on the plumbing drawings or herein specified.
- B. Sanitary drains and fittings shall include floor drains, shower drains, open site drains, area drains, deck drains, floor sinks, trench drains and specialty fittings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions - Plumbing: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Basic Piping Requirements: Section 22 05 29
- D. Identification for Piping and Equipment: Section 22 05 53
- E. Trenching, Backfilling and Compacting (Interior): Section 22 05 41
- F. Drainage Piping Cleanouts: Section 22 05 76
- G. Plumbing Pipe and Equipment Insulation: Section 22 07 19
- H. Sanitary Waste & Vent Piping System: Section 22 13 16

1.03 SUBMITTALS

- A. Submit shop drawings for each sanitary drain type and drainage fittings in accordance with Specifications Section 22 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 SANITARY DRAINS

- A. Refer to Floor Drain Schedule on drawings for characteristics of drains.
- B. Manufacturers:
 - 1. ACO (trench drains)
 - 2. ABT, Inc. (trench drains)
 - 3. Dura - Trench (trench drains)
 - 4. Jay R. Smith Co.
 - 5. Josam Mfg. Co.
 - 6. MIFAB
 - 7. Sioux Chief Manufacturing

8. Wade/Tyler Pipe; Subs. Of Tyler Corp.
9. Watts Drainage Products
10. Zurn Industries, Inc.

2.02 FLOOR DRAIN TRAP GUARDS

- A. All floor drains which do not receive regular discharge of wastewater year round shall be protected by a trap primer system or equipped with a floor drain "Trap Guard".
- B. Refer to drawings for seal methods.
- C. The omission of listing "Trap Guard" for a scheduled floor drain on the Floor Drain Schedule, shall not result in additional costs to the project.
- D. Floor Drain Trap Guards:
 1. Sewer Gas and Sewage Odor Protection Trap Guard:
 - a. Material: Smooth, soft, flexible elastomeric PVC material molded into shape of duck's bill open on top with curl closure at bottom, or of a diaphragm shape with sealing gaskets and ABS plastic housing.
 - b. Allows wastewater to open and adequately discharge floor drain through its interior.
 - c. Closes and returns to original molded shape after waste water discharge is complete.
 2. Compliance:
 - a. ASME A112.6.3.
 - b. ASSE 1072.
 - c. CSA B 79.
 - d. IAPMO R & T
 - e. NSF/ANSI 14.
- E. Manufacturers:
 1. IPS Corporation – Green Drain
 2. Jay R. Smith Co.
 3. MIFAB
 4. ProSet Systems, Inc.
 5. SureSeal Manufacturing, LLC
 6. Zurn
 7. Sioux Chief Manufacturing

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install drains in accordance with manufacturer's written instructions and in location shown on the drawings.

- B. Drain outlets to be same size as shown on drawings.
- C. Provide deep seal P-traps on all drains not specified with integral traps.
- D. Coordinate flashing work with work of waterproofing and adjoining substrate work.
- E. Maintain integrity of waterproof membranes, where penetrated.
- F. Waterproof each floor drain above ground by providing a 16-inch x 16-inch flashing constructed in place using 40 mil chlorinated polyethylene sheets (Chloraloy 240). Install using manufacturers recommended procedure and in accordance with the Plumbing Code. Installation of flashing shall be coordinated with the floor construction.
- G. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor surface.
- H. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring.
- I. Position drains so that they are accessible and easy to maintain.
- J. Install trap guard in each floor drain where indicated or specified.
- K. Connect trap primer to each floor drain where indicated or specified.

END OF SECTION

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SECTION 22 13 23 - INTERCEPTORS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install interceptor as shown on the drawings.
- B. All piping to and from interceptors shall be installed in compliance with the latest local approved Plumbing Code and as recommended by the International Code Council (ICC).

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Basic Piping Requirements: Section 22 05 29
- D. Trenching, Backfilling and Compacting (Exterior): Section 22 05 40
- E. Trenching, Backfilling and Compacting (Interior): Section 22 05 41
- F. Drainage Piping Cleanouts: Section 22 05 76
- G. Identification for Piping and Equipment: Section 22 05 53
- H. Plumbing Pipe and Equipment Insulation: Section 22 07 19
- I. Sanitary Drains: Section 22 13 19
- J. Plumbing Fixtures and Trim: Section 22 42 00

1.03 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of interceptors of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Indiana State Board of Health.
 - 2. Indiana State Plumbing Code.
 - 3. City of Indianapolis, Indiana, Utility Company requirements.
- C. PDI Compliance: Test and rate grease interceptors in accordance with PDI Standard G101, "Testing and Rating Procedure for Grease Interceptors".
- D. Hydromechanical third party performance tested and listed IAPMO to ASME #A112.14.3 (Type D for 100 GPM and Type C for 200 GPM) and CSA B481.1 grease interceptor standards. (TBD)

1.04 SUBMITTALS:

- A. Shop Drawings: Submit manufacturer's assembly type interceptor shop drawings indicating capacities, dimensions, weights, required clearances, and methods of assembly of all components.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Handle interceptors carefully to prevent damage, and/or breaking. Do not install damaged or broken interceptors; replace with new.
- B. Store interceptors in clean dry place. Protect from weather, dirt, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.01 OIL INTERCEPTORS:

- A. General: Provide oil interceptors of size and capacity as indicated on drawings.
- B. Construction: Seamless, rotationally – molded high-density polyethylene tank
 - 1. Built-in flow control
 - 2. Diffusion flow technology
 - 3. Vent connection
 - 4. Cover with water and gas tight seal, field adjustable riser, minimum 16,000 pound load capacity.
- C. Variations: provide the following variations
 - 1. Anchor kit
 - 2. Extension riser
 - 3. Oil level monitoring system (120 volt, 60 hz)
 - a. UL Listed
 - b. Provides warning of high oil level conditions with interface float.
 - c. Single phase, 120 volt, 60 hertz power required.
 - d. NEMA 4X fiberglass, corrosion resistant, weatherproof enclosure suitable for outdoor use and damp environments.
 - e. Audible Alarm Buzzer, 95dB pulsing horn with no timeout.
 - f. High Oil Light, indicates oil has accumulated below the oil interface float or the tank liquid level is below the High Oil Interface Float.
 - g. Power On light inside enclosure. Visible from the outside. Green light indicates the power is on.
 - h. Horn off button that silences the audible alarm when pressed.
 - i. Test button that when pressed will test the system electronics.
 - j. Locking clasp on door.
 - k. Alarm bell stays on until reset. Light stays on until reset, even if level goes down.
 - l. Unit comes supplied with extra dry contact for connection to a building alarm system.

- m. Interface float, detecting oil level.
- 4. Manufacturer: subject to compliance with requirements
- D. Manufacturer: subject to compliance with requirements provide interceptors of the following manufacturers:
 - 1. Striem
 - 2. Proceptor
 - 3. Approved equal

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which interceptors are to be installed, and substrate which will support interceptors. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF INTERCEPTORS:

- A. General: Install interceptors as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
- B. Support: Anchor interceptors securely to substrate. Locate interceptors so adequate clearance is provided to remove covers and sediment buckets. Set recessed units so top of cover is flush with finished floor **(OR)** finish grade.
- C. Set interceptor level and plumb.
- D. Piping: Connect inlet and outlet piping to interceptors. Extend oil draw-off where applicable.
- E. Vent: Provide vent from flow control to building vent system or to exterior.
- F. Provide vent pipe from Grease Interceptor as indicated on detail and route as indicated on drawings.
- G. Install level sensor and controller. Coordinate with Electrical Contractor.
- H. Coordinate invert elevations of piping at inlet and outlet of interceptor with Site Contractor.

3.03 PROTECTION:

- A. Protect interceptors during remainder of construction period, to avoid clogging with construction materials and debris, and to prevent damage from construction debris and traffic.

END OF SECTION

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SECTION 22 31 00 - WATER SOFTENERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install from inlet to outlet an automatic water softener(s) system and appurtenances as shown on the drawings and herein specified.

1.02 DESCRIPTION OF WORK:

- A. Types of water conditioners specified in this Section include the following:
 - 1. Commercial water softeners
- B. Refer to Division 26 Sections for the following work; not work of this Section.
 - 1. Power supply wiring from power source to power connection on water conditioners. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- C. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections:
 - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.

1.03 QUALITY ASSURANCE:

- A. Manufacturers' Qualifications: Firms regularly engaged in manufacturer of water conditioners, of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.04 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Concrete Pads and Curbs: Section 22 05 05
- D. Basic Piping Requirements: Section 22 05 29
- E. Identification of Piping and Equipment: Section 22 05 53
- F. Plumbing Pipe and Equipment Insulation: 22 07 19
- G. Domestic Water Piping: Section 22 11 16
- H. Division 26

1.05 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units.
 - 1. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and parts lists for each water conditioner, control, and accessory; including "troubleshooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division-1.

1.06 CODES AND STANDARDS:

- A. ASME Compliance: Construct softener tanks in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, provide stamp and certification.
- B. UL Labels: Provide water conditioners ancillary electrical components which have been listed and labeled by UL.
- C. NEMA Standards: Provide electrical controls and enclosures conforming to applicable standards of NEMA for environment where water conditioners are indicated.
- D. NSF Compliance: Construct and install water conditioners in accordance with NSF Standard 44 "Cat-ion Exchange Water Softeners Relating to Supplementary Treatment of Potable Water."
- E. Mineral Standards: Provide mineral products acceptable under state and local public health control regulations.

1.07 PRODUCT WARRANTY:

- A. General: Provide limited product warranty for water conditioners covering the following:
 - 1. Attrition loss of mineral not to exceed 3 % per year for first 3 years.

2. Under actual operating conditions, mineral shall not be washed out of system during service run or backwashing period.
3. Turbidity and color of effluent, due to passing through softener system, shall not be greater than incoming water.
4. Underdrain system, gravel, and mineral shall not become fouled, either with turbidity or by dirt, or scale from the softening system, or present in soft water, while operating as noted in manufacturer's operating instructions.

1.08 EXTENDED MAINTENANCE SERVICES:

- A. Agreement to Maintain: Prior to time of final acceptance, submit 4 copies of Manufacturer's "Agreement for Continued Service and Maintenance" for water softener, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing and including replacement of materials and equipment for 1-year period with option for renewal of Agreement by Owner.

PART 2 - PRODUCTS

2.01 WATER SOFTENER: (FIBERGLASS SYSTEM)

- A. Softener Tank(s):
 1. Softener tanks to be one-piece, non-metallic and of seamless construction with continuous fiberglass roving outer shell. Tank shall be rated at 125 psig and 100°F. A handhole shall be provided in the top head.
 2. A lower distribution system shall be provided within the softener tank for the uniform collection of the softened water and the equal distribution of the backwash water and shall discharge water laterally or downward.
 3. Construction shall be of corrosion resistant materials not subject to dezincification, galvanic corrosion or rusting. The upper distribution system shall be installed in the softener tank to equally distribute incoming hard water over the cross-sectional area of the mineral bed. The use of screens or retaining devices will not be acceptable.
- B. Softener Capacity:
 1. Provide high capacity exchange resin of sulfonated polystyrene, stable over the entire pH range with good resistance to bead fracture from attrition or shock. Provide resin having the capacity of removing 30,000 grains of hardness as calcium carbonate, per cubic foot of resin, when regenerated with 15 pounds of salt.

C. Brine System:

1. A combination of fiberglass salt storage tank and brine measuring tank with dimensions as scheduled shall be provided. Construct tank of 3/16 inch thick fiberglass or rotationally molded polyethylene with cover. Equip brine tank with full-operated plastic fitted brine valve for automatic control of brine withdrawn and freshwater refill.

D. Main Operating Valve:

1. Provide motor driven piston type valve, incorporating 2 time-tested hydraulically balanced pistons. Valve to have no contact of dissimilar metals within the valve and require no special tools to service. Equip valve with internal brine injector to draw brine at a constant rate independent of water pressure. Valve shall be made of lead-free brass manufactured by Fleck or approved equal.
2. Provide sampling cock on valve or piping.
3. Provide automatic flow control to maintain proper backwash and flush rates over wide variations in operating pressures. The flow control to require no field adjustment.

E. Automatic Controls:

1. Provide cycle controls, factory mounted and wired on units, which incorporate adjustable duration of various steps of regeneration. Provide push button start as well as automatic operation.
2. Provide electronically actuated main operating valve through steps of regeneration and return to service.
3. All control mechanisms shall be enclosed in a gasketed moisture resistant case, rated as a NEMA 3 enclosure and conforming to Underwriters Laboratories specifications. The unit will have provisions for individual adjustment of the backwash and rinse cycles and shall also have provisions for manually regenerating the water softener in the event of power failure.
4. The control valve mechanism shall be designed to prevent hard water by-pass to service during regeneration.
5. Water softeners shall regenerate from electronic usage flow meters.

F. Accessories:

1. Provide pressure gauges for hard water inlet and soft water outlet.
2. Provide sampling cocks for hard water inlet and soft water outlet for each tank.
3. Provide position indicator to indicate the position of the main operating valve.

G. Test Kit:

1. Furnish a complete hardness test kit for Owner's use to periodically ascertain water quality.

- H. Manufacturers
 - 1. Aqua Systems
 - 2. Culligan
 - 3. Enting
 - 4. Lakeside Water Treatment
 - 5. Marlo
 - 6. North Star

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Examine areas and conditions under which water conditioners are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF WATER CONDITIONERS:

- A. General: Install water conditioners where indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that water conditioners comply with requirements and serve intended purposes.
- B. Access: Provide access and service space around and over water conditioners as indicated, but in no case less than that recommended by manufacturer.
- C. Support: Provide 4" high concrete pad under water conditioners. Plumb and level units.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submitted to Electrical Installer.
- E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- F. Provide shutoff valves and unions or flanges on water connections.
- G. Pipe discharge drain line to nearest floor drain. Terminate over the floor drain with a code approved air gap fitting.

3.03 SALT AND RESIN CHARGE:

- A. Softeners shall be fully charged with fresh salt and mineral at the project completion.
- B. Contractor to supply one brine tank full of salt.

3.04 SERVICE:

- A. Start-up service shall be furnished at no additional expense to the Owner consisting of pre-start-up inspection, initial start-up after installation, adjustments as required, soft water check, and instructions to the Owner's representative as to proper operation. Said service shall not be less than 8 hours total time and shall continue until such time as the Architect/Engineer determines that the equipment operation is satisfactory.

END OF SECTION

SECTION 22 34 00 – DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide water heater(s) and appurtenances as shown on the drawings and herein specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Identification for Pipe and Equipment: Section 22 05 53
- D. Plumbing Pipe and Equipment Insulation: Section 22 07 19
- E. Domestic Water Piping System: Section 22 11 16
- F. Flues and Vents: Section 22 51 23

1.03 SUBMITTALS

- A. Submit shop drawings for domestic water heaters specified herein in accordance with Specifications Section 22 05 01, General Provisions.

1.04 DESIGN BASE

- A. The construction drawings indicate a system based on the information available to Engineer by a selected manufacturer of equipment. Electrical services, size, configuration and space allocations are consistent with that manufacturer's information.
- B. This manufacturer and other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the manufacturer for any different services, space, clearances, etc.

1.05 TESTING

- A. Heat exchangers shall be hydrostatically factory tested to 1-1/2 times the design pressure in accordance with ASME VIII Code.
- B. The inspector shall make visual inspections with regard to:
 - 1. Location, size and straightness of supports, nozzles and couplings.
 - 2. Quality of welds.

3. Surface finish.
- C. Capacity Test:
1. The heat exchangers must be factory tested and certified to deliver the specified flow and heating capacity under the specified conditions as listed in the equipment schedule. The tube friction shall not exceed those specified in the schedules.
 2. Heat exchangers must be under steady state conditions for a minimum of 30 minutes before test data is taken.
 3. Test data for heat exchangers capacity shall be collected for a minimum of 30 minutes under steady state conditions. Test data shall be recorded in not longer than 5 minute intervals and shall be averaged or integrated with time.

1.06 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of water heaters of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
1. UL Compliance: Construct water heaters in accordance with the following UL standards:
 2. UL 1453, "Electric Booster and Commercial Storage Tank Water Heaters"
- C. Provide water heater components which are UL-listed and labeled.
- D. NSF Compliance: Construct and install water heaters located in food service establishments in accordance with NSF 5, "Standard for- Hot Water Generating Equipment for Food Service Establishments using Spray Type Dishwashing Machines."
- E. NEC Compliance Install electric water heaters in accordance with requirements of NFPA 70, "National Electrical Code."
- F. NSF Labels: Provide water heaters which are listed and labeled by National Sanitation Foundation.
- G. ASME Code Symbol Stamps: Provide water heater and safety relief valves which comply with ASME Boiler and Pressure Vessel Code and are stamped with appropriate code symbols.
- H. ASHRAE Compliance: Provide water heaters with Performance Efficiencies not less than prescribed in ASHRAE 90.1.

PART 2 - PRODUCTS

2.01 HIGH EFFICIENCY TANKLESS GAS FIRED WATER HEATER

- A. Gas fired, tankless, condensing, wall-mounted water heater(s) shall be direct vent and certified by CSA Group to the latest edition of ANSI Standard Z21.10.3/CSA 4.3.
- B. Water Heater(s) shall have a 15-year limited Heat Exchanger warranty and 5-year limited Parts warranty (8 year Heat Exchanger and 5-year Parts for Commercial use).
- C. Unit(s) shall be designed to burn natural gas.
- D. Water heater(s) shall be vented with 2" CPVC vent pipe at a distance not to exceed 60' (or equivalent) with each elbow equal to 8' of pipe length or 3" CPVC vent pipe at a distance of 150' (or equivalent) with each elbow equal to 5' of pipe length. Water heater(s) is rated for 150 PSI working water pressure and 300 PSI test pressure. Gas supply pressure shall be 3.5" to 10.5" WC for natural gas.
- E. Unit(s) shall have a steel case, dual stainless steel heat exchangers, eco premixed burner, negative pressure gas valve, dual venturi, 3/4" inlet gas connection, 3/4" brass inlet/outlet water connections.
- F. Unit(s) shall include features such as an adjustment for installations at high elevation, temperature lockout and temperature options from 98 - 120°F in 1°F intervals and 125-140°F in 5°F intervals.
- G. The unit(s) shall include additional temperature options of 150 – 180°F in 10°F intervals, and 182°F for high temperature commercial applications.
- H. The water heater(s) shall be controlled by an internal circuit board that monitors the inlet and outlet temperatures with installed thermistors, sensing and controlling flow rate to set point temperature with air-fuel ratio controls in order to maintain thermal combustion efficiency.
- I. Unit(s) shall include safety features such as flame sensor system, high limit sensors, overheat prevention device, freeze protection mode and fan motor rotation detector.
- J. Manufacturers:
 - 1. Navien, Inc.

2.02 THERMAL EXPANSION ABSORBERS:

- A. Furnish and install where indicated on Contract Documents. Thermal expansion absorber constructed of materials suitable for potable water.
- B. Size and number as indicated, constructed of welded carbon steel for 150 psig working pressure.

- C. Separate air charge from system water to maintain design expansion capacity, by means of a flexible diaphragm securely sealed into the tank.
- D. Provide taps for pressure gage, air charge fitting and drain fitting. Support vertical tanks with steel legs or base: support horizontal tanks with steel saddles.
- E. Tank, with taps and supports, shall be constructed, tested and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.
- F. Manufacturers: Subject to compliance with requirements, provide thermal expansion absorbers of one of the following:
 - 1. Amtrol Inc.
 - 2. A. O. Smith Corp.
 - 3. Armstrong Pumps, Inc.
 - 4. Bell & Gossett ITT: Fluid Handling Div.
 - 5. Calefactio
 - 6. Watts
 - 7. Wessels Company

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which water heaters are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 GENERAL

- A. General: Install water heaters in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Place units on concrete pads, orient so controls and devices needing service and maintenance have adequate access.
- C. Piping: Connect hot and cold water piping to units with shutoff valves and unions. Connect recirculating water line to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain, or as indicated.
- D. Gages: Provide thermometers on inlet and outlet piping of water heaters, in accordance with Division 22, Section 22 05 19 "Meters and Gages".
- E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- F. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with water heater startup until wiring installation is acceptable to water heater

Installer.

- G. Furnish and install dielectric couplings at piped connections to heater.
- H. Terminate all temperature/pressure relief valves over nearest code approved drain.

3.03 INSTALLATION OF THERMAL EXPANSION ABSORBERS:

- A. General: Install thermal expansion absorbers in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Place units on concrete pads **or in-line of cold water piping**, orient so controls and devices needing service and maintenance have adequate access.
- C. Piping: Provide cold water piping connections to units with unions.
- D. Pressurize expansion tank to equal water pressure inside building.

3.04 CLOSEOUT PROCEDURES:

- A. Training: Provide services of manufacturer's technical representative for 1- half day to instruct Owner's personnel in operation and maintenance of water heaters.
- B. Schedule training with Owner, provide at least 7 day notice to Contractor and Engineer of training date.

END OF SECTION

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SECTION 22 34 05 - THERMOSTATIC MIXING VALVES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide LEAD-FREE thermostatic mixing valve(s) and appurtenances as shown on the drawings and herein specified.

1.02 QUALITY ASSURANCE:

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B 31.9 "Building Services Piping" for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. NSF/ANSI Standard 61 "Drinking Water System Components".
 - 3. Indiana Plumbing Code.
- B. Potable components shall comply with NSF 14 and NSF 61.
- C. Reference Standards:
 - 1. ASSE Standard 1016: Performance Requirements for Individual Thermostatic, Pressure Balancing and Combination Control Valves for Bathing Facilities.
 - 2. ASSE Standard 1017: Performance Requirements for Temperature Actuated Mixing Valves for Primary Domestic Use
 - 3. ANSI Standard Z358.1-1998: Emergency Eyewash and Shower Equipment
 - 4. Americans with Disabilities Act (ADA) Accessibility Guidelines
- D. Each thermostatic mixing valve unit shall be completely factory assembled, piped, tested, and adjusted with water flow, prior to shipment.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Meters and Gauges: Section 22 05 19
- D. Basic Piping Requirements: Section 22 05 29
- E. Identification for Pipe and Equipment: Section 22 05 53
- F. Pipe and Equipment Insulation: Section 22 07 19
- G. Domestic Water Piping: Section 22 11 16

1.04 SUBMITTALS

- A. Submit shop drawings for each thermostatic mixing valve specified herein in accordance with Specifications Section 22 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 THERMOSTATIC MIXING VALVE (PUBLIC HAND WASHING)

- A. ASSE 1070 approved thermostatic mixing valves shall be provided for all public hand wash lavatories and kitchen hand wash sinks.
- B. Inlet temperature shall be 120°F with an outlet temperature of 105°F.
- C. Provide individual valve for each isolated or wall hung lavatory/sink.
- D. Provide one common valve for up to six (6) lavatories in a common countertop with a total load of 5 gpm or less.
- E. Manufacturers:
 - 1. Acorn Controls
 - 2. Bradley
 - 3. Lawler
 - 4. Leonard
 - 5. Powers Hydroguard
 - 6. Sloan
 - 7. Symmons
 - 8. Sioux Chief

2.02 THERMOSTATIC MIXING VALVE

- A. Refer to Plumbing Equipment Schedule for characteristics of valve.
- B. GENERAL:
 - 1. Thermostatic mixing valve requirements shall include a cast bronze body, thermostatic element of bellows or wax design of non-corrosive components, advanced paraffin actuation technology, or liquid filled thermostat, union inlets, combination strainer check-stops, tamper resistant adjustment, and provide protection against hot or cold supply line failure and thermostat failure. All valves listed to ASSE 1017 and certified to CSA B125.

C. HIGH/LOW VALVE

1. Single mixing valves shall be selected to meet maximum and minimum demand for hot water requirements with components as required in general thermostatic mixing valve requirements. Valve shall adjust to varying flow requirements of low and high flow. System shall be furnished complete with shutoffs on inlets and outlet with thermometer. Valve shall provide protection against hot or cold supply line failure and thermostat failure.

D. HIGH/LOW MANIFOLD SYSTEMS

1. Large and small mixing valves shall be selected to meet maximum and minimum demand for hot water requirements with components as required in general thermostatic mixing valve requirements. A pressure regulating valve shall adjust to varying flow requirements, opening to allow flow from the larger valve as demand increases. System shall be furnished complete with shutoffs on each mixing valve, pressure gauges and outlet temperature dial.

E. SHOWER CONTROL MIXING VALVES

1. Exposed cast bronze body, stainless steel face plate with components as required in general thermostatic mixing valve requirements.
2. Concealed mixing valve for use on shower applications with components as required in general thermostatic mixing valve requirements, cast brass body, die-cast chrome plated lever handle control, stainless steel face plate.

F. Manufacturers:

1. Acorn Controls
2. Bradley
3. Lawler
4. Leonard
5. Powers Hydroguard
6. Sloan
7. Symmons
8. Sioux Chief

2.03 1-1/2" DIGITAL RE-CIRCULATING THERMOSTATIC MIXING VALVE

- A. Refer to Plumbing Equipment Schedule for characteristics of valve.
- B. Digital Re-Circulating Valves shall be supplied pre-piped (in parallel for 2 and 3 valve assemblies) and pressure tested as a lead free Digital Mixing Center complete with inlet hot water, inlet cold water, outlet mixed water, inlet re-circulation return water and outlet return to heater water connections.

- C. DMC shall comprise check valves, strainers, thermometers, pressure gauges, ball valves, inlet hot water to outlet mixed water by-pass and shall be mounted onto an enameled steel frame.
- D. Digital Re-Circulating Valves (DRV)
 - 1. Each Re-Circulating Valve shall be digital of lead free stainless steel/polymer construction.
 - 2. Each DRV shall have 1" inlet/outlet connections, deliver a mixed water flow of 41GPM @ 7.5ft/sec and shall have no minimum system draw off requirement.
 - 3. Each DRV shall have all of the following operational capabilities:
 - a. +/- 2F water temperature control
 - b. 2F minimum inlet to outlet water temperature differential
 - c. Automatic shutoff of hot water flow upon cold water inlet supply failure.
 - d. Automatic shutoff of hot water flow in the event of a power failure
 - e. Programmable set point range of 81-158°F (27-70°C)
 - f. Programmable thermal disinfection mode
 - g. Programmable 1st level hi/lo temp alarm display
 - h. Programmable temperature error level for safety shutdown
 - 4. DRV shall have all of the following connectivity capabilities:
 - a. SPCO relay outputs which are energized during operation.
 - b. LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
 - c. MODBUS 485 port for remote set point adjustment and remote operating temperature visibility.
 - d. RS485 Serial Port for connection to a performance matched hot water monitoring system.
 - 5. DRV shall be compliant with ASSE Standard 1017 and CSA B125 and so certified and identified.
- E. Manufacturer:
 - 1. Armstrong
 - 2. Lawler

2.04 3" DIGITAL RE-CIRCULATING THERMOSTATIC MIXING VALVE

- A. Refer to Plumbing Equipment Schedule for characteristics of valves.
- B. Digital Re-Circulating Valves shall be supplied pre-piped (in parallel for 2 and 3 valve assemblies) and pressure tested as a lead free Digital Mixing Center complete with inlet hot water, inlet cold water, outlet mixed water, inlet re-circulation return water and outlet return to heater water connections.

- C. DMC shall comprise check valves, strainers, thermometers, pressure gauges, ball valves, inlet hot water to outlet mixed water by-pass and shall be mounted onto an enameled steel frame.
- D. Digital Re-Circulating Valve(s) (DRV)
 - 1. Each Re-Circulating Valve shall be digital of lead free stainless steel/polymer construction.
 - 2. Each DRV shall have 3" inlet/outlet connections, deliver a mixed water flow of 165GPM @ 7.5ft/sec and shall have no minimum system draw off requirement.
 - 3. Each DRV shall have all of the following operational capabilities:
 - a. +/- 2F water temperature control
 - b. 2F minimum inlet to outlet water temperature differential
 - c. Automatic shutoff of hot water flow upon cold water inlet supply failure.
 - d. Automatic shutoff of hot water flow in the event of a power failure
 - e. Programmable set point range of 81-158°F (27-70°C)
 - f. Programmable thermal disinfection mode
 - g. Programmable 1st level hi/lo temp alarm display
 - h. Programmable temperature error level for safety shutdown
 - 4. DRV shall have all of the following connectivity capabilities:
 - a. SPCO relay outputs which are energized during operation.
 - b. LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
 - c. MODBUS 485 port for remote set point adjustment and remote operating temperature visibility.
 - d. RS485 Serial Port for connection to a performance matched hot water monitoring system.
- E. DRV shall be compliant with ASSE Standard 1017 and CSA B125 and so certified and identified.
- F. Manufacturer:
 - 1. Armstrong
 - 2. Lawler

PART 3 - EXECUTION

3.01 GENERAL

- A. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.
- B. Do not proceed until unsatisfactory conditions have been corrected.

- C. Install thermostatic mixing valves and trim as recommended by manufacturer. Provide valve, strainer, and union on each inlet, check valve, and shut-off valve on outlet. On installations which include a domestic hot water return system, piping arrangement shall be installed per the manufacturer's requirements.
- D. Following completion of installation, plumbing contractor shall verify each thermostatic mixing valve for proper operation and shall adjust each unit for correct discharge temperature. On High/Low thermostatic valve setup, the contractor shall open enough fixtures to establish a high flow condition during temperature adjustment. Contractor shall maintain flow for a minimum of 10 minutes to ensure adequate temperature settings.

END OF SECTION

SECTION 22 42 00 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work includes the installation and clean-up of all plumbing fixtures as shown on the drawing and herein specified.
- B. All plumbing fixtures manufactured and installed under the provisions of this section shall comply with the latest adopted Indiana Plumbing Code.

1.02 QUALITY ASSURANCE

- A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems. Including the following:
 - 1. ANSI / ASME A112.6.1M – Supports for Off-the-Floor Plumbing Fixtures for Public Use.
 - 2. ANSI A112.18.1 – Plumbing Fixture Fittings.
 - 3. ANSI A112.19.1 – Enameled Cast Iron Plumbing Fixtures.
 - 4. ANSI A112.19.2 – Vitreous China Plumbing Fixtures.
 - 5. ANSI A112.19.3 – Stainless Steel Plumbing Fixtures (Designed for Residential Use).
 - 6. ANSI Z358.1 – Emergency Eye/Face Wash and Shower Equipment.
- B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.
- C. NAHB Label: Provide fiberglass bathtub units and shower stalls which have been tested and labeled by NAHB Research Foundation, Inc.
- D. UL Compliance: Construct water coolers in accordance with UL Standards 399 "Drinking-Water Coolers," and provide UL-listing and label.
- E. ASHRAE Compliance: Test and rate water coolers in accordance with ASHRAE Standard 18 "Methods of Testing for Rating Drinking Water Coolers with self-Contained Mechanical Refrigeration Systems."
- F. ARI Compliance: Construct and install water coolers in accordance with ARI Standards 1010 "Drinking-Fountains and Self-Contained Mechanically Refrigerated Drinking-Water Coolers," and provide Certification Symbol.
- G. ANSI Compliance: Construct and install barrier-free plumbing fixtures in accordance with ANSI Standard A117.1 "Specifications for making buildings and facilities accessible to and usable by physically handicapped people.
- H. ASSE Compliance: ASSE 1037 – Flushometers (Pressurized Flushing Devices).

- I. ADA Compliance: Construct and install barrier-free plumbing fixtures in accordance with Title III of the ADA of 1990- accessibility guidelines for buildings and facilities.
- J. IBC Compliance: Construct and install barrier-free plumbing fixtures in accordance with IBC Chapter 11 – Accessibility for Public Accommodations and Commercial Facilities, as adopted and amended by the State of Indiana, latest enforced edition.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 22 05 01
- B. Complete and Startup: Section 22 05 03
- C. Separate grab bars and toilet accessories are not an integral part of plumbing fixtures and are specified in Division 10.
- D. Refer to Division 26 Sections for field installed electrical wiring required for water coolers, food waste disposers, and other plumbing fixtures; not work of this Division

1.04 GENERAL

- A. All equipment, materials and components shall be new and specifically designed for the intended purpose as shown on the drawings.
- B. Fixtures shall have individually trapped waste outlet and individual hot/cold water supply shutoff or stop.
- C. All exposed metal work and tubing in or around the fixtures shall be best quality brass, chromium plated. Supply pipes shall be seamless, and chrome plated. Escutcheons for pipes which pass through walls, floors and ceilings shall be chromium plated brass.
- D. Furnish all plumbing fixtures complete with the necessary accessories for a complete installation, such as supplies, shutoff valves for hot and cold water, risers, couplings, nuts, washers, bolts, drain fittings, etc.
- E. Provide carriers suitable for the particular installation conditions encountered for the wall hung fixtures.
- F. Vitreous China fixture to be Class A and white unless color is specifically noted. All enamelware to be acid resisting.
- G. Fixtures and equipment requiring anti-siphon devices shall be constructed to eliminate possibility of siphoning waste or foreign material into water supply.
- H. All fixtures except those provided with flush valves shall be provided with supply stops.

- I. Chromium plate to be in accordance with the U. S. Government standards under license from Chrome Corp. of America.

1.05 SUBMITTALS

- A. Provide shop drawings for all plumbing fixtures and trim in accordance with Specifications Section 22 05 01, General Provisions. Plumbing fixture shop drawings shall contain a picture of the plumbing fixture as well as specific written information on the fixture and accessories as specified herein.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All wall hung fixtures shall be mounted on suitable floor mounted fixtures carriers as manufactured by J. R. Smith, Josam, Wade or Zurn unless detailed otherwise.
- B. All wall hung lavatory and sink carriers shall be rated for 250 lb. capacity.
- C. All water closet seats shall be solid plastic and the style as recommended by fixture manufacturer or as described herein.
- D. All plumbing fixtures marked (ADAAG) shall mean that the fixture(s) is to be of the style designed for persons with disabilities and should be set and plumbed in accordance with practices as set forth by the American with Disabilities Act Accessibility Guidelines.
- E. Where no-hub couplings are used to connect water closet carriers to chase piping, heavy duty couplings shall be used as follows:
 - 1. Anaco/Husky (SD2000 or SD4000)
 - 2. Charlotte/Ideal (MD or HD)
 - 3. Mission (Heavyweight)
 - 4. Tyler Pipe (Wide-Body)
- F. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide trim and fittings including faucets, supplies, stops, traps, tailpieces, waste nipples, hangers, plates, brackets, anchors, supports, hardware, and fastening devices required for a complete installation.
- G. All vitreous china plumbing fixtures shall be furnished by the same manufacturer for each product specified throughout.
- H. All fixture trim shall be furnished by the same manufacturer for each product specified throughout.

2.02 MATERIALS

- A. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting, seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.
- B. Where fixture trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless-steel units. Provide copper or brass where not exposed.
- C. Stainless Steel: ASTM A 167, Type 302/304, hardest workable temper, with No. 4 finish having, bright, directional polish on exposed surfaces.
- D. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ASTM C 554.
- E. Fiberglass: ANS1 Z124, smooth surfaced, with color selected by Architect/Engineer.
- F. Synthetic Stone: High quality, free from defects, glaze on exposed surfaces, stain resistant.

2.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver plumbing fixtures, specialties, accessories, and trim individually wrapped in factory fabricated containers.
- B. Handle plumbing fixtures specialties, accessories, and trim carefully to prevent breakage, chipping, and scoring fixture finish. Do not install damaged plumbing fixture specialties, accessories, or trim; replace and return damaged units to equipment manufacturer.

2.04 CARRIERS

- A. ASME / ANSI A112.6.1M, lavatory, chair carrier for thin wall construction steel plate as detailed on drawing. All lavatory chair carriers shall be capable of supporting the lavatory with a 250 -pound vertical load applied at the front of the fixture.
- B. Where lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. The drainage fitting of the back to back carrier shall be so constructed that it prevents the discharge from one fixture from flowing into the opposite fixture.

2.05 FIXTURES

- A. Extent of plumbing fixtures work required by this Section is indicated on drawings and schedules and by requirements of this section.

B. Types of Plumbing Fixtures specified in this Section include the following:

1. Water Closets
2. Urinals
3. Lavatories
4. Sinks
5. Food Waste Disposers
6. Mop Basins
7. Showers
8. Shut-off Valve Boxes
9. Clothes Washer Boxes

2.06 WATER CLOSETS (WALL HUNG FLUSH VALVE):

A. Water Closet (WC-1): 1.6 GPF, 15" to rim, white vitreous china, wall-mount, wall outlet, top spud, siphon jet, elongated bowl with top spud.

1. Kohler K-4325 Kingston.
2. ASSE 1037- Flushometer Valve;
 - a. Sloan Royal 111-1.6 exposed, quiet-operating diaphragm type, chrome plated flushometer valve. Valve shall be non-hold-open with no external volume adjustment, vacuum breaker with bottom hex coupling nut, screwdriver stop with (free spinning), vandal resistant stop cap and sweat solder adapter kit with cast set screw wall flange.
3. Bemis 1655CT white solid plastic, open front, integral check seat, less cover.

B. Water Closet (WC-2): 1.6 GPF, ADA compliant, 17" to rim, white vitreous china, wall-mount, wall outlet, top spud, siphon jet, elongated bowl with top spud.

1. Kohler K-4325 Kingston.
2. ASSE 1037- Flushometer Valve;
 - a. Sloan Royal 111-1.6 exposed, quiet-operating diaphragm type, chrome plated flushometer valve. Valve shall be non-hold-open with no external volume adjustment, vacuum breaker with bottom hex coupling nut, screwdriver stop with (free spinning), vandal resistant stop cap and sweat solder adapter kit with cast set screw wall flange.
3. Bemis 1655CT white solid plastic, open front, integral check seat, less cover.

2.07 URINALS (WASHOUT WALL HUNG):

A. Urinal (UR-1): 0.5 GPF, white vitreous china, wall hung, washout urinal with extended shields, top spud, integral flush spreader, and trap.

1. Kohler K-4991-ET Bardon.
2. ASSE 1037- Flushometer Valve;

- a. Sloan Royal 186-0.5 exposed quiet-operating diaphragm type, chrome plated flushometer valve. Valve shall be non-hold-open with no external volume adjustment, vacuum breaker with bottom hex coupling nut, screwdriver stop with (free spinning), vandal resistant stop cap and sweat solder adapter kit with cast set screw wall flange.
3. J.R. Smith 636 floor mount support.

2.08 LAVATORIES:

- A. Lavatory (L-1): 19.8125" x 15.625" O.D., white vitreous china, rectangular basin with vertical sides, undercounter mounted, overflow drain opening and with faucet holes in countertop on 4" centers.
 1. Kohler K-2882, Verticyl Rectangle.
 2. Chicago Faucet 894-ABCP-VP, deck mount with pop-up waste, 2.2 GPM aerator, color index lever handles, rigid/swing gooseneck spout, vandal resistant.
 3. Adjustable two piece cast-brass P-trap with cleanout with escutcheon.
 4. McGuire #LFST, 1/2" I.P.S. x 3/8" O.D. wheel handle angle stop supplies with flexible risers and 1/2" chrome plated nipples and escutcheons.
- B. Lavatory (L-2): ADA compliant, 21.25" x 18.25" white vitreous china, 34" to rim, high back basin for concealed arm bracket, overflow drain opening, open grid strainer and with faucet holes on 4" centers.
 1. Kohler K-2005 Kingston.
 2. Chicago Faucet 895-GN2AE72ABCP-VP, 0.5 GPM aerator, deck mount, color index lever handles, vandal resistant.
 3. Grid strainer, drain assembly with 4-1/2" offset tailpiece.
 4. Adjustable two piece cast-brass P-trap with cleanout with escutcheon.
 5. McGuire #2165LK, 1/2" I.P.S. x 3/8" O.D. loose key angle stop supplies with flexible risers and 1/2" chrome plated nipples and escutcheons.
 6. Insulate waste and water supplies.
 7. J.R. Smith 700 floor mount concealed arm support.
 8. Lead-Free ASSE 1070 thermostatic mixing valve.

2.09 SINKS (STAINLESS STEEL SINGLE COMPARTMENT):

- A. Sink (SK-1): 35.75"L x 18.5"W x 10"D double compartment, 18-gauge stainless steel, undermount, rear center drain, single faucet hole in countertop, sink with 10" deep bowl.
 1. Elkay ELUH361710 Lustertone Classic Stainless Steel equal double bowl undermount sink.
 2. Kohler Purist K-24982, three function spray, aerated stream, single lever handle 1.5 gpm, vibrant stainless finish
 3. (1) Elkay LK-35 standard duo strainer with tailpiece.
 4. Adjustable two-piece chrome plated cast-brass P-trap with cleanout with escutcheon.
 5. Chicago Faucet 1017-CP supply pipes with loose key stops, lock shield

caps, wall flanges, and flexible tube risers.

- B. Sink (SK-2): 23"L x 18"W x 10"D single compartment, 16-gauge stainless steel, undermount, rear center drain, faucet holes in countertop on 4" centers, sink with 10" deep bowl.
1. Zline, Meribel SRS-23.
 2. Bradley S19-505M combination deck mounted swing activated faucet/eye/face wash unit, mixed faucet, right hand.
 - a. Navigator S19-2010 thermostatic mixing valve for eyewash and faucet.
 3. Elkay LK-35 standard duo strainer with tailpiece.
 4. Adjustable two-piece chrome plated cast-brass P-trap with cleanout with escutcheon.
 5. Chicago Faucet 1017-CP supply pipes with loose key stops, lock shield caps, wall flanges, and flexible tube risers.

2.10 FOOD WASTE DISPOSERS:

- A. Food Waste Disposer (WD-1): In-Sink-Erator Badger 5, continuous feed, 120 Volt, 60 Hz, 1725 RPM, 1/2 HP motor with overload protector and manual reset, splash guard and stopper, cord with plug. Two-year warranty on parts and in-home service.
1. Deck mounted air-activation switch assembly on island sink, **Satin Nickel finish** equal to In-Sink-Erator STS-00.

2.11 MOP BASINS:

- A. Mop Basin (MB-1): 25" x 21" x 17" O.D., 20" x 16" x 12" bowl. floor mounted, 16-gauge type 304 stainless steel bowl, rounded edges, stainless steel dome strainer-lint basket.
1. Regency 600SM162012.
 2. Chicago Faucet 445-897SRCXKCP supply fitting with integral checks and stops, vacuum breaker, bucket hook, wall brace, and hose end spout.
 3. Fiat 832-AA, 30" long heavy-duty cloth reinforced rubber hose with stainless steel hose bracket, 833-AA silicone sealant.
 4. Fiat 889-CC, stainless steel mop hanger with three rubber tool grips.
 5. 36" high wall guard panels and corner bracket made with 20-gauge, 304 stainless steel and mounting hardware.

2.12 SHOWERS:

- A. Shower (SH-1): One-piece 42" x 34 3/4" x 73" acrylic module shower enclosure with integral soap ledges, 2" shower drain and strainer assembly and curtain rod, factory installed.
1. Aquarius model G 2494
 2. Moen L2352, pressure balancing valve, vandal resistant metal handle

- adjustable high temperature limit stop, field set at 110-degree F.
 3. 1/2" I.P.S. female inlets and outlets, screwdriver check stops, chrome plated finish.
 4. Moen 1300 head, arm, and flange kit, with 2.5 GPM flow restrictor, shower valve, head, and trim to be installed at the job site.
 5. ASSE 1016-2011 / ASME A112.1016-2011 / CSA B125.16-11, compliance.
- B. Shower (SH-2): CMU wall, see architectural drawings for finish
1. Moen L2352, pressure balancing valve, vandal resistant metal handle adjustable high temperature limit stop, field set at 110-degree F.
 2. 1/2" I.P.S. female inlets and outlets, screwdriver check stops, chrome plated finish.
 3. Moen 1300 head, arm, and flange kit, with 2.5 GPM flow restrictor, shower valve, head, and trim to be installed at the job site.
 4. ASSE 1016-2011 / ASME A112.1016-2011 / CSA B125.16-11, compliance.

2.13 SHUT-OFF VALVE BOXES:

- A. Ice Maker Supply Box (VB-1): Recessed in wall box with cold water 1/4 turn control valve and water hammer arrester. Oatey #38680 or approved equal. Mounting height as shown on drawings.

2.14 CLOTHES WASHER BOXES:

- A. Washing Machine Box (WB-1): Control box with hot and cold water control valves and 2" drain connection, water hammer arresters on cold and hot supplies. Guy Gray #B-200 or approved equal. Mounting height as shown on drawings.

2.15 ACCEPTABLE MANUFACTURERS:

Subject to compliance with requirements, provide plumbing fixtures of one of the following:

- A. WATER CLOSETS, URINALS, AND LAVATORIES:
1. American Standard
 2. Crane Co.
 3. Eljer
 4. Kohler Co.
 5. Sloan
 6. Zurn
- B. FLUSH VALVES:
1. Coyne and Delany Co.
 2. Sloan Valve Co.
 3. Zurn Industries, Inc.: Hydro Mechanics Div.

C. WATER CLOSET SEATS:

1. Bemis Mfg. Co.
2. Beneke Corp.
3. Centoco Mfg. Corp.
4. Church Products
5. Olsonite Corp.
6. Sperzel Ind.

D. FIXTURE CARRIERS:

1. J.R. Smith Mfg. Co.
2. Josam Mg. Co.
3. MIFAB
4. Sioux Chief Manufacturing
5. Wade Div.
6. Watts Drainage Products
7. Zurn Industries, Inc.

E. SINKS:

1. American Standard
2. Elkay Mfg. Co.
3. Franke
4. Just Mfg. Co.
5. Moen Commercial

F. FOOD WASTE DISPOSERS:

1. General Electric (GE)
2. In-Sink-Erator
3. Kitchenaide
4. Sears (Kenmore)
5. Waste King
6. Whirlaway
7. Whirlpool

G. STOPS AND SUPPLY TUBING:

1. American Standard
2. Brass Craft (Commercial-Heavy Pattern)
3. Chicago Faucet Co.
4. Kohler Co.
5. McGuire
6. T & S Brass and Bronze Works. Inc.
7. Zurn Aqua-Spec

H. LAVATORY/SINK FAUCETS AND TRIM:

1. American Standard
2. Cambridge Brass; Div. of Masco Corp.

3. Chicago Faucet Co.
4. Delta Faucet Co; Div. of Masco Corp.
5. Eljer Plumbing Ware
6. Elkay Mfg. Co.
7. Kohler Co.
8. Moen Commercial
9. Speakman
10. Symmons
11. T & S Brass and Bronze Works, Inc.
12. Zurn Aqua-Spec

I. LAVATORY/SINK P-TRAPS AND TAILPIECES:

1. American Standard
2. Crane
3. Dearborn
4. Eljer
5. Elkay Mfg. Co.
6. Kohler Co.
7. McGuire
8. Sanitary-Dash
9. Zurn Aqua-Spec

J. ADA INSULATION KITS:

1. Dearborn Brass Safety Series
2. Plumberex
3. SKAL – GARD
4. Truebro

K. SERVICE SINK/MOP RECEPTOR FAUCETS AND TRIM:

1. Cambridge Brass; Div. of Masco Corp.
2. Chicago Faucet Co.
3. E.L. Mustee and Sons, Inc.
4. Fiat Products, Inc.
5. Speakman
6. Zurn Aqua-Spec

L. FLOOR MOUNTED MOP RECEPTORS:

1. Creative Industries Terrazzo, Products, Inc.
2. E.L. Mustee and Sons, Inc.
3. Fiat Products, Inc.
4. Stern-Williams, Co., Inc.
5. Swan Corp.

M. CONVENTIONAL SHOWER AND SHOWER VALVES:

1. Chicago Faucet Co.
2. Leonard Valve Co.

3. Powers Regulator Co.
4. Speakman Co.
5. Symmons Ind., Co.
6. Zurn Aqua-Spec

N. FLOOR MOUNTED SHOWER RECEPTORS:

1. Creative Industries Terrazzo, Products, Inc.
2. E.L. Mustee and Sons, Inc.
3. Fiat Products, Inc.
4. Stern-Williams, Co., Inc.
5. Swan Corp.

O. SHOWER UNITS:

1. Aquarius Bathware
2. Best Bath
3. Fiat
4. Lasco Div. of Philips Industries, Inc.
5. Oasis

P. MOLDED TUBS AND SHOWER UNITS:

1. Aquarius Bathware
2. Bradley Corp.
3. E.L. Mustee and Sons, Inc.
4. Eljer Plumbing Ware
5. Kohler Co.
6. Lasco Div. of Philips Industries, Inc.
7. Oasis

Q. SHUT-OFF VALVE BOXES:

1. Acorn Engineering Co.
2. Guy Gray
3. IPS Corp.
4. Oatey
5. Sioux Chief Manufacturing

R. CLOTHES WASHER SUPPLY BOXES:

1. Acorn Engineering Co.
2. Guy Gray
3. IPS Corp.
4. Oatey
5. Sioux Chief Manufacturing

PART 3 - EXECUTION

3.01 INSTALLATION OF FIXTURES

- A. Contractor shall protect all fixtures from damage until final acceptance. Keep fixtures completely covered and all exposed pipes, fittings and faucets wrapped to prevent injury or scratching.
- B. All fixtures, trim and supplies shall be set plumb and true to wall lines and securely held in place.
- C. The trade shall install all plumbing fixtures complete with all water, waste and vent connections.
- D. Upon completion of the work and before final acceptance, all plumbing fixtures shall be thoroughly tested, inspected and found to be free from defects.
- E. All wall-hung water closets, lavatories, etc. shall be supported by fixed or adjustable chair carriers as required. All chair carriers shall be provided with block base supports or with feet turned backward and bolted to the floor (using each available hole) in pipe spaces.

3.02 CONNECTIONS TO FIXTURES

- A. Each plumbing fixture or equipment item shown or implied shall be provided with all connections required (including piping, valves, union, stops, traps, etc.)
- B. All pipes shall be connected to fixtures with chrome plated brass couplings or unions of such type that fixtures can be removed and reset without making new joints. Supply connections shall be made with ground joint unions and not with slip joints. 7/16" O.D. flexible risers will be permitted for lavatory and sink supply connections. All supply lines shall be securely held in place.
- C. All escutcheons shall be finished to match the pipe rough-ins and shall be provided around waste and supply piping wherever piping passes through the floors, walls or ceilings, including under countertops and within vanities and casework.
- D. A supply stop, finished to match the fixture trim, shall be provided on each supply connection.

3.03 CLEANING FIXTURES

- A. Upon completion of installation, all trade labels shall be removed and all fixtures shall be thoroughly cleaned. The fixtures shall be cleaned and caulked to wall/floor as required a second time immediately before turning them over to the Owner.
- B. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream and specified gpm.

- C. Adjust or replace washers to prevent leaks at faucets and stops.

3.04 CAULKING

- A. Neatly and professionally caulk plumbing fixtures to finished building surfaces (i.e.: floors, walls, etc.). Use silicone caulking compound with mildew resistive silicone formula.

3.05 INSPECTION:

- A. Installer of rough-in work of potable water, waste and vent piping systems to verify actual locations of piping connections prior to installing fixtures. Examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.06 INSTALLATION OF PLUMBING FIXTURES:

- A. General: Install plumbing fixtures of types indicated where shown and at indicated heights: in accordance with fixture manufacturer's written instructions, rough-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of The Americans with Disabilities Act of 1990, The Indiana Handicapped Code, ANSI A117.1 and The Plumbing Code pertaining to installation of plumbing fixtures.
- B. Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Install all hardware, supports and fasteners provide with each fixture. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.
- C. Protect installed fixtures from damage during remainder of construction period.
- D. Caulk around all wall or floor mounted fixtures using nonporous-bond silicone rubber mold/mildew resistant acid type sealant depositing a uniform continuous ribbon without gaps or air pockets, and with complete "wetting" of joint bond surfaces equally on opposite sides. Fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal and vertical surface, fill joints to form a slight cove, so that joint will not trap moisture and dirt.
- E. Waterproof each shower room floor above ground by providing a completely waterproof pan constructed in place using 40 mil chlorinated polyethylene sheets (Chloraloy 240). Install using manufacturers recommended procedure and in accordance with the Plumbing Code. Joints and/or seams shall be welded type with comer ears first folded and then welded. Fabrication of pan shall be coordinated with the shower wall construction, with the fitting of the tile of prime importance.
- F. Flush Controls designated as "barrier free" which are hand operated or automatic

shall comply with The Americans with Disabilities Act of 1990, Article 4.16.5 and 4.27.4. Controls for flush valves shall be mounted on the wide side of toilet areas no more than 44 inches above the floor to centerline of trip lever/push button for use by adults, and no more than 32" above the floor to centerline of trip lever/push-button for use by children in elementary schools.

- G. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Owner.
- H. Fire Barrier Penetrations: Where fixtures (shower valves, washer boxes, etc.) are located in fire rated walls, partitions, ceilings, and/or floors, maintain the fire rated integrity. Refer to Division 7 for special sealers and materials.

MOUNTING HEIGHTS SCHEDULE

<u>FIXTURE</u>	<u>MOUNTING HEIGHT</u>
Water Closet	15" floor to seat
Wheelchair Water Closet	18" floor to seat
Standard Urinals	24" floor to rim
Barrier Free Urinals	17" floor to rim
Lavatory or Sink	31" floor to rim
Barrier Free Lavatories	29" Min. Knee Clearance
Adult Men Standard Shower Head	72" floor to head
Adult Women Standard Shower Head	66" floor to head
Barrier Free Shower Head	48" to 72" floor to head
Standard Shower Valve	48" floor to valve
Barrier Free Shower Valve	35" to 48" floor to valve
Grab Bars in Showers and Tubs	54" floor to center for upper bar, 33" to 36" floor to centers for lower bar

3.07 FIELD QUALITY CONTROL:

- A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site and then retest to demonstrate compliance: otherwise, remove and replace with new units and proceed with retesting.
- B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect/Engineer. Remove cracked or dented units and replace with new units.

3.08 EXTRA STOCK:

- A. General: Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt. Furnish one device for every 10 units.

END OF SECTION

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SECTION 22 70 16 - NATURAL GAS PIPING SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install fuel gas pipe and fittings to gas fired equipment as shown on the drawings and herein specified.
- B. Furnish and install a gas regulator capable of providing capacity listed on the drawings.
- C. All piping and valves shall be installed in compliance with the latest local approved Building, Fire, Plumbing Code, Fuel Gas Code, National Fire Protection Association (NFPA) and American Gas Association (AGA).
- D. All work specified in this section includes all fuel gas piping within the building, from gas meter to and including final connection of appliances and/or equipment. This work excludes buried supply from gas utility company's main, meter and pressure reducing valve.

1.02 INFORMATIONAL SUBMITTALS:

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Reference required submittals in 23 05 29 Basic Piping Requirements.

1.03 QUALITY ASSURANCE:

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. Regulatory Requirements: Comply with the requirements of the following codes:
 - 1. Fabricate and install natural gas systems in accordance with local gas utility company requirements.
 - 2. International Fuel Gas Code.
 - 3. International Mechanical Code.
 - 4. State Plumbing Code.
- E. Polyethylene piping and tubing requirements:
 - 1. All polyethylene piping, tubing, and fittings shall conform to all applicable provisions and requirements of the latest revision of the U. S. Department of Transportation Pipeline Safety Regulations (CFR) Title 49, Part 192, "Federal Minimum Safety Standards: Transportation of Natural and Other Gases by Pipeline" and, by inclusion, all appropriate standards referenced therein.

1.04 RELATED WORK

- A. General Provisions - Plumbing: Section 22 05 01
- B. Completion and Startup: Section 22 05 03
- C. Identification for Pipe and Equipment: Section 22 05 53
- D. Basic Piping Requirements: Section 22 05 29
- E. Trenching, Backfilling and Compacting (Exterior): Section 22 05 40
- F. Trenching, Backfilling and Compacting (Interior): Section 22 05 41

PART 2 - PRODUCTS

2.01 PIPING SYSTEM MATERIALS (PIPING ABOVE GROUND)

- A. 1/2" thru 4": Schedule 40 black steel pipe A53; malleable iron or steel fittings; screwed, flanged or welded joints. ASA B36.
- B. 1/2" thru 4": Wrought iron pipe ASA B36; malleable joint fittings; welded joints.
- C. 4" thru 10": Schedule 40 black steel pipe A53; steel fittings; welded joints; ASA B36.

D. Corrugated Stainless Steel Tubing (CSST):

1. 1/2 – 2" Pipe: CSST shall be 300 Series Corrugated Stainless Steel tubing conforming to ASTM A240 rated for 25 psi and have an elevated pressure rating of 125G for sizes up to 1 1/4" and 25G for 1 1/2" and 2". Tubing shall not be subjected to heat treating or annealing after the corrugation forming operation.
2. Conductive Jacket: jacket shall be an extruded fire-retarded engineered polymer designed to enhance the energy dissipating properties of the flexible gas piping. Conductive jacket shall conform to ASTM E-84 (UL723) flame spread rating not to exceed 25 and ASTM-E84 (UL723) smoke density rating shall not exceed 50. Conductive jacket shall be resistant to UV.
3. Fittings:
 - a. fittings shall be made of yellow brass and be tested and listed by CSA International for use in concealed locations. The fittings shall provide a metal to metal seal. Brass fittings shall not contain gaskets or O-rings to facilitate the seal between the tubing and the fitting.
 - b. TracPipe® CounterStrike® AutoSnap® fittings shall be made of yellow brass and be tested and listed by CSA International for use in concealed locations. Fittings shall have an integral snap ring requiring no disassembly or reassembly of the fitting for attachment to the tubing. The fittings shall provide a metal to metal seal. Brass fittings shall not contain gaskets or O-rings to facilitate the seal between the tubing and the fitting.
4. Approved Manufacturers:
 - a. Omega Flex, Inc. TracPipe Counter Strike
 - b. Approved equal

2.02 PIPING SYSTEM MATERIALS (UNDERGROUND OR IN-SLAB)

- A. Schedule 40 black steel pipe; welded joints. Pipe shall be mill wrapped or plastic coated.
- B. 1/2" thru 2": corrugated flexible, semi-rigid, stainless steel tubing with brass mechanical fittings. Pre-sleeved polyethylene for underground use with built-in vent ports.
 1. Manufacturers: TracPipe/PS 11 or Flashshield CSST.
- C. PE Pipe: ASTM D 2513, SDR 11.
 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 - a. Product shall have product code printed on the pipe at regular intervals. Code shall notate the manufacturer, date of manufacture, product lot and supplier of raw material, and location of manufacture.

2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. **Vent casing aboveground.**
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - (1) Lyall, R. W. & Company, Inc.
 - (2) Mueller Co.; Gas Products Div.
 - (3) Perfection Corporation; a subsidiary of American Meter Company.
 - (4) Approved equal
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.
6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - (1) Lyall, R. W. & Company, Inc.
 - (2) Mueller Co.; Gas Products Div.
 - (3) Perfection Corporation; a subsidiary of American Meter Company.
 - (4) Approved equal
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.
 - d. Buna-nitrile seals.
 - e. Acetal collets.
 - f. Stainless-steel bolts, nuts, and washers.
7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - (1) Dresser Piping Specialties; Division of Dresser, Inc.
 - (2) Smith-Blair, Inc.
 - (3) Approved equal
 - b. Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Steel bolts, washers, and nuts.
 - e. Factory-installed anode for steel-body couplings installed underground.

2.03 FUEL GAS VALVES

A. Ball Type Valves

- 1. Description (1/2" thru 2-1/2"): bronze body, chrome plated ball, teflon seats and seals, lever operated, threaded, AGA and approved UL listed for gas service.
- 2. Manufacturers
 - a. 150# Jamesbury #2111-UL
 - b. 150# Lunkenheimer
 - c. 150# Metraflex
 - d. 150# Stockham

B. Eccentric Plug Valves:

- 1. Description (3" and larger): cast iron body, or nickel plated cast iron (1/2" - 4") plug, BUNA stem seal Hycar or Petroleum Hycar Plug seal, lever operated, U.L. listed for natural gas service, (175 psi maximum working pressure), threaded connection
- 2. Manufacturers
 - a. DeZurik
 - b. Rockwell

c. Or approved equal

C. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation; a subsidiary of American Meter Company.
 - d. Approved equal
2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

D. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

E. Emergency Fuel Gas Control Valves

1. Gas Control Valves: Aluminum body, packless, single Buna "N" seat, explosion proof construction for low pressure gas, solenoid operated two-way, normally closed. UL-approved, automatic reset, maximum pressure shall be 25 psi for pipe sizes 1-1/2" to 1-1/4" and 15 psi for 1-1/2" to 2" pipe. Control voltage shall be 120 volts AC, 60 Hz: ASCO Bulletin 8215.

2. Control Station: Remote Control Stations shall consist of at least a mushroom push button operated, normally closed contact for de-energizing the gas valve, with the mushroom button pull or twist to re-energize the gas valve. The single or 2-gang stainless steel faceplate shall have the wording "EMERGENCY STOP", the mushroom button shall have the wording "PULL TO RESET" or "TWIST TO RESET". The quantity and mounting shall be as shown on the project drawings and be equal to ASCO, Pilla Electrical, EATON or approved equal.
 - a. Exterior remote control stations shall be housed in weatherproof enclosure with wording "EMERGENCY GAS SHUT OFF", and easy associability to mushroom button.

F. Pressure Regulator

1. Description: cast iron body; die cast aluminum alloy diaphragm case; Buna-N Diaphragm; brass orifice and stem; zinc plated steel diaphragm pans, valve lever and adjustment screw.
2. Size, capacity and pressure range as shown or noted on the drawings.
3. Indoor regulators shall be ventless unless otherwise indicated on drawings.
4. Manufacturers
 - a. Equimeter
 - b. Fisher
 - c. Maxitrol
 - d. Approved equal

PART 3 - EXECUTION

3.01 GENERAL

- A. Do not run piping below concrete floor slabs on grade, without containment.
- B. Only AGA approved joint compounds may be used on threaded pipe joints.
- C. No gas pipe smaller than 1/2" iron pipe size shall be used in any concealed location.
- D. Pipe service entering building must meet approval of agencies listed in the specification and local utility for building service standards.
- E. All branch lines supplying appliances/equipment must be arranged so that an accessible shutoff valve is installed ahead of appliance and/or equipment.
- F. All fuel gas piping penetrating floors, roofs and walls shall be protected from contact with metallic structures, reinforcing rods, electrical neutral conductors, etc.
- G. Protect piping against corrosion per AGA recommendations.
- H. Install piping in a manner that system may be entirely drained of moisture (no traps).

- I. Install dirt legs at all gas fired devices, appliances and/or equipment.
- J. Vent all pressure regulators and similar devices in an approved manner.
- K. Do not install brass or copper tubing unless approved by Engineer.
- L. Piping installed above ceilings shall be made accessible.
- M. Valves shall not be located above inaccessible ceilings.
- N. Provide shut-off (isolation) valves at each gas fired equipment rough-in.
- O. Properly support piping on roofs with prefabricated roof supports. On low slope roofs, piping shall be supported following the pitch of the roof with a consistent height above the roof surface. Branch piping less than 2" in diameter shall be supported 8" or less above the surface.

3.02 OUTDOOR PIPING INSTALLATION:

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.

3.03 PIPING JOINT CONSTRUCTION:

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.04 TESTING

- A. Test the fuel gas piping at 1-1/2 times the normal operating pressure, but not less than 3 psi.

END OF SECTION

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SECTION 23 05 01 - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. The requirements of the General Conditions, General Requirements, Special Conditions, Instructions to Bidders, Contract Documents and other information bound herewith form a part of and shall govern all work performed under these specifications.
- B. The accompanying mechanical drawings are issued as part of this project manual. Any specification requirements shown on the drawings are equally affective as if included herein. Any omissions of specifications or on the drawings are not to be a basis for failure on the part of the Contractor, from installing mechanical components required by the systems to operate in the intended manner.
- C. The drawings depict the systems' components and distribution method. Every attempt is made to complete the distribution piping and ductwork; however discrepancies may develop in the process. The contractor, within reason, is required to prepare his bid and construct the project that the result is fully developed, complete and operable systems. (This includes obvious omitted piping and duct connections from point-to-point or drawing-to-drawing). In the event of discrepancies in duct or pipe sizes from drawing to drawing, the contractor shall include the cost for the larger size.
- D. Should any work be called for on the drawings, specifications or in the codes, in such a manner that the Contractor cannot, in his judgement, comply with the requirements, then the Contractor shall bring the matter to the attention of the Engineer before proceeding with the work.
- E. Work includes the installation of equipment, piping, ductwork and components necessary for complete and operable systems.
- F. This project includes the following systems:
 - 1. Supply, return and relief air distribution system(s)
 - 2. Exhaust air system(s)
 - 3. Refrigeration piping system

1.02 DEFINITIONS AND TERMS USED IN THE DIVISION 23 SPECIFICATIONS AND MECHANICAL DRAWINGS

- A. The word "Owner" shall mean the party mentioned in the prime contract agreement, or any representative of his party duly authorized to act in his behalf in the execution of the work.
- B. The word "Construction Manager" shall mean the person, firm or corporation entering into a contract with the Owner to manage construction operations.

- C. The word "Contractor" shall mean the person, firm or corporation entering into a contract to construct and complete the work as described herein.
- D. The word "Engineer" shall mean Circle Design Group and their representatives assigned to this project.
- E. The word "Architect" shall mean StudioAxis and their representatives acting as the Owner's appointed agent.
- F. The words "Commissioning Agent or Engineer" shall mean the Owner's Agent and their representatives, hired to commission or verify performance of all or portions of the work included in the contract documents.
- G. The words "furnish" or "supply" shall mean to purchase and deliver to project site, ready for unloading, unpacking, assembly, installation and similar subsequent requirements.
- H. The word "install" shall mean operations at the project site, including unloading, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar requirements.
- I. The word "provide" shall mean both "furnish" and "install" complete and ready for intended use.

1.03 CODES, FEES AND MISCELLANEOUS COSTS

- A. All materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards and utility company regulations.
- B. In cases of difference between building codes, specifications, state laws, local ordinances, industry standards and utility company regulations and the Contract documents, the most stringent shall govern. The Contractor shall promptly notify the Engineer in writing of any such differences.
- C. Non-Compliance: Should the Contractor perform any work that does not comply with requirements of applicable building codes, states laws, local ordinances, industry standards and utility company regulations, he shall bear all costs arising for correction of non-complying items.
- D. Applicable Codes and Standards shall include all state laws, local ordinances, utility company regulations and applicable requirements of the following nationally accepted laws, codes and standards. These requirements are to be considered minimum and are to be exceeded when so indicated on the drawings or herein specified.
 - 1. Governing Agencies
 - a. Fire Prevention and Building Safety Commission
 - b. Indiana Department of Health
 - 2. Applicable Codes

- a. Indiana Building Code (IBC), 2014, consisting of:
 - (1) International Building Code, 2012
 - (2) Indiana Amendments
- b. Indiana Electrical Code (IEC), 2009, consisting of:
 - (1) NFPA 70, National Electrical Code, 2008
 - (2) Indiana Amendments
- c. Indiana Safety Code for Health Care Facilities, 1991, consisting of:
 - (1) NFPA 99 Standard for Health Care Facilities 1992
 - (2) Indiana Amendments
- d. Indiana Mechanical Code (IMC) 2014 consisting of:
 - (1) International Mechanical Code 2012
 - (2) Indiana Amendments
- e. Indiana Energy Conservation Code (IECC) 2010, consisting of:
 - (1) American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. Standard 90.1, 2007 Edition
 - (2) Indiana Amendments
- f. Indiana Elevator Safety Code 2011 Edition 675 IAC21 (ANSI ASME A17.1 2007 Edition)
- g. Indiana Fire Code (IFC), 2014, consisting of:
 - (1) International Fire Code, 2012
 - (2) Indiana Amendments
- h. Indiana Rules for Boilers and Pressure Vessels and excerpts from Indiana Statue (IC22-12) governing licensing and regulation

3. Standards

- a. ASTM: American Society of Testing Materials
- b. ANSI: American National Standards Institute
- c. AGA: American Gas Association
- d. ARI: American Refrigeration Institute
- e. ASME: American Society of Mechanical Engineers
- f. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
 - (1) Standard 55 – 2013 Thermal Environmental Conditions for Human Occupancy
 - (2) Standard 62.1 – 2016 Ventilation for Acceptable Indoor Air Quality
 - (3) Standard 90.1 – 2013 Energy Standard for Buildings except Low-Rise Residential Buildings
 - (4) Standard 189.1 – 2014 Standard for the Design of High-Performance Green Buildings
- g. ASCE: American Standard Code for Information Exchange
- h. AMCA: Air Moving and Conditioning Association Exchange
- i. NEC: National Electric Code
- j. NECA: National Electrical Contractors Association

k.	NEIS:	National Electrical Installation Standards
l.	NEMA:	National Electrical Manufacturers Association
m.	NFPA 101:	Life Safety Code
n.	NFPA 90A:	Standard for the Installation of Air Conditioning and Ventilating Systems
o.	NFPA 90B:	Standard for Installation of Warm Air Heating and Air Conditioning Systems
p.	NFPA 92B:	Standard for Smoke Management Systems in Malls, Atria, and Large Spaces
q.	OSHA:	Occupational Safety and Health Act
r.	SMACNA	Sheet Metal & Air Conditioning Contractors Assn.
s.	UL:	Underwriters Laboratories
t.	ADAAG:	Americans with Disabilities Act Accessibility Guidelines

- E. The Contractor shall be responsible for obtaining all permits, payment of all fees, necessary drawings and arranging and paying for all inspections, tests, etc. which may be required by any governing authority or utility company in connection with the furnishing or installation of any of his work.

1.04 WORK AND WORKMANSHIP

- A. All materials and equipment shall be of the highest quality in every respect. All materials and equipment shall be new and of the latest design and free of defects.
- B. Workmanship shall be by skilled workmen of highest standard in strict accordance with all applicable manufacturers' printed specifications (which, by reference, are made completely a part of these specifications as though herein repeated), performed under supervision of competent foremen at all times.
- C. The Owner has full power to condemn or reject any work, materials or equipment not in accordance with these specifications and construction drawings or not in conformance with the manufacturers' specifications or drawings which were approved by the Owner or Engineer.
- D. 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 Engineer.
- E. Such decisions that the Owner or Engineer may make with respect to questions concerning the quality, fitness of materials, equipment and workmanship shall be binding upon the parties thereto.

- F. 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.

1.05 DEVIATIONS FROM DRAWINGS

- A. Mechanical drawings show the intended arrangement and routing of all piping, ductwork, equipment and appurtenances. They shall be followed as closely as actual building construction and work of other trades will permit.
- B. The Contractor shall investigate structural and finish conditions affecting his work and shall provide any fittings, offsets and accessories required to accommodate said conditions.
- C. The Contractor shall coordinate with other trades and provide any fittings, offsets and accessories required to obtain the coordinated installation, in addition adjustment shall be made for reasons to improve the installation or performance, etc., made upon receiving the approval of the Engineer. The Contractor shall document that adjustments have been coordinated with all parties concerned.

1.06 OCCUPATIONAL SAFETY AND HEALTH ACT

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

1.07 COORDINATION BETWEEN CONTRACTORS

- A. The Contractor and his subcontractors shall study all drawings and specifications for this project so that complete coordination between trades will be obtained. Special attention shall be given to points where ducts cross other ducts, piping or cables, where lights fit into ceilings and where pipe, ducts and conduit pass through walls and structural elements.
- B. It is the responsibility of the contractor and his Subcontractors to leave necessary room for other trades. No extra compensation will be allowed to cover the cost of relocating piping, conduit, ducts or equipment found encroaching on space required by other trades.
- C. The Contractor shall review the electrical requirements of the final equipment selections to ensure such items receive proper electrical services or connections.
- D. The Contractor shall provide complete information and cooperation to the other Contractors and trades pertaining to his work to accomplish coordination for the complete project.
- E. The Contractor shall provide the necessary sleeved openings, excavations, etc. Cutting and patching shall be held to a minimum.

- F. The Contractor and his Subcontractors shall be required to attend the periodic progress meetings to accomplish coordination with the Owner, Architect and Engineer.
- G. Assure a minimum of 30" clear access at the front for all equipment requiring maintenance access.

1.08 INSPECTION

- A. At the appropriate intervals of the mechanical installation, the Contractor shall inform the local and state authorities to arrange inspections of his work. Provide Certificates of Inspection when completed.

1.09 REPORTS AND FINAL SUBMISSIONS

- A. The Contractor shall submit, for attachment to the Substantial Completion Certificate, a letter certifying that the mechanical systems are in accordance with the Indiana Mechanical Code, as amended by the State of Indiana.
- B. Submit all other test reports, as specified in other Divisions 23 specifications.

1.10 COORDINATION WITH COMMISSIONING AND PERFORMANCE VERIFICATION

- A. The purpose of the commissioning and performance verification process is to provide the Owner of the facility with a high level of assurance that the mechanical and electrical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Construction Documents.
- B. Each trade contractor shall review the procedures in the specification sections and include the necessary cooperation and coordination.

PART 2 - PRODUCTS

2.01 PRODUCT AND MATERIAL APPROVAL

- A. When Manufacturer's model numbers are listed, they are for reference only and are not to be considered a basis of design. The model numbers listed are the best information made available to the designer by the manufacturer and not intended to supplant or be inclusive of the criteria defined in the specifications and drawings. The Contractor/Manufacturer shall review the complete construction documents to assure the products proposed are appropriate and meet the system design criteria, including dimensional restrictions.
- B. The performance requirements listed in the specifications, or shown on the drawings are the basis of design and will be the benchmark used for submittal review and approval as well as determining if work is accepted or rejected.

- C. A specification followed by one or more manufacturers is limited to those manufacturers. Names of other proposed manufacturers may be submitted for approval to the Engineer a minimum of ten (10) days prior to receiving bids. Approval will be granted only if issued by Addendum (no exceptions).
- D. A specification followed by one or more manufacturers and "or approved equal" is open to equal products or materials. However, the Contractor shall supply one of the listed manufacturers at no additional cost if Engineer determines substituted product unsatisfactory.
- E. Any substituted equipment offered for consideration shall be stated as a separate item with the bid. State any additive or deductive cost.
- F. If changes in piping, ductwork, equipment, layout or electrical service are brought about by the use of equipment which is not compatible with the layout shown on the drawings, the Contractor shall include the cost of the necessary changes in his bid.

2.02 SUBCONTRACTORS AND MATERIAL LIST

- A. The Contractor shall submit, with his bid, a completed list of subcontractors, manufacturers and suppliers of each item listed. No substitutions will be allowed, by the Contractor, after award of contract.
- B. Failure to submit a fully completed list within the stated time may be cause to reject the bid.
- C. Remove or copy the following list and attach it to the bid form.

2.03 LIST FOR MECHANICAL CONTRACTOR:

(The Contractor)

A.	Sub-Contractors	SUBCONTRACTORS AND MATERIALS	
	Sheetmetal Subcontractor	_____	
	Insulation Subcontractor	_____	
	Balancing Subcontractor	_____	
	Temperature Control Subcontractor	_____	
B.	Material and Suppliers List		
	<u>SECTION</u>	<u>MATERIAL</u>	<u>MANUFACTURER</u> <u>SUPPLIER</u>
	23 05 48	Vibration Isolators	_____
	23 05 53	Equipment and	_____
		Pipe Labels	_____
	23 07 13	Duct Insulation	_____
	23 07 19	Pipe and Equip Insulation	_____
	23 09 13.43	Temp. Control	_____
		Dampers	_____
	23 21 13	Condensate Drain	_____
		Piping system	_____
	23 23 00	Refrigerant Piping	_____
	23 31 00	Sheetmetal Fabrica-	_____
		tion Drawings	_____
	23 33 00	Balancing Dampers	_____
	23 33 53	Duct Lining	_____
	23 34 00	Fans	_____
	23 34 24	HVLS Fans	_____
	23 35 10	Vehicle Exhaust Sys.	_____
	23 37 00	Grilles/Registers/	_____
		Diffusers	_____
	23 37 50	Louvers	_____
	23 40 00	Filters	_____
	23 51 23	Flue Piping	_____
	23 55 33	Gas Fired Heating	_____
		Equipment	_____
	23 73 01	Coils	_____
	23 74 13	DOA Units	_____
	23 81 11	Ductless Split System	_____
	23 82 20	Furnace Coil and Split Systems	_____
	23 83 40	Elec.Terminal Heating	_____
		Units	_____

2.04 EQUIPMENT DELIVERY SCHEDULE

- A. Submit a schedule listing equipment and materials required for complete installation, quantity ordered, date of placing order and the promised delivery dates.

- B. Any and all probable delivery delays shall be identified at the pre-construction meeting.

2.05 SUBMITTALS

- A. The Contractor shall submit shop drawings, fabrication drawings, and specific product literature for all products specified and shown on the drawings.
- B. Approval of submittals does not relieve the Contractor of the responsibility for ordering proper quantities and miscellaneous appurtenances required for operation and/or installation of the respective material, equipment or system.
- C. The following general information is required with each submittal as applicable:
 - 1. Contractor's stamp, signature and date shall be affixed to the submittal with indication of his review and approval.
 - 2. The full manufacturer's model number of each item
 - 3. Identification of each item's performance, physical size and construction data.
 - 4. Identification of finishes. Furnish two (2) chips for each color for items requiring color/finish selections.
 - 5. Indicate any modifications made to manufacturers' standard design which are required by these specifications.
 - 6. Location of connection points for external piping, duct or electrical connections.
 - 7. Rough-in, foundation and support point dimensions.
 - 8. Complete wiring diagrams and connection identifications, specific to this project.
- D. When manufacturer's information contains multiple model numbers and capacities on the same data sheet, specific equipment to be provided shall be identified by highlighting or clouding relevant data or striking non-relevant data.
- E. Unit equipment designations from the plans and schedules (unit tags) shall be identified for each piece of equipment.
- F. In addition, submit any detailed or specific information as stated in the respective specification sections.

2.06 RECORD DRAWINGS

- A. The Contractor shall submit record drawings as stated in the General Conditions, and as specified herein.
- B. During construction, maintain a complete and legible set of drawings, at the job site showing changes and deviations between actual construction and Engineer's drawings.
- C. Submit to Engineer for review at the 25%, 50%, 75% and 100% completion of the work a complete, accurate and neat set of marked-up blue-line drawings showing the complete "as built" construction.

- D. This marked-up set shall be returned to the Contractor as many times as necessary in order to obtain desired results.

2.07 MAINTENANCE MANUALS

- A. Contractor shall submit at job completion, two (2) hard copies of maintenance manuals and (1) electronic copy in pdf format to the Engineer for approval. Do not submit hard copies until the electronic copy is approved.
- B. Maintenance manuals are to include all information relative to maintenance and operating instructions for all new mechanical equipment.
- C. Maintenance manuals shall be assembled in the following sections:
 - 1. Section 1
 - a. Title of project
 - b. Name and addresses of:
 - (1) Owner
 - (2) Engineer
 - (3) Contractor
 - 2. Section 2: Index of complete contents
 - 3. Section 3:
 - a. List of all equipment with model number and serial number
 - b. Warranty of each piece of equipment with start and completion dates.
 - 4. Section 4: valve tag chart
 - 5. Section 5:
 - a. Air balance report
 - b. Water balance report
 - c. Operating and test reports
 - 6. Section 6: Products
 - a. Include performance characteristics of each piece of equipment.
 - b. Incorporate data sheets, operating instructions, maintenance instructions, parts list, installation instruction and performance characteristics on each piece of equipment or system in individually tabbed subsections.
 - c. Label and assemble tabbed sections in numerical order by corresponding specification section number.
 - d. Include a copy of the final approved submittals for each piece of equipment.
- D. Each section shall be separated by a pasteboard tabbed divider. Each section tab shall identify equipment by same name as listed in the index. Tabs shall extend outside of sheet size.
- E. All information shall be arranged in a three-ring (3" D configuration) vinyl coated

notebook.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle equipment and components carefully to prevent damaging, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.
- B. Store equipment and components in clean dry place. Protect from weather, theft, dirt, fumes, water, construction debris and physical damage at all times.

3.02 UTILITY START-UPS

- A. Facilitate the startup of new utility services for this project and ensure the proper operation of utility metering for billing and energy management.

END OF SECTION

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SECTION 23 05 02 - ASSIGNMENT OF MISC. WORK

PART 1 - GENERAL

1.01 PAINTING

- A. Painting of exposed mechanical system in public areas shall be by General Contractor. Mechanical Contractor to coordinate with General Contractor.
- B. Painting of piping systems in mechanical rooms and fan rooms (color coded) shall be by the Mechanical Contractor in accordance with Specification Section 23 05 64, Painting.
- C. Painting of all interior and exterior, non-galvanized, metal supports, stands and miscellaneous metal for mechanical equipment and piping shall be by the Mechanical Contractor in accordance with Specifications Section 23 05 64, Painting.
- D. Painting of patched and new ceiling and wall surfaces shall be by the Mechanical Contractor in accordance with application requirements of Specification Section 23 05 64, Painting.
- E. Painting of all exterior piping shall be by the Mechanical Contractor in accordance with Specifications Section 23 05 64, Painting.

1.02 WALL OPENINGS

- A. Wall openings for mechanical work, not noted on the Architectural or Structural drawings, shall be arranged for and provided by the Mechanical Contractor.
- B. Lintels for wall openings required by mechanical work will be furnished and installed by the Contractor constructing the wall. The Mechanical Contractor is responsible for notifying the Contractor of locations and sizes of openings requiring lintels prior to wall construction. Openings not coordinated and provided shall be arranged for and provided by the Mechanical Contractor.
- C. Final sizes and locations of mechanical penetrations in walls are the responsibility of the Mechanical Contractor.
- D. Provide approved fire stops for fire rated wall openings.
- E. Provide acoustical seals for sound proofing in wall openings.

1.03 ROOF AND FLOOR OPENINGS

- A. Roof and floor openings for mechanical work not noted on the architectural or structural drawings shall be arranged for and provided by Mechanical Contractor. Miscellaneous framing required and cutting of openings, shall be furnished, and installed by the contractors constructing the roof or floor structure. Mechanical Contractor is responsible for notifying those Contractors of exact locations and sizes prior to construction of the framing. Openings not coordinated and provided shall be arranged and paid for by the Mechanical Contractor.
- B. Final sizes and locations of mechanical penetrations through the roof and floor structures are the responsibility of the Mechanical Contractor.
- C. All post-tensioned slab penetrations shall be sleeved. Sleeves shall be provided by the Mechanical Contractor and coordinated with the General Contractor.
- D. Roof curbs and supports for mechanical equipment and penetrations shall be provided by the Mechanical Contractor requiring same.
- E. Counterflashing shall be provided by the Mechanical Contractor. Roof flashing shall be provided by the roofing contractor.
- F. Provide fire retardant plywood sheets when roof areas are completed during construction operations for walkways and work areas. The Contractors working on the completed new roof shall be responsible for roof protection and assuring the warranty on the roof system is maintained.

1.04 WALL AND CEILING ACCESS PANELS

- A. Wall and ceiling panels for access to mechanical equipment, dampers, valves, or controls shall be furnished by the Mechanical Contractor.
- B. Mechanical Contractor is responsible for coordinating and assisting in locating all access panels, for installation by the General Contractor, prior to his wall or ceiling construction.
- C. Access panels are required in inaccessible (non-lay-in) ceilings and walls for all valves, actuators, dampers, controls, filters, or other components requiring periodic maintenance. Panels shall be located to be accessible without causing damage to final finishes. Coordinate items requiring access including with other trades so that the quantity of access panels is kept to a minimum.
- D. The panel locations shall be also coordinated with, and receive the approval of, the Architect and Engineer.

1.05 CUTTING AND PATCHING

- A. Cutting and patching of finished areas for mechanical work shall be provided by the Mechanical Contractor. Mechanical Subcontractors shall coordinate responsibility for cutting and patching with Mechanical Contractor prior to bidding.

- B. Cutting and patching of finished areas shall be provided by the Contractor requiring same, however, the work shall be performed by the trade responsible for this type of work.
- C. Patched surfaces shall be finished to match existing unless the surface is scheduled to receive new finish.

1.06 CONCRETE PADS

- A. Concrete pads for mechanical equipment shall be provided by Mechanical Contractor in accordance with Specifications Section 23 05 05, Concrete Pads and Curbs.
- B. Concrete pad removals and floor patching by Mechanical Contractor.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.01 PLATFORMS AND SUPPORT STANDS

- A. Platforms and supporting stands for mechanical equipment shall be provided by Mechanical Contractor.
- B. Each piece of equipment or apparatus suspended from ceiling or mounted above floor level shall be provided with suitable structural support, platform or carrier constructed in accordance with best recognized practice in a neat and workmanlike manner.
- C. Contractor shall exercise extreme care that structural members of building are not overloaded by such equipment. In all cases, details of such hangers, platforms and supports together with total weights of mounted equipment shall be approved by Structural Engineer.
- D. Non-galvanized steel supports shall be painted. See Section 23 05 64 Painting.

3.02 ATTACHING TO BUILDING CONSTRUCTION

- A. Equipment, ductwork, and piping supports shall be attached to structural members (beams, joists, etc.) rather than to floor or roof slabs.
- B. Where equipment is suspended from concrete or masonry construction, use expansion shields to attach supports to construction. Expansion shield bolt diameter shall be the same size as support rod diameter, hereinafter specified.
- C. 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 Architect and/or Engineer.

- D. Where supports are attached to structural members coated with fireproofing, the contractor shall clean the fireproofing, attach the support, and patch the fireproofing with like material.

3.03 ELECTRICAL CONNECTIONS TO EQUIPMENT

- A. In the event that equipment furnished requires a larger starter or disconnect than that which is indicated on the documents, the Contractor supplying the larger equipment shall reimburse the Electrical Contractor supplying the larger starter or disconnect for the difference in labor and material cost.
- B. Detailed diagrams and instructions shall be provided by Contractor supplying equipment. If connections are different from those shown on the drawings, the contractor shall notify the electrical contractor prior to start of his related work.
- C. Relays, switches, contactors, etc. which may be required in addition to those specified or indicated on the electrical drawings shall be furnished by the supplying contractor for installation by the Electrical Contractor. These devices shall be mounted by the Electrical Contractor at the apparatus to be installed and the contractor supplying these additional devices shall reimburse the Electrical Contractor for his labor and material costs.
- D. In the event that several pieces of mechanical equipment from different suppliers are combined into one system, Contractor shall furnish complete interface wiring and control diagram to enable the Electrical Contractor to make proper connections. Diagrams shall be submitted to the Engineer for approval prior to actual wiring.
- E. Contractor shall furnish to Electrical Contractor written notice of approval and acceptance of all control wiring which was installed by the Electrical Contractor for his system(s). Such approval shall be given within thirty (30) days of completion of all such control wiring. The letter shall be copied to the Engineer.

END OF SECTION

SECTION 23 05 03 - COMPLETION AND STARTUP

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish material and labor required to perform startup of equipment and systems installed in this project and provide operating and maintenance instructions to the Owner.
- B. Coordinate, schedule and perform this work with the Commissioning Engineer.
- C. Furnish labor and material required to inspect the installed piping and duct systems and correct deficiencies as specified herein.
- D. Furnish labor and equipment required to maintain clean work areas throughout the project and to perform final cleanup.

1.02 RELATED WORK

- A. General Provisions: Section 23 05 01
- B. Assignment of Miscellaneous Work: Section 23 05 02
- C. Testing, Adjusting and Balancing: Section 23 05 93

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.01 GENERAL COMPLETION REQUIREMENTS

- A. Adhere strictly to the following procedures in completing mechanical systems.
 - 1. Adjust tension in V-belt drives, adjust vari-pitch sheaves and drives for proper equipment speed. Remove any foreign materials from sheaves or belts before starting operations, adjust drives for alignment of sheaves and V-belts.
 - 2. Adjust direct drives for proper alignment of flexible couplings, provide lubrication of particular couplings so required, check security of couplings to driver and driven shafts, set drive components to assure free rotation with no undesirable stresses present on coupling or attached equipment.
 - 3. 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.

4. Check pump packing glands or mechanical seals for cleanliness and adjustment before running pump. Inspect shaft sleeves for scoring and proper placement of packing, replace if necessary. Inspect mechanical faces, chambers and seal rings and replace them if necessary. Make sure the piping system is free of dirt and scale before circulating liquid through pumps.
 5. Tighten unions and flanges in piping systems after the system has been placed in operation. Replace gaskets in flanges that show any signs of leakage after tightening.
 6. 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.
 7. Clean strainers, dirt pockets, orifices, valve seats and headers in all fluid systems after the system has been placed in operation to assure, they are free from foreign material.
 8. Adjust pipe hangers and supports for correct pitch and alignment.
 9. Inspect both hand and automatic control valves, clean bonnets, and stems, tighten packing glands to assure no leakage but permit valve stems to operate without galling. Replace packing in valves that require same to retain maximum adjustment after system is judged complete. Replace entire packing in any valve that continues to leak after adjustment, remove and repair bonnets that leak, coat packing gland threads and valve stems with surface preparation similar to Moly Cote or FelPro after cleaning.
 10. Inspect and make certain that all control valve seats are free from foreign material and are properly positioned for intended service.
 11. Inspect each pressure gauge and thermometer for calibration and replace those that are defaced, broken, or read incorrectly.
 12. Remove rust, scale and foreign materials from equipment and renew any defaced surfaces. If equipment is badly marred, the Engineer shall have authority to request that new materials be provided.
 13. After completion of equipment test and balance, replace air filters in all units.
 14. Repair pipe and duct insulation or duct liner that may have been damaged during construction period.
 15. After the air balance is complete, replace all variable pitch sheaves to fixed pitched sheaves.
- B. Complete all applicable startup procedures described in preceding paragraphs and in the associated articles for particular systems prior to occupancy of spaces served.
- C. Provide such continuing adjustment services as necessary to ensure proper functioning of all mechanical systems after building occupancy and during warranty period.

3.02 STARTUP

- A. A pre-startup construction meeting shall be scheduled by the Mechanical Contractor for the specific purpose of achieving a coordinated systems startup with the Commissioning Engineer and Owner.
- B. The Commissioning Engineer, Owner, Mechanical Contractor, Sheetmetal Contractor, Temperature Control Contractor, Balancing Contractor and Electrical Contractor shall be present at the pre-startup meeting and at the initial startup of each mechanical system and air handling unit.
- C. Perform a startup of each system installed in this project in strict accordance with manufacturer's printed procedure.
- D. Check for proper rotation of all fans and pumps.
- E. Check for proper electrical services and usage during the startup procedure.
- F. Perform operational tests on all equipment as specified in Specifications Section 23 05 93, Testing, Adjusting and Balancing.
- G. If a piece of equipment is not performing satisfactorily during testing and balancing, the Balancing Contractor shall notify the Installing Contractor for corrective action.
- H. All involved contractors shall submit to the decision of the Owner/Engineer of any conflict of responsibility.

3.03 TEMPORARY USE OF NEW EQUIPMENT

- A. The permanent heating and cooling systems shall not be utilized as the temporary tempering source for constructing the building, prior to full enclosure.
- B. When it becomes necessary to operate any equipment during the construction period for system checkouts, or maintaining reasonable temperatures or humidity levels for finishes, the Contractor will be required to do so, but only after proper adjustments, trial operation and Owner or Engineer's approval in writing.
- C. When this occurs, the contractor shall prepare a written procedure for the temporary operation to the Owner/Engineer for acceptance. The procedure shall address the following issues:
 - 1. All ductwork openings shall be protected with filter media to prevent dust, dirt, and debris from entering. The media shall be maintained and replaced periodically to obtain protection.
 - 2. Fire alarms and smoke detectors shall be protected and isolated during operation of air handling equipment. Temporary detectors shall be installed for fire protection to shut down air handling equipment.
 - 3. Variable frequency drives shall be protected and isolated from the construction atmosphere (dust).

- 4. All equipment intended to run shall be protected for operation with all safeties intact and operational.
- D. The warranty on the equipment will not begin until the date of the Owner's final acceptance at the completion of the project.
- E. Should the Owner elect to receive beneficial operation of the equipment prior to final acceptance, he may do so. The warranty period may begin then upon the Contractor receiving written approval from the Owner accepting the equipment with conditions of any incomplete portions of the work.

3.04 TOUCH-UP

- A. All mechanical equipment, cabinets, control panels and other enclosures shall be cleaned, and 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 by the installing contractor to match original finish or shall be replaced before final acceptance.

3.05 CLEANING

- A. Maintain a clean project site throughout the construction period. Provide personnel to regularly remove debris and unused materials. Coordinate this cleaning effort with your subcontractors.
- B. Remove all debris and unused materials from job sites created by mechanical work.
- C. Clean all mechanical equipment to a "like new" condition prior to systems startup, prior to balancing and in preparation of final inspection. Vacuum clean all internal components.
- D. Clean all mechanical rooms and/or areas of debris and unused material. Vacuum clean mechanical room floors.
- E. Clean the exterior surfaces of all ductwork and piping systems. Vacuum clean if appropriate. Damp/wet clean with soap (chemical if necessary) and water where required or directed by Owner/Engineer.

END OF SECTION

SECTION 23 05 05 - CONCRETE PADS AND CURBS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install cast-in-place concrete pads and curbs for equipment and ductwork where shown on the drawings and as specified herein.

1.02 RELATED WORK

- A. General Provisions: Section 23 05 01
- B. Assignment of Misc. Work: Section 23 05 02

1.03 SUBMITTALS

- A. Submit complete shop and setting drawings in accordance with Specifications Section 23 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 CONCRETE FORMWORK

- A. Design criteria: conform to tables for form design in APA Form V345, including strength.
- B. Lumber: construction standard grade.
- C. Plywood: exterior type softwood plywood, PS 1.
- D. Ties: carbon steel, snap ties, 1" breakback, 1/4" maximum diameter.
- E. Form Coatings: non staining
- F. Form Joint Tape: closed cell foam.

2.02 CONCRETE REINFORCEMENT

- A. Materials
 - 1. Bars: deformed billet steel: ASTM A615, Grade 40.
 - 2. Wire:
 - a. Cold drawn steel: ASTM A82
 - b. Deformed steel: ASTM A496
 - 3. Tie Wire: FS-QQ-W-461, annealed steel, black 16-gauge, min.
 - 4. Welding Electrodes: AWS A5.1, low hydrogen, E70 Series.
 - 5. Splice Devices: sized to develop 125% of yield strength of bar.

6. Bar Supports: conform to "Bar Support Specifications", CRSI Manual of Standard Practice, Chapter 3.
 7. Wire Fabric: welded steel, ASTM A195
- B. Placement: Set reinforcing accurately and tie all items securely.
- C. Pin all interior pads and curbs to floor slabs, with dowels or bars.

2.03 EXPANSION AND CONTRACTION JOINTS

- A. Joint Filler: Pre-molded, treated, non-bituminous, non-extruding wood fiber in concrete color and compatible with specified sealants. The filler shall conform to the performance requirements of ASTM D1752, Type 1.
- B. Acceptable Manufacturers
1. Everlastic
 2. Rescor
 3. Homex 300
 4. Sponge Rubber
 5. Williams Products
 6. W. R. Meadows
 7. Homasote
 8. Construction Gaskets

2.04 CAST-IN-PLACE CONCRETE

- A. Interior: 4000 PSI, ready mix, to conform to ASTM C94
- B. Exterior and Below Grade: 4000 PSI with 4% - 6% air entrainment.
- C. Slump: 5 inch maximum, tolerance, zero plus or minus 2 inches.
- D. Concrete shall be thoroughly consolidated without honeycombed finish surface.
- E. All top, side, and vertical edges of concrete pads and curbs shall have 3/4" chamfer.

2.05 CONCRETE FINISHING

- A. Interior Pads and Curbs
1. Provide smooth (floated) sides and top.
 2. Grind smooth all chamfered edges.
- B. Exterior Pads
1. Provide smooth (floated) sides.
 2. Provide broom finish top.
 3. Grind smooth all chamfered edges.

2.06 CONCRETE CURING

- A. Apply concrete curing compound only at exposed slab.
- B. Acceptable Manufacturers
 - 1. Curetox - Toch Brothers
 - 2. Sealtight AR-30C - W.R. Meadows
 - 3. Promulsion 100 - Protex

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide nominal 4" concrete housekeeping pads under all interior floor mounted Mechanical Equipment.
- B. Provide nominal 6" concrete pads under all exterior ground mounted mechanical equipment.
- C. All housekeeping pads shall include welded steel wire fabricated reinforcement.
- D. Provide nominal 6" high by 6" wide concrete curbs above grade to surround all floor openings for ductwork and pipe penetrations.
- E. Coordinate location and size of pads and curbs with other concerned contractors.
- F. Coordinate pad location with floor drains.
- G. Expansion joints will not be permitted to cross limits of a piece of equipment.
- H. Concrete pads shall extend 6" past all sides of equipment. Determine size of equipment from manufacturer's shop drawings prior to forming pad. Do not scale from design drawings.

END OF SECTION

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SECTION 23 05 29 - BASIC PIPING REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Pipe Hangers and Supports
- B. Sleeves and Plates
- C. Installation of Piping Systems
- D. Fire Stop Sealants
- E. Acoustic Seals

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Prefab. Roof Curbs and Supports: Section 23 05 30
- C. Vibration and Seismic Controls for Piping and Equipment: Section 23 05 48
- D. Painting: Section 23 05 64
- E. HVAC Pipe and Equipment Insulation: Section 23 07 19
- F. Refrigeration Piping System: Section 23 23 00

1.03 COORDINATION DRAWINGS

- A. Coordination Drawings are required on this project.
 - 1. Piping systems coordination drawings as defined below are used to obtain complete coordination with all other trades.
 - 2. Prepare coordination drawings of all piping systems, and above. Drawings to reflect all offsets and routing adjustment required as a result of coordination with structural, ductwork and other trades. Note bottom of pipe elevations above finish floor.
- B. Drawings:
 - 1. Submit drawings for Engineer's approval prior to installation. Refer to Specifications Section 23 05 01, General Provisions and Division 1 for submission requirements.

- a. Drawings shall be prepared utilizing AutoCAD or Revit. Contact the Architect to obtain generic floor plans. Engineers' drawings are not intended for use as coordination drawings.
 - b. Drawings shall be minimum scale of 1/4" = 1'-0" for floor plans. Include sections and elevations of all pipe offsets or risers.
 - c. Coordinate the routing with all other trades and the structural/architectural drawings during drawing development period. Detail all areas requiring close or critical coordination points on the drawings.
2. Thoroughly review all construction documents to verify all routings, heights, and locations of all piping. Visit the jobsite and field verify all routings, heights, and locations. Notify the Engineer of any conflicts and proposed coordinated solutions.
 3. For remodeled areas the Contractor shall visit the jobsite and field verify all routings, heights, and locations of all piping. Notify the Engineer of any conflicts.
 4. Completed drawings shall be submitted to General Contractor, Sprinkler Contractor, Sheet metal Contractor, Temperature Control Contractor, and Electrical Contractor for their coordination and impact to the final layouts. Prepare any drawing corrections required to obtain a coordinated layout. Provide sufficient sets of drawings for distribution.
 5. Submit drawings to the Balancing Contractor for that contractor's review and comments before such drawings are submitted for approval.
 6. No pay requests for installed work will be honored until fully coordinated drawings are accepted by the Owner.

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Section 23 05 01, HVAC General Provisions for all products in this section including pipe hangers and supports, fire stops, etc.
- B. Submit shop drawings which indicate complete material data, a list of materials proposed for this project.

1.05 GENERAL PIPE SYSTEM INSTALLATION REQUIREMENTS

- A. Fabricate and install all pressure piping systems in accordance with the procedures established in the ANSI B31 Code. Materials and fittings shall be as defined by the applicable standards of ANSI, ASHRAE, or ASME
- B. Provide fittings for all branch fittings and changes in direction, elevation or size in accordance with the ANSI B16 Standard. No mitered joints or pipe bends will be permitted. Reduction of pipe size shall be by tapered reducing fittings or couplings; bushings or reducing flanges will not be permitted. No thread-o-let and/or weld-o-let type products will be allowed.

- C. Install branch connections to mains using tee fittings in main with takeoff out the bottom of the main, except for up feed risers which shall have takeoff out the top of the main line.
- D. Each length of pipe, fitting and item shall be marked with the manufacturer's name and material identification.
- E. Install all piping to present a neat and orderly appearance. Run all lines parallel with building walls and construction. Keep piping free from contact with structure or equipment to prevent noise transmission, allowing clearance for expansion and contraction. Offset piping, in an approved manner, where required to avoid interference with other work, to increase headroom under piping or to improve the appearance of the work.
- F. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- G. Install air vents at high points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- H. Install deep seal P-traps in condensate drain lines between the source of condensate and the point of discharge.
- I. Provide ample space between piping and construction for proper insulation covering thickness.
- J. Provide eccentric reducing couplings in all cases where air or water pockets would occur due to a reduction in pipe size. Do not use bushings.
- K. Install hydronic supply and return piping at a uniform grade of 1" in 40 feet upward in the direction of flow.
- L. Install condensate drain piping with a uniform grade of 1/8" per foot downward in the direction of flow.
- M. Anchor piping as required to prevent undesirable movements.
- N. Use dielectric couplings when joining dissimilar piping materials.
- O. Provide adequate protection for piping and equipment against freezing.
- P. Pipes passing through exposed construction shall be provided with escutcheons or other seals as described herein. Exposed escutcheons in finished areas shall have a chrome finish.
- Q. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inches shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.

- R. Penetrations of fire rated walls, floors, roofs, and ceilings are to be made with rated fire stops equal/exceeding the fire rating of the building separation being penetrated.

1.06 PIPING SYSTEMS WARRANTY

- A. Maintain integrity of all piping systems through warranty period, repairing all leaks.
- B. Warranty work shall include repair/replacement of building materials and finishes damaged by leak(s).
- C. All damage resulting from leaking pipes shall be paid for by the installing contractor.

1.07 CLEARANCE FROM ELECTRICAL EQUIPMENT

- A. Piping is prohibited in electric and telephone rooms and closets, elevator machine rooms, and for installations over or within 6 ft. of transformers, substations, switchboards, motor control centers, standby power plants, and motors.
- B. Branch piping to equipment is acceptable when installed over or within 6 ft. of motors.

1.08 DRIP PANS

- A. Provide drip pans under piping when installation over or within 6 ft. of electrical apparatus is unavoidable or in rooms containing electrical equipment or under drainage piping at ceilings of food preparation areas. Pan shall be reinforced, properly supported, and made watertight. Provide enclosed type for pressure piping. Extend 1-1/2 in. drainpipe from pan to spill over nearest floor drain or as indicated.

PART 2 - PRODUCTS

2.01 PIPING SYSTEM MATERIALS

- A. All pipe hangers and supports shall conform to the latest requirements of ANSI Code for Pressure Piping B 31.1

2.02 PIPE HANGERS (UNINSULATED PIPE)

- A. Hangers: Steel pipe
 - 1. 2" and smaller: adjustable clevis, light weight
 - a. Anvil Fig. 65
 - b. PHD Fig. 440
 - 2. Larger than 2": adjustable clevis

- a. Anvil Fig. 260
 - b. PHD Fig. 450
- B. Hangers: copper pipe
 - 1. 2" and smaller: copper plated adjustable split ring
 - a. Anvil Fig. CT-109
 - b. PHD Fig. 502
 - 2. Larger than 2": copper plated adjustable clevis
 - a. Anvil Fig. CT-65
 - b. PHD Fig. 502
- C. Riser clamps: steel and cast-iron pipe.
 - 1. Anvil Fig. 261
 - 2. PHD Fig. 550
- D. Riser clamps: copper pipe
 - 1. Anvil Fig. CT-121
 - 2. PHD Fig. 552
- E. Floor supports steel and cast iron pipe
 - 1. 2" and smaller: U-bolt on structural steel channel secured to floor with angle clips.
 - a. Anvil Fig. 137
 - b. PHD Fig. 90
 - 2. larger than 2": adjustable pipe saddle
 - a. Anvil Fig. 264
 - b. PHD Fig. 875
- F. Floor supports: copper pipe, 2" and smaller: U-bolt on structural steel channel secured to floor with angle clips
 - 1. Anvil Fig. 120
 - 2. PHD Fig. 95
- G. Supports at walls or columns: cast iron or steel brackets properly selected to support weight suspended.
 - 1. Anvil Fig. 194, 195, 199, 202
 - 2. PHD Fig. 850, 855, 860
- H. Trapeze hangers: where parallel pipes may be grouped at approximately the same elevation, supports of unistrut, structural steel angles or channels with rods of sufficient strength to support weight can be used. Provide double nuts on support rods and angles and channels. Review weights with the Structural

Engineer on this project.

1. Secure individual pipes on trapeze with U-bolts specified above.
 2. Uninsulated pipes shall be isolated from the trapeze support with cradles.
 3. After final height is established, trim all excess thread rod supports under trapeze hangers to not exceed $\frac{1}{2}$ " length.
 4. MSS SP-69, Type 59, shop or field-fabricated assemblies constructed of structural steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.
- I. Roller supports: provide adjustable type roll hangers properly braced to prevent hanger movement of roll stands as applicable.
1. Roller hangers
 - a. Anvil Fig. 181
 - b. PHD Fig. 470
 2. Roller stands
 - a. Anvil Fig. 177
 - b. PHD Fig. 480
- J. Rods: galvanized steel, all threaded hanger rods; threaded both ends

<u>PIPE SIZE</u>	<u>ROD DIAMETER</u>
2" and smaller	3/8"
2.5" to 3.5"	1/2"
4" and 5"	5/8"
6" and 8"	3/4"
10" and 12"	7/8"
14" to 18"	1"
20" and above	1-1/4"

- K. Turnbuckles: where required to adjust pipe elevation.
- L. Beam Clamps
1. To 400 pounds loading, hardened steel point set screw; 6" pipe malleable iron clamp
 - a. Anvil Fig. 86
 - b. PHD Fig. 270
 2. To 1300 pounds loading, malleable iron jaw, steel tie rod, center load.
 - a. Anvil Fig. 218 (FM listed)
 - b. PHD Fig. 630
 3. To 11,000 pounds loading, forged steel: Anvil Fig. 292 Observe Manufacturer's stress limits.
- M. Pipe Rollers

1. Nonadjustable roller stand, cast iron
 - a. 2-12 inch pipe
 - (1) Anvil Fig. 175
 - (2) PHD Fig. 460
 - b. 14-42 inch pipe: Anvil Fig. 271
2. Adjustable roll support, cast-iron roll-on steel rod, 1 to 30 inch pipe.
 - a. Anvil Fig. 177
 - b. PHD Fig. 480

2.03 PIPE HANGERS (INSULATED PIPE)

- A. Provide hanger and support materials as specified for uninsulated pipe but with the following exceptions:
 1. Size hanger ring to fit outside insulation.
 2. Copper plated rings are not required.
- B. Insulation cradles:
 1. Provide manufactured welded steel cradles on all insulated heating (steam or hydronic piping above 160°F) pipe services sized for the insulation thickness.
 2. Provide hard wood (oak, etc.) cradles on all insulated chilled water piping and heating water below 160°F, sized for the insulation thickness. The insulation vapor barrier is to encompass the wood block. Wood cradles shall be 6" in length.

2.04 ANCHORS AND GUIDES

- A. Provide anchors and guides as required and where shown on the drawings.
- B. Guides shall be Flexonics Flexon pipe alignment guide or approved equal.

2.05 SLEEVES AND PLATES (ESCUTCHEONS)

- A. Schedule of Sleeve Usage:
 1. All sleeves through concrete walls shall be Schedule 40 PVC pipe.
 2. All sleeves through wall board, drywall, plasterboard or wall panels shall be 20-gauge galvanized steel.
 3. All sleeves through masonry walls, metal roof deck, concrete floors on grade shall be Schedule 40 galvanized steel pipe.
- B. Special sleeves and sealing as shown on drawings.
- C. Plates and escutcheons shall be chromium plated for finished areas and painted steel elsewhere.

2.06 FIRE STOP SEALANTS

A. Penetration Sealants

1. Dow Corning "Firestop Foam" and "Firestop Sealant"
2. Insta-Foam Products, Inc. "Insta-Foam Seal Silicone RTV Foam"
3. 3M Brand "Fire Barrier" Caulk
4. 3M Brand Moldable Putty "Pads" and Moldable Putty "Stix"

B. Intumescent sealants for use in openings and sleeves involving plastic pipe or insulated pipe:

1. Dow Corning "Firestop Intumescent Wrap Strip"
2. Fox Coupling, Inc. "Cast-In-Place Firestop Coupling"
3. 3M Brand "Fire Barrier" Caulk with FS-195 wrap strip and CS-195 composite sheet

PART 3 - EXECUTION

3.01 HANGERS AND SUPPORTS

A. General

1. Furnish and install supports, guides, anchors and swaybraces required for proper installation and support of pipelines.
2. Pipe suspensions shall prevent excessive stress and excessive variation in supporting force. Fabrication and installation of supports for pipelines shall not constrain piping to cause excessive transfer of load from support 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. Piping systems where flexibility is not desired shall be supported by rigid hangers.

B. Vibration and Noise Transfer Control

1. 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 supports themselves or through addition of flexible piping connectors or auxiliary equipment.
2. Refer to Specification Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

C. Pipe Hanger and Supports

1. Piping may be suspended by individual pipe hangers or where two or more pipes are paralleling each other at same elevation, Contractor may at his option support them on common trapeze bars. Construct of structural steel angles or channels with rods of sufficient strength to support weight and of design satisfactory to the Owner. Use U-bolts for securing individual pipes in trapeze. Under no circumstances shall piping

- be supported from other piping.
2. Where smaller piping must be suspended closer to overhead construction than is possible with single rod hangers, use double rod supports.
 3. Spacing
 - a. All pipe hanger spacing specified below are also applicable to trapeze hangers. Spacing shall be determined by smallest pipe among pipes carried on trapeze.
 - b. Spacing of hangers or supports for steel pipe as scheduled below.

PIPE SIZE		MAXIMUM SPACING
(1)	thru 1"	6'-0"
(2)	1-1/4" thru 2"	10'-0"
(3)	2-1/2" thru 5"	12'-0"
(4)	6" and above	15'-0"

- c. Spacing of hangers or supports for copper pipe as scheduled below.

PIPE SIZE		MAXIMUM SPACING
(1)	thru 3/4"	5'-0"
(2)	1" and 1-1/4"	7'-0"
(3)	1-1/2" to 3"	9'-0"
(4)	4" to 8"	11'-0"

- d. Provide hanger or support at all valves, tees and elbows.
 - e. Other risers shall be supported at lowest floor through which they pass. Pipe 2" and smaller in size shall be guided at every floor.

D. Securing Hangers and Supports at Building Construction

1. Provide as required steel or malleable iron inserts in poured concrete construction. The maximum load which may be applied to any one foot length of continuous insert shall not exceed 1000 pounds.
2. Where piping is suspended from masonry construction, use expansion shields to attach pipe supports to construction. Expansion shield bolt diameter the same size as the support rod diameter specified.
3. 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 beam clamps made of heavy steel forged to fit structural member (I-beam, angle, channel) and securely fastened in place. No building member to be drilled, welded, cut or otherwise deformed in attaching pipe supports unless approved by the Engineer.
4. Where existing masonry is not suitable to receive and hold expansion shields or where other means of attachment is advantageous, the Contractor shall submit an alternate method for approval to Engineer.
5. Do not suspend hangers from the deck. Suspend from structural framing members in an approved and workmanlike manner.
6. Provide additional bracing and support wherever needed, in opinion of the Engineer. Install structural steel members, attached to building framing,

where required, to provide additional points of support. Drill building structural and miscellaneous steel only as directed by the Engineer.

- E. Vertical Pipe Hangers
 - 1. Support vertical runs under 15 feet long with hanger adjacent to elbows.
 - 2. Support vertical runs over 15 feet long with riser clamps. Weld clamps to pipe and support on pipe sleeve or building structure. Space clamps at every floor with maximum spacing of 28 feet.
 - 3. Malleable iron risers shall be supported at every floor.
 - 4. All risers shall be supported at the lowest floor through which they pass. Pipe 2" and smaller in size shall be guided at every floor through which it passes. Larger pipes may be guided at every other floor.
 - 5. Provide supports at the bottom of risers with structural steel supports of a Structural Engineer approved design. Secure to floor with angle clips.
- F. Anchors and Guides: provide rigid anchors where required and as indicated on the drawings with not less than 2 guides in piping at each side of anchor unless otherwise indicated.
- G. Roof Supports: Provide prefabricated roof supports as specified in Section 23 05 30, Prefab. Roof Curbs and Supports, anchored to the roof deck. Vary support height from sloping roofs to obtain a level piping installation.

3.02 PIPE SLEEVES

- A. Furnish, locate and set pipe sleeves where piping passes through floors, walls and other concrete or masonry structural materials except where tunnels, chases or shafts are provided in the construction.
- B. Wall Sleeves
 - 1. Below Grade:
 - a. Sleeves set in walls below finished grade, in which one side is open to a space within the building, shall be provided with a water stop/collar which will seal against the passage of water between the sleeve and concrete. Sleeves shall be sized to finish flush with face of wall. Manufacturer" 'Century Line Sleeves' or approved equal.
 - b. Sleeves shall be installed where pipes pass under or through footings, grade beams or other structural bearing walls existing or new.
 - 2. Above Grade: Sleeves set in walls above grade shall be sized to finish flush with face of walls and shall be constructed of material which is equal to or greater than the fire rating of the wall.
- C. Floor Sleeves: Floor sleeves shall extend 1-1/2" above finished floor in chases and mechanical spaces. Sleeves shall extend to 3" above finished floors in areas such as kitchens, food preparation, dishwashing and laboratory areas. Sleeves shall be flush with finish floor in occupied spaces.

- D. Sleeves shall be in accordance with the following schedule unless otherwise specified.

<u>SLEEVE SCHEDULE</u>				
PIPE SIZE	UNINSUL.	1" INSUL.	1-1/2" INSUL.	2" INSUL.
1"	2"	4"	6"	6"
1-1/2"	3"	4"	6"	8"
2"	3"	6"	8"	8"
3"	4"	6"	8"	10"
4"	6"	8"	10"	10"
6"	8"	10"	12"	12"

- E. The void between the sleeve and wall, and the pipe or insulation jacket shall be neatly filled with an approved fire stop material.

3.03 UNION AND FLANGES

- A. Provide at intervals and locations where they will facilitate disconnection and removal of piping at all valves, at connections to equipment and elsewhere as shown.

3.04 APPLICATION OF FIRE STOP SEALANTS

- A. Prepare and apply preparation sealing system in accordance with manufacturer's printed instructions.
- B. Employ installation techniques which will ensure that firestopping is deposited to fill and seal holes and openings.
1. Provide flame (F) rating minimum one-hour, but not less than fire resistance rating of the assembly in which it is installed, per ASTM E-814.
 2. Ensure effective smoke seal.
- C. Tool exposed surfaces of applied sealant smooth.

3.05 VALVE INSTALLATION

- A. Furnish and install valves as specified in Hydronic Piping specification.
- B. Unless specifically otherwise indicated, provide valves in accordance with the following:
1. Shut-off valves shall be provided at each piece of equipment.
 2. Valves same size as lines in which they are installed.
 3. Valves in each service branch at the point where it leaves main.
 4. All valves 2" and smaller shall be threaded.
 5. Install a union just downstream of all threaded valves.
 6. Install a line size valve on both sides of control valves.
 7. Provide valve stem extensions on all insulated valves.
- C. Install valves with stems vertical where possible but in no case lower than horizontal position.

- D. Where locations of valves are not shown in detail, install valves in accessible positions arranged for easy access.
- E. Provide chain wheels with guides, and extension stem handwheels, for convenient operation of all valves 2-1/2" and larger located above 8 feet from finished floor. Extend chains to 7'-0" above floor.

END OF SECTION

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide vibration isolation systems, complete, as specified herein and shown on the drawings.
- B. Provide seismic supports as specified herein.
- C. The work of this section includes, but is not limited to, the following:
 - 1. Vibration isolation elements for piping systems
 - 2. Vibration isolators for ductwork.
 - 3. Equipment vibration isolators for:
 - a. Air Compressors
 - b. Fans
 - c. Furnaces/Air Handling Units
 - d. DOAS Units

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Basic Piping Requirements: Section 23 05 29
- C. Refrigerant Piping System: Section 23 23 00
- D. HVAC Ducts and Casings: Section 23 31 00
- E. HVAC Fans: Section 23 34 00
- F. Kitchen Hood Makeup Air/Exhaust System: Section 23 38 13

1.03 SUBMITTALS

- A. Submit the following data for approval, clearly identifying each item of equipment supported and the isolation to be installed at each point of support.
 - 1. Floor span if the equipment is to be supported by structure above grade.
 - 2. Horsepower of each motor, and rpm of both driven and driver, in each supported unit.
 - 3. Calculated horsepower transmitted to the structure through the vibration isolation as applied.
 - 4. Deflection as per the Schedule at the end of this section.
 - 5. Scheduled deflection of each isolator. Identification of each isolator selected by model number and spring color.
 - 6. Deflection of each isolator under the calculated load, actual loaded and unloaded measurable spring height.

7. The loading at which each isolator would be fully compressed to solid.
 8. The load at which each isolator would operate at the deflection recommended by the ASHRAE Guide, and at scheduled deflection.
- B. Shop Drawings, Supplemental to Division 1 Requirements:
1. Concrete and steel details for all inertia blocks.
 2. Vibration isolation devices: catalog cuts, isolation efficiencies and deflections.
 3. Anchor bolt locations.
 4. Reinforcing and template steels.
 5. Quality Assurance Provisions
- C. Final Inspection Report

1.04 MANUFACTURER RESPONSIBILITIES

Manufacturer of vibration isolation equipment shall have the following responsibilities:

- A. Determine vibration isolation sizes and locations
- B. Provide piping and equipment isolation systems as scheduled or specified.
- C. Guarantee specified isolation system deflection.
- D. Provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.05 QUALITY ASSURANCE

- A. It is the objective of this specification to require the necessary design for the control of excessive noise and vibration in the buildings due to the operation of machinery or equipment and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolation units and associated hangers and bases shall be under the direct supervision of the vibration isolation manufacturer's representative.

1.06 VIBRATION ISOLATION SCHEDULE

EQUIPMENT TYPE		ISOLATOR TYPE	MINIMUM STATIC DEFLECTION INCHES
A.	Air Handling Units		
	1.	Indoor Casing (floor mtd.)	F 0.35" Casings
	2.	Internal fans under 15 HP	A, FC-3 (H) 2.00"
B.	Ductwork		C 1.00"

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Submit to compliance with requirements specified herein, provide vibration isolation materials, bases and systems by one of the following or approved equal.
1. Kinetics Noise Control, Incorporated
Ian Place, P.O. Box 655
Dublin, Ohio 43017
(614) 889-0480
 2. Mason Industries, Incorporated
350 Rabro Drive
Hauppauge, New York 11788
(516)348-0282
 3. Vibration Mountings & Controls, Inc.
113 Main Street
Bloomington, NJ 07403
(201) 838-1780
 4. Keflex
221 S. Main St
Bartlett, IL 60103
(630)837-2581/2686(f)
 5. Vibro-Acoustics
Tel 416-291-7371 Fax 416-291-8049
info@vibro-acoustics.com
 6. Vibration Eliminator Co., Inc.
Tel 631-841-4000 Fax 631-841-0020
 7. Crystal Distribution, Inc. (CDI)
17560 Tyler Street NW
Elk River, MN 55330
(888) 234-7001
- B. Where listed, references are to Kinetics Noise Control, Inc. (K.N.C.), Mason Industries, Inc. (M.I.I.), and Vibration Mountings and Controls, Inc. (V.M.C.I.).
- C. Where exposed to outdoors or corrosive elements: provide corrosion protection.

2.02 VIBRATION ISOLATOR GENERAL REQUIREMENTS

- A. All vibration isolators shall have either known undeflected heights or other markings so that after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

- B. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and shall be linear over a deflection range of 50% above the design deflection.
- C. The ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 2.0.

2.03 SPRING MOUNTINGS

- A. Type 'A' spring isolators shall incorporate the following:
 - 1. Minimum diameter of 0.8 of the loaded operating height.
 - 2. Corrosion resistance where exposed to corrosive environment with:
 - a. Springs cadmium plated and neoprene coated
 - b. Hardware cadmium plated.
 - c. All other metal parts hot dip galvanized.
 - 3. Reserve deflection (from loaded to solid height) of 50% of rated deflection.
 - 4. Leveling device.
 - 5. 1/4-inch-thick neoprene acoustical base pad.
 - 6. Designed and installed so that ends of springs remain parallel.
 - 7. Adequate operating clearance.
 - 8. Non-resonant with equipment forcing frequencies or support of structure natural frequencies.
 - 9. Manufacturers:
 - a. M.I.I - Type SLF
 - b. V.M.C.I. - Type AC
 - c. K.N.C - Type FDS
- B. Type 'B' spring isolators shall be the same as Type 'A' except.
 - 1. Where operating weight differs from installed weight, provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops not in contact during normal operation.
 - 2. Two layers of 1/4 inch neoprene base pad separated by 1/16 inch sheet steel.
 - 3. Tapped holes in top plate for bolting to equipment.
 - 4. Capable of supporting equipment at a fixed elevation during equipment erection.
 - 5. Manufacturers:
 - a. M.I.I - Type SLR
 - b. V.M.C.I. - Type AWR
 - c. K.N.C - Type FLS.
- C. Type 'C' spring hanger rod isolators shall incorporate the following:
 - 1. Spring element seated on a steel washer within a neoprene cup.
 - 2. Steel retainer box encasing the spring and neoprene cup.
 - 3. Neoprene bushing for lower rod hole to prevent steel-to-steel contact.

4. Spring diameters and hanger box lower hole size large enough to permit hanger rod to swing through a 30E arc before contacting the hole and short circuiting the spring.
5. Manufacturers:
 - a. M.I.I - Type 30
 - b. V.M.C.I. - Type SH30A
 - c. K.N.C - Type SH

2.04 ELASTOMER MOUNTINGS

- A. General: all elastomer isolators shall incorporate the following:
 1. Bolt holes for bolting to equipment base.
 2. Bottom steel plates for bolting to sub-base as required.
 3. Unit type design molded in black oil-resistant neoprene.
 4. All metal surfaces shall be neoprene covered.
 5. Neoprene to be compounded to meet the following:
 - a. Not greater than 50 durometers
 - b. Maximum tensile strength 2000 psi
 - c. Minimum elongation 300%
 - d. Maximum compression set at 25% of the original deflection.
- B. Type 'D' double deflection neoprene mount
 1. Rated deflection minimum 0.35 inches
 2. Manufacturers:
 - a. M.I.I - Type ND
 - b. V.M.C.I. - Type RHD
 - c. K.N.C - Type RH
- C. Type 'E' Double deflection elastomer hanger rod isolators incorporating the following:
 1. Molded unit type neoprene element
 2. Steel retainer box encasing neoprene mounting.
 3. Clearance between mounting hanger rod and steel retainer box.
 4. Manufacturers:
 - a. M.I.I - Type HD
 - b. V.M.C.I. - Type RHD
 - c. K.N.C - Type RH
- D. Type 'F' Pad type neoprene mountings
 1. 5/16 inch minimum thickness
 2. 50 psi maximum loading
 3. Ribbed or waffled design
 4. 1/16 inch deflection per pad thickness.
 5. 1/16 inch galvanized steel plate between multiple layers of pad thickness.
 6. Suitable bearing plate to distribute load.
 7. Manufacturers:

- a. M.I.I - Type W
- b. V.M.C.I. - Type Shearflex
- c. K.N.C - Type NP

2.05 COMBINATION SPRING AND ELASTOMER MOUNTINGS

- A. Type 'G' Combination spring/elastomer hanger rod isolators.
 - 1. Spring and neoprene isolator elements in a steel box retainer.
 - 2. Characteristics of spring and neoprene as described in Type 'C' and Type "E" isolators.
 - 3. Factory preloading to 75% of rated load (for pre-compressed springs).
 - 4. Manufacturers:
 - a. M.I.I. - Type 30N (PC30N for pre-compression)
 - b. V.M.C.I. - Type RSH-30A (RSHP-30A for pre-compression).
 - c. K.N.C. - Type SRH (SRPH for pre-compression)
- B. Type 'H' Thrust Restraints
 - 1. Use on all fan heads and axial or centrifugal fans where the air thrust exceeds 10% of the equipment weight.
 - 2. The thrust restraint consists of a TYPE 'G' isolator with the same deflection as specified in the schedule for the mountings or hangers.
 - 3. Spring element contained within a steel frame designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop.
 - 4. Assembly furnished with one rod and angle brackets for attachment to both equipment and ductwork or the equipment and the structure.
 - 5. Restraints attached at the centerline of thrust and symmetrically on either side of the unit.
 - 6. Manufacturers:
 - a. M.I.I - Type WB
 - b. K.N.C. - Type HSR
 - c. V.M.C.I. - Type HTR

2.06 ROOFTOP EQUIPMENT SPRING CURBS

- A. Type "RSC-1" curb mounted isolation base (low deflection).
 - 1. Integral spring and weather seal curb arrangement that fits under the equipment to be isolated and over the curb.
 - 2. Top and bottom members constructed of extruded aluminum and connected by a flexible, waterproof neoprene membrane. The aluminum members seal against the curb with continuous closed cell neoprene sponge.
 - 3. Cadmium plated springs with a 1" deflection and 50% additional travel to solid. Spring diameters no less than 0.8 of the sprig height at rated load.
 - 4. Wind resistance and seismic restraint shall be provided by resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds or seismic activity.

5. Manufacturers:
 - a. Type CMAB - M.I.I.
 - b. Type ASR - K.N.C.
 - c. Type AXR - V.M.C.I.
- B. Type 'RSC-2': Curb mounted isolation base (high deflection).
 1. Integral spring and weather seal curb arrangement that fits under the equipment to be isolated and directly on top of the manufacturer's roof curb.
 2. Bottom member constructed of rectangular, tubular structural steel. Top member, supporting the equipment, constructed of an inverted steel "U" channel with cross member bracing.
 3. Water-proofing by a flexible formed aluminum weather seal on all four sides of the base. Corner joints constructed of molded rubber.
 4. Springs cadmium plated with deflections as called out in the schedule and 50% additional travel to solid. Spring diameters of no less than 0.8 of the spring height at rated load.
 5. Wind resistance and seismic restraint shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds or seismic activity.
 6. Where called out in the drawings, the system should incorporate (for improved air-borne acoustical isolation), two layers of staggered joint 5/8" drywall directly attached to the top of the roof structure within the curb surrounding the ducts. All interfaces should be caulked. In addition, 4" thick, 1.5 pound density glass or mineral fiber shall cover the drywall surface under the unit and all sides of the plenum.
 7. Manufacturers:
 - a. M.I.I. - Type RSC
 - b. K.N.C. - Type SSR
 - c. V.M.C.I. - Type RIC.

2.07 EQUIPMENT BASES

- A. Type "B-1" Base
 1. Type B-1 base shall be a structural steel frame with clearance holes located to correspond to the mounting bolt holes of the equipment mounted on the base.
 2. Bases shall have built-in motor slide rails and shall be reinforced as necessary to withstand belt pull without drive misalignment or base distortion. The bases shall be constructed with deep angle steel sections with a minimum vertical angle leg of 4 inches (100mm) for motors of 7.5 hp (5.6 kW) or less, 5 inches (125mm) for motors between 7.5 hp (5.6 kW) and 20 hp (14.9 kW), and 6 inches (150mm) for motors over 20 hp (14.9 kW).
 3. Type 1 base shall be (subject to the requirements of this specification):
 - a. Type WFSLFSW Base (Mason)
 - b. Type SFB Base (Kinetics)

- c. Type WSB-HS Base (ABC)
- d. or as approved from VMC.

B. Type "B-2" Base

1. Type B-2 base shall consist of an integral rectangular structural steel form into which concrete is poured. Perimeter members shall be beams of depth equal to 10% of the longest span of the base, but not more than 12 inches (300mm) nor less than 6 inches (150mm) deep. Forms shall include motor slide base and all reinforcing steel. Where anchor bolt locations fall in concrete, the reinforcing steel shall include drilled members with sleeves welded below the steel to accept the anchor bolts. Height saving steel brackets shall be used in all mounting locations.
2. When the concrete base is "T" shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.
3. Thickness of concrete within inertia base shall be as follows:

<u>Motor Size</u>	<u>Minimum Thickness of Inertia Base</u>
5 to 20 Horsepower	6 inches
25 to 50 Horsepower	8 inches
60 to 100 Horsepower	10 inches
Greater than 100 Horsepower	12 inches

4. Type 2 base shall be (subject to the requirements of this specification):
 - a. Type KSLFSW Base (Mason)
 - b. Type CIB Base (Kinetics)
 - c. Type CPF Base (ABC)
 - d. Type MPF Base (VMC)

2.08 PNEUMATIC SPRING MOUNTINGS

- A. Welded, restrained, twin sphere air spring mounts.
- B. Air spring leveling valves.
- C. ¼" NPT air supply connections (80 psi)
- D. Neoprene cushioned down stop and restraining bolt bushing.
- E. Non-Skid neoprene friction pad base.
- F. Compressor and accessories for complete installation.
- G. Confirm load characteristics with equipment manufacturer for sizes.

H. Manufacturers:

1. Mason Industries SLR-MT-6
2. Leveling Valves Model LV-206
3. Air Compressor Model JG-2020

2.09 FLEXIBLE CONNECTORS

A. Type "FC-1" Flexible stainless-steel hose

1. Braided flexible stainless-steel hose.
2. 3/4" to 2-1/2" pipe sizes have carbon steel, threaded nipples, carbon steel grooved nipples or copper sweat ends appropriate to system piping.
3. 3" and above pipe sizes use Type "FC-2".
4. Rated minimum 315 psi at 70°F.
5. Length 12" or as noted differently on the drawings.
6. Manufacturers
 - a. Mason-Mercer GN, CPSB, CSAMN
 - b. VMCI
 - c. Keflex

B. Type "FC-2": Flanged flexible stainless-steel hose

1. Braided flexible stainless-steel hose.
2. Fixed carbon steel flanges.
3. Suitable for operating pressure of the system with 4:1 minimum safety factor.
4. Length as shown on manufacturer's certified drawings.
5. Manufacturers
 - a. Mason-Mercer - Type FFL
 - b. V.M.C.I.
 - c. Keflex

C. Type "FC-3": Flexible duct connections to fans

1. 30 ounce woven glass fiber coated with neoprene, sewn together at the edges and joints.
2. 6" long and held in place with 1" wide bands of 12 gauge galvanized steel bolted to duct and to outlets and inlets of the units and fans with 1/8" stove bolts, 5" o.c. Metal connections 3" wide on either side of the flexible material, as provided by the manufacturer, may also be used.
3. Manufacturers:
 - a. Ventglass, manufactured by Ventfabrics, Inc., Chicago, IL 312-775-4477
 - b. Insulflex, manufactured by DuroDyne, Farmingdale, NY 516-249-9000

D. Type "FC-4": Neoprene Connectors

1. Double sphere type – flanged 150 lb.

2. Pressure rating 245 psi at 190°F.
3. Multi-layered Kevlar tire cord fabric reinforcement with peroxide cured EPDM cover, liner and fabric frictioning.
4. Molded-in reinforcing ring between spheres.
5. Baked enamel, ductile iron floating flanges.
6. Manufacturers: Mason Industries Safeflex SFDCR

2.10 ACOUSTICAL FLOOR, CEILING AND WALL SEAL

A. Type M

1. Description: Where piping passes through equipment room walls, floors or ceilings, provide a split seal consisting of two bolted pipe halves with 3/4" or thicker neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240°F, 10# density fiberglass may be used in lieu of the sponge.
2. Manufacturers: Mason Industries Model No. SWS; or approved equal

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine all work prepared by the appropriate trades to receive work of this section and report problems or defects affecting installation to the General Contractor/Construction Manager for correction.
- B. Inspect all components of the Work to ensure no damage has occurred during shipment or storage.

3.02 INSTALLATION

- A. Install vibration isolation devices and systems in accordance with the manufacturer's instructions.
- B. Floor Mounted Equipment:
 1. Nominal 4-inch-thick concrete housekeeping pads:
 - a. Over entire floor area of supported equipment
 - b. Supporting all vibration isolation devices and bases.
 - c. Keyed with pins as required to be integral with the structural slab.
 2. Concrete pad specification describing requirements.
- C. General Isolation Requirements

1. Provide 2-inch operating clearance between concrete inertia bases and housekeeping pad.
2. Provide 1-inch operating clearance between equipment or structural bases and housekeeping pad.
3. Isolation mounting deflection (minimum) as specified or scheduled on manufacturer's certified drawings.
4. Position equipment, structural bases and concrete bases on blocks or wedges at proper operating height.
5. Provide operating load conditions prior to transferring base isolator loads to springs and removing wedges.
6. Temperature control and electrical conduit connections to isolated equipment shall be looped or installed with flexible conduit to allow free motion of isolated equipment.
7. Install equipment directly on isolation system. Support rails between the equipment and isolators should not be used.
8. Verify all installed isolators and mounting systems permit equipment motion in all directions.
9. Adjust or provide additional resilient restraints to limit startup equipment lateral motion to 1/4 inch.
10. Prior to startup, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.
11. No rigid connections between rotating or vibrating equipment and building structure shall be made that degrades the vibration isolation system herein specified.
12. Coordinate work with other trades to avoid rigid contact with the "building". Inform other trades following, such as plastering, drywall, electrical or sheet metal, to avoid any contact which would reduce the vibration isolation.
13. Bring to the Engineer's attention immediately, prior to installation, any conflicts with other trades which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the contractor's expenses.
14. Correct, at no additional costs, all installations which are deemed defective in workmanship or material as a result of project completion inspection or subsequent inspections due to Owner complaints within a period of one year following the project completion date.

D. Piping

1. Use factory preloading for the first three hangers from both rotating equipment and for all piping greater than 6 inches in diameter. The first three isolators from the equipment shall have the same static deflection of the isolator used for the equipment itself. Subsequent isolators shall have a static deflection of 1/2 that of connected equipment with a minimum of 1".
2. Isolate all refrigerant piping within 50 feet of the vibrating mechanical equipment, with Type 'G' hanger rod isolators with a minimum static deflection of 1 inch.
3. Isolate piping where exposed to the exterior of the building and supported by the roof with Type 'B' isolators with 1-inch minimum static deflection.

4. Support piping in shafts and at floor supports entering the shaft, with Type "F" isolators (2 layers).
5. Provide flexible connections at all connections of pipe to rotating equipment.
6. Suspend isolators from rigid and massive support points.
7. Adjust as required all isolators to eliminate all contact of the isolated rod with the hanger rod box retainer or short circuiting of the spring.
8. Supplementary steel to be sized for a maximum deflection of 0.08 inches at the center span.

E. Ductwork

1. Use factory preloading for the first three hangers from rotating equipment. The first three isolators from the equipment shall have the same static deflection of the isolator used for the equipment itself. Subsequent isolators shall have a static deflection of $\frac{1}{2}$ that of connected equipment with a minimum of 1".
2. Isolate all ductwork in mechanical rooms and outside of equipment room that which is within 50 feet of the fan equipment, with Type 'C' hanger rod isolators with 1-inch static deflection.

- F. Kitchen exhaust ducts shall be supported on Type 'G' mounts or hangers within 10 feet of the exhaust fan and Type 'C' mounts or hangers for the remainder of the duct run. The first isolator both upstream and downstream of the fan on springs shall have a static deflection equal to 1.5 times that of the equipment mounts or hangers, up to a maximum of 2 inches (50mm). Neoprene riser guides shall be used if lateral restraint is required in shafts.

3.03 ADJUST AND CLEAN

- A. Check and adjust all isolators to ensure there is not short circuiting such as:
1. Hanger rods touching boxes
 2. Hold-down bolts not released
 3. Bolts touching springs
 4. Springs and/or neoprene overloaded.
 5. Bottom neoprene pads short circuited by welding bottom plate to structure.
 6. Isolation device touching adjacent structures.

3.04 FINAL INSPECTION

- A. On completion of installation of all vibration isolation herein specified, the local representative of the isolation materials manufacturer shall inspect the completed systems and report, in writing, any installation error, improperly selected isolation devices or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Engineer, including the manufacturers representative's final report, indicating all isolation reported as properly installed or requiring correction and include a report by the Contractor on steps taken to properly complete the isolation work.

- B. The Engineer will subsequently inspect the systems for conformance to specifications and for proper installation methods. The contractor shall replace or repair, at his expense, any isolation devices that deviate from the specifications, approved shop drawings, and manufacturer's recommendations as a result of this inspection.

END OF SECTION

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SECTION 23 05 53 - IDENTIFICATION OF PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Label all mechanical equipment furnished and/or installed in this project.
- B. Label all electrical equipment furnished by the Mechanical Contractor.
- C. Label all control panels and space thermostats, humidistats and CO₂ sensors and other sensors furnished under this project (Temperature Control Contractor).
- D. Label all piping systems installed in this project.
- E. Provide valve tags and chart.

1.02 RELATED WORK

- A. General Provisions: Section 23 05 01
- B. Basic Piping Requirements: Section 23 05 29
- C. Painting: Section 23 05 64
- D. HVAC Pipe and Equipment Insulation: Section 23 07 19
- E. Instrumentation and Control Devices: Section 23 09 13

1.03 SUBMITTALS

- A. In accordance with Specifications Section 23 05 01, General Provisions, submit manufacturer's data on labels. Include a listing of labels ordered with the name of equipment or control device.
- B. Submit manufacturer's data on valve tags including a list of all valves to be tagged on the project.

PART 2 - PRODUCTS

2.01 MECHANICAL EQUIPMENT LABELS

- A. Labels shall be engraved, laminated plastic plates. The height of letters shall be as scheduled herein.
- B. Letters shall be black; plates shall be white.
- C. Manufacturers
 - 1. Brady
 - 2. Seton Nameplate Corporation
 - 3. Or approved equal.

2.02 ELECTRICAL AND CONTROL EQUIPMENT LABELS

- A. Labels shall be engraved, laminated plastic plates. The height of letters shall be as scheduled herein.
- B. Letters shall be black; plates shall be white.
- C. Manufacturers
 - 1. Brady
 - 2. Seton Nameplate Corporation
 - 3. Or approved equal.

2.03 VALVE TAGS

- A. Valve tags shall be consecutively numbered, brass tags (1-1/2" round).
- B. Where valves are located above ceilings, provide a location marker on the ceiling grid, as specified under 2.05, of same general description as brass tags.
- C. All main valves shall include text on the tag to read "Main Shutoff Valve". Tag size shall be increased to include text and valve number.
- D. Manufacturers
 - 1. Brady
 - 2. Seton Nameplate Corporation
 - 3. Or approved equal. System shall meet ANSI A13.1-1975 specification.

2.04 VALVE TAG CHART

- A. Prepare a computer-generated chart listing all valves tagged on this project. List the valve number, service, and normal position (closed or open). Submit file disk of chart to Owner at project completion.
- B. The chart shall be mounted in a suitably sized frame with shatterproof glass front and installed on the wall of the main mechanical room.

2.05 CONCEALED EQUIPMENT AND VALVE LOCATION MARKERS

- A. Furnish white plastic marker with engraved black numbers and letters, 1/4" high to attach to ceiling grids. Confirm width of ceiling grids with ceiling contractor and match the size. Numbers and letters shall match the equipment label wording as scheduled. Marker width shall match ceiling grid width.
- B. Manufacturers
 - 1. Brady
 - 2. Seton Nameplate Corporation - Style No. M5300
 - 3. Or approved equal.

2.06 PIPE LABELS

- A. Furnish snap-around type markers through 5" pipe sizes. Furnish strap-around type markers with nylon ties for 6" pipe sizes and larger.
- B. Letter height shall vary with pipe size as follows:
- | | | |
|----|-----------------------------|--------|
| 1. | Thru 1-1/4" insulated pipe: | 1/2" |
| 2. | Thru 2" insulated pipe: | 3/4" |
| 3. | Thru 6" insulated pipe: | 1-1/4" |
| 4. | 8" and above: | 2-1/2" |
- C. Use ANSI/OSHA designated colors.
- D. Include directional flow arrows.
- E. Manufacturers
- | | |
|----|--|
| 1. | Brady
Seton Nameplate Corporation - "Setmark" system |
| 2. | Or approved equal. Equal brands must meet ANSI specifications. |

PART 3 - EXECUTION

3.01 MECHANICAL EQUIPMENT LABEL INSTALLATION

- A. Schedule of Mechanical Equipment Labels (List is not necessarily inclusive of all equipment on this project to be labeled).

<u>Equipment</u>	<u>Example Wording</u>	<u>Letter Height</u>
Fans	EF-1, SR-1, SP-1	1/2"
Furnaces	FURN-1	1/2"
Make-up Air Units	MUA Unit -1	1"
Kitchen Exhaust Hoods	HOOD-1	1/2"
Fire dampers (on access door)	FIRE DAMPER	1/2"
Cabinet unit heaters (exposed)	CUH-1	1/4"
Propeller Unit heaters	PUH-1	1/2"

- B. Labels shall be secured to the equipment in a readily apparent location with a minimum of four (4) screws for 1" size labels and two (2) screws for 1/2" and smaller. (Glue shall not be used.) Drill holes for screw openings. Cracked labels shall be replaced.

- C. Equipment which is not suitable to receive the above fastening method shall be labeled on an adjacent wall, chain hung from the ceiling, or on a readily sighted disconnect switch, at the direction of the Designer.

3.02 ELECTRICAL AND CONTROL EQUIPMENT LABEL INSTALLATION

- A. Items to be labeled include:
 - 1. Temperature control panels
 - a. Letters to be 1" high.
 - b. Panels shall be labeled to represent equipment controlled.
 - 2. Motor starters: ½" high
 - 3. Remote pushbutton stations: 1/8" high
 - 4. Motors which cannot be readily identified by their starter label when observer is standing by the motor: ½" high.
 - 5. Room sensors, thermostats, and humidistats
 - a. Letters shall be 1/8" high. Plate shall be attached to cover as directed by Engineer.
 - b. Terminal unit designations shall match the equipment label wording as scheduled.
 - 6. Temperature Control Conduits and Junction Boxes:
 - a. Labeling consistent with electrical conduit.
 - b. Reference applicable Division 26 Sections.
- B. 1" and ½" letter size labels shall be secured to the devices with appropriately sized screws or rivets. (Glue shall not be used.) Screw holes shall be drilled. Cracked labels shall be replaced.
- C. ¼" and 1/8" letter size labels shall be glued to the device.

3.03 VALVE TAG INSTALLATION

- A. Install tags on each operating valve installed in this contract, i.e., main or branch line shutoff valves, manual and automatic flow control valves, temperature control valves, etc.
- B. Valves at the equipment whose function is obvious (i.e., shutoff valves located inside the cabinet of equipment, etc.) need not be tagged.
- C. Use scheduled abbreviations for service indication.
- D. Attach tags with nickel plated brass bead chain.

3.04 PIPE LABEL INSTALLATION

- A. Install pipe identification labels on each piping system where required to provide easy identification of the system and flow.
- B. Minimum requirements include the following:

1. At both sides of all wall penetrations, concealed and exposed, throughout the building.
 2. At an accessible location for every exposed 25 lineal feet of piping.
 3. At each piece of equipment.
- C. Do not install labels until the pipe has been insulated and painted.

3.05 CONCEALED EQUIPMENT AND VALVE LOCATION MARKER INSTALLATION

- A. Install plates directly on to exposed bottom of ceiling T-bar, with glue. Confirm size of grid.
- B. Locate plate adjacent to ceiling tile which accesses the equipment or valve above.
- C. Install plates directly on to access panels in drywall ceilings.

END OF SECTION

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SECTION 23 05 64 - PAINTING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials and equipment necessary for painting of mechanical piping systems, equipment supports and of other surfaces as specified herein. All painting shall be performed by a trade responsible for this type of work.
- B. The following surfaces shall be painted:
1. All interior and exterior exposed, non-galvanized, metal hangers, platforms, supports and miscellaneous steel for piping and equipment
 - a. Equipment Stands and Bases: Color shall be PPG Light Grey.
 2. The following surfaces shall be painted (within mechanical equipment and fan rooms only):
 - a. All exposed insulated covering on pipes (color coded)
 - b. All exposed galvanized ventilation equipment
 - c. All exposed ductwork.
 - d. All exposed bare pipe (color coded)
- C. Piping systems, as specified in 1.01, shall be color coded, as follows:
- | | <u>COLOR</u> | <u>PPG COLOR
NUMBER (USE FOR
COLOR MATCH)</u> |
|--------------------------------|--------------|---|
| 1. Insulated Generator Exhaust | Orange Juice | D-6149-5 |

1.02 RELATED WORK

- A. General Provisions: Section 23 05 01
- B. Assignments of Miscellaneous Work: Section 23 05 02
- C. Completion and Startup: Section 23 05 03
- D. Identification for Piping and Equipment: Section 23 05 53

1.03 CERTIFICATE

- A. Submit to Engineer, prior to any approvals of start of any work, a schedule of the exact materials proposed for each application on all surfaces.

1.04 GENERAL REQUIREMENTS

- A. All surfaces to be painted shall be clean and dry.

- B. Do not paint valve surfaces which are non-ferrous metals such as brass or bronze and those items which have a factory finish.

1.05 SUBMITTALS

- A. Samples: Furnish three (3) samples of each type of finish and color to Engineer for approval.
- B. Furnish three (3) samples of each type of finish and color to Engineer for approval.

1.06 DELIVERY

- A. All paint shall be delivered to the site in manufacturer's sealed containers. Each container shall be labeled with the manufacturer's labels and shall give manufacturer's name, type of paint, color of paint and instructions for reducing. Thinning shall be done only in accordance with directions of manufacturer.

PART 2 - PRODUCTS

2.01 ACCEPTABLE PAINT MANUFACTURERS

- A. PPG Paints
- B. Sherwin Williams
- C. Glidden Coatings and resins, Division of ICI Corporation
- D. Benjamin Moore and Co.
- E. M.A. Bruder Co. (MAB)
- F. Dampney (High Temperature Paint)

2.02 QUALITY ASSURANCE

- A. Materials of all kinds shall be first line products and of the best quality and of brands approved by the Engineer. All paint shall be delivered in original containers with unbroken seals, plainly marked with manufacturer's name and the trade name or brand, to be opened and used only after approval and applied strictly in accordance with the manufacturer's recommendations with no substitutions.

2.03 SCHEDULE OF PAINTING AND FINISHING

- A. Interior and exterior bare ferrous metal
 - 1. First Coat: Porter No. 6-208/6-212 oxide red or white
 - 2. Second Coat: Porter No. 2909 acrylic gloss enamel
 - 3. Third Coat: Porter No. 2909 acrylic gloss enamel

- B. Interior non-ferrous metal
 - 1. First Coat: Porter No.6-208/6-212 oxide red or white
 - 2. MAB 073-1891 primer
 - 3. Second Coat: Porter No. 439 Glyptex eggshell interior alkyd enamel
 - 4. Third Coat: Porter No. 439 Glyptex eggshell interior alkyd enamel
- C. Exterior non-ferrous metal
 - 1. First Coat: Porter No.6-208/6-212 oxide red or white
 - 2. MAB 073-1891 primer
 - 3. Second Coat: Porter No. 619 exterior acrylic gloss
 - 4. Third Coat: Porter No. 619 exterior acrylic gloss
- D. Interior galvanized metal
 - 1. First Coat: Porter No. 215 acrylic rust inhibitive primer (white)
 - 2. Second Coat: Porter No. 439 Glyptex eggshell interior alkyd enamel
 - 3. Third Coat: Porter No. 439 Glyptex eggshell interior alkyd enamel
- E. Exterior galvanized metal
 - 1. First Coat: Porter No. 290 galvanized metal primer
 - 2. Second Coat: Porter No. 619 exterior acrylic gloss
 - 3. Third Coat: Porter No. 619 exterior acrylic gloss
- F. Pipe and duct insulation
 - 1. First Coat: Porter No. 426 vinyl sealer
 - 2. Second Coat: Porter No. 1119 silken touch velvet
 - 3. Third Coat: Porter No. 1119 silken touch velvet
 - 4. For Armaflex Insulation: MAB 036-1581 primer
- G. Interior PVC pipe
 - 1. First Coat: Porter No. 1129 acrylic primer
 - 2. Second Coat: Porter 1119 silken touch velvet
 - 3. Third Coat: Porter 1119 silken touch velvet
- H. Exterior PVC pipe
 - 1. First Coat: Porter No. 515 bonding primer
 - 2. Second Coat: Porter No. 1119 silken touch velvet
 - 3. Third Coat: Porter No. 1119 silken touch velvet
- I. Drywall
 - 1. First Coat: Porter 109 latex semi-gloss
 - 2. Second Coat: Porter #109 latex semi-gloss
- J. Exterior steam relief discharge piping (to 350°F)

1. First Coat: Porterguard Silicone Alkyd Enamel, 2200 Series
 2. Second Coat: Porterguard Silicone Alkyd Enamel, 2200 Series
 3. Third Coat: Porterguard Silicone Alkyd Enamel, 2200 Series
- K. Exterior emergency generator exhaust piping (to 1000°F)
1. Preparation: blast clean to SP10 profile depth.
 2. First Coat: Dampney Thermalox Series 245
 3. Second Coat: Dampney Thermalox Series 230, 1.5 to 2 mils.
 4. Third Coat: Dampney Thermalox Series 230, 1.5 to 2 mils

PART 3 - EXECUTION

3.01 PREPARATION

- A. Steel and Iron: Remove grease, rust, scale and dust by wire brushing and washing and touch up any chipped or abraded places on items that have been shop coated. Where steel and iron have a heavy coating of scale, it shall be removed by a wire brushing or as necessary to produce a satisfactory surface for painting.
- B. Before painting, remove and protect hardware, accessories, plates, lighting fixtures and similar items and replace same upon completion of area. Protect adjacent surfaces during work. Damage to or spillage upon adjacent work shall be repaired and/or cleaned and returned to a finished area.
- C. Apply paint to clean, dry and smooth surfaces only. Apply paint smoothly, worked out evenly and allow to dry a minimum of 48 hours before subsequent coats are applied. Protect from dampness. Do not apply exterior paint in damp, rainy weather or until surface has dried thoroughly. Do not apply any paint when temperature is below 50°F. Avoid painting surfaces while surfaces are exposed to hot sun.
- D. Finished work shall be completely covered, be uniform, smooth and free of runs, sags, clogging or excessive flooding. Make edges of paint adjoining other materials or colors sharp and clean with no overlaps. Use masking where required.
- E. At completion, touch up and restore finish where damaged and leave in new condition.
- F. Concrete and Masonry
1. Fill cracks and irregularities with portland cement grout to provide uniform surface texture.
 2. Etch cement and poured concrete surfaces with 5% solution (by weight) of muriatic acid.
 3. Fill concrete masonry unit surfaces with block filler.

3.02 STORAGE

- A. A lockable area will be assigned for storing and mixing paints. The floor of this place shall be covered with an approved, reinforced, kraft building paper and then with tarpaulins. No mixing shall be done in rooms or spaces other than those assigned for such purpose.
- B. Take all necessary precautions to prevent fire, explosions and other damage. All rags and paint or solvent must be stored in closed metal containers at all times.

3.03 CLEANING AND PROTECTION

- A. Any materials of other trades damaged to such extent that they cannot be restored to their original condition shall be replaced by this Contractor at his own expense.
- B. Protect adjacent work and materials by suitable coverings during progress of work. Remove all splattering from floors and other surfaces. Leave work in a clean, orderly, acceptable condition.

END OF SECTION

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SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Test and Balance Contractor to monitor the job progress to schedule his work in conjunction and cooperation with other trades involved and comply with the project completion date.
- B. Test and Balance Contractor shall prepare and submit pencil copies of reports to the Engineer as the work progresses and completes.
- C. Provide assistance and cooperation to Engineer as Performance Verification or progresses. Provide labor to assist in troubleshooting and fine tuning of the HVAC systems to suit the final building conditions.
- D. Provide assistance and cooperation to successfully test and demonstrate all life safety systems (stair pressurization, smoke removal, etc.) This will require multiple demonstrations to satisfy compliance with local inspectors, fire departments, and Owner representatives.
- E. Prepare and submit the final report as defined herein.

1.02 WORK INCLUDED

- A. General
 - 1. Provide equipment, materials, labor, and services necessary for complete testing, balancing and performance verification of all systems in the project, and as specified herein.
 - 2. ***Operational Testing, Performance Verification, and Capacity Verification are included in the project scope, in addition to traditional test and balance procedures.***
- B. Test, balance and adjust every system and piece of equipment installed and/or modified on this project. They shall include:
 - 1. Air handling units (including DOAS)
 - 2. Furnaces
 - 3. Supply, return and outside air distribution systems.
 - 4. Exhaust air systems
 - 5. Kitchen hood exhaust systems
 - 6. Domestic hot water return systems

- C. The Mechanical and/or Sheet Metal Contractor shall furnish to the Test and Balance Contractor a fan curve for each fan serving systems of 2000 cfm or greater and a pump curve for each circulating pump of 50 gpm or greater. A copy of the curves shall be included in the final balance report.
- D. Record all test readings on a standard test outlet form which includes room name or number, terminal device designation, manufacturer, model number, size and Ak factor. Include the design conditions, the initial and each follow-up test readings and the final test results.

1.03 WORK INCLUDED BUT SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Completion and Startup: Section 23 05 03
- C. HVAC Fans: Section 23 34 00
- D. HVAC Ducts and Casings: Section 23 31 00
- E. Dedicated Outdoor Air Handling Units: Section 23 74 13

1.04 RELATED WORK

- A. Sequence of Operation for HVAC Controls: Section 23 09 93

1.05 QUALITY ASSURANCE

- A. Balancing of the Heating and Air Conditioning Systems: Contractor shall be either.
 - 1. Registered in Indiana a current member of TABB, NEBB or AABC with 5 years experience, or
 - 2. A registered professional engineer licensed in Indiana that specializes in the adjusting and balancing of systems specified with a minimum of 10 years documented experience.
 - 3. TABIC Certified Contractor
- B. Testing, adjusting and balancing shall be performed, in the field, under direct field supervision of a Certified TABB, NEBB Supervisor, a Certified AABC Supervisor. Mechanical Engineer, or TABIC Certified Contractor.
- C. Work shall be performed only by a Contractor which employs certified testing and balancing Technicians. If Contractor cannot meet this criterion, then the following information shall be provided for each technician during the bid period. Approval will be by Addenda.
 - 1. Identify each Technician by name.
 - 2. The Technicians shall have successfully completed testing, adjusting and

- balancing classes and shall present for review their certification of training.
 - 3. The Technician's previous work experience shall not be less than five years.
 - 4. Technician's references (including contact names and phone numbers) from all jobs during the past 12 months shall be presented.
 - 5. No Technician substitutions will be made without prior approval from the Owner.
- D. Instruments shall be in first class state of repair and have been calibrated within a period of six months prior to starting the job.
- E. Provide all software and hardware required to interface with the Buildings' DDC temperature control system.
- F. Test and Balance Contractor shall not be owned by any of the Contractors on this project which includes the General, Mechanical and Electrical Contractors.
- G. Approved Test and Balance Contractors: (Indiana)
- 1. Fluid Dynamics
 - 2. Fulton Air Balance
 - 3. Gibson
 - 4. Reliance (formerly Midwest Associates)
 - 5. National Test and Balance
 - 6. Thermal Balance, Inc.
 - 7. Total Balance

1.06 SUBMITTALS: BALANCING REPORT

- A. Each distribution system shall be schematically drawn (single line diagram) on 8-1/2"x11" sheets of paper. Larger systems may require several sheets. All components and terminal devices shall be shown and labeled. Room names or numbers shall be included.
- B. Record operating data for each piece of equipment on 8-1/2"x11" report form. Data shall include pressures, temperatures, amperages, rpm, etc. as outlined below under Part 2 (2.02) and Part 3.
- C. Submit report to Contractor of conditions experienced with any piece of equipment or device which did not perform satisfactorily, or which required special settings. Include in the report any proposed corrections. Copy the Engineer on all correspondence.
- D. All final reports shall be signed and sealed by the certified Test and Balance Engineer.
- E. Data Sheets
- 1. Submit 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.

F. Final Report

1. Upon completion, all information shall be neatly printed, and two (2) copies submitted to the Engineer through the Mechanical Contractor with accompanying schematic diagrams of systems tested.
2. All test reports shall be assembled, numbered, indexed, and submitted with project name and Balancing Contractor's name permanently printed thereon.

1.07 BALANCING REQUIREMENT: AIR SYSTEMS

- A. The requirement of the air system balance is to direct the specified air quantities as shown on the plans to each of the rooms and zones detailed on the plans. The supply system must be set to provide proper quantities and the return system must be adjusted proportionately for an overall balance of supply air, return air and outside air. A balance of $\pm 5\%$ of total design volume shall be the requirement in the overall system balance. But beyond this requirement is providing a comfortable, controlled environment of temperature, humidity, noise, ventilation, and air motion.
- B. Should noise problems develop when obtaining design air flow, the Test and Balance Contractor shall aid the Engineer in determining the cause and assist in determining the solution. If in the opinion of the Test and Balance Contractor, noise occurs due to poor field duct arrangements, the Test and Balance Contractor shall also report suggested solutions to the Engineer and Sheet Metal Contractor.

1.08 COORDINATION WITH CONTRACTORS

- A. The Test and Balance Contractor shall review the fabrication drawings to verify and coordinate the location of all necessary dampers, access doors and duct arrangements to assure a proper air balance can be obtained.
- B. The Test and Balance Contractor shall review the sheet metal fabrication shop drawings and affix his review stamp before drawings are submitted for final approval to the Engineer.
- C. The Test and Balance Contractor shall review and coordinate with the Mechanical Contractor the location of all necessary balancing valves and piping arrangements at flow control devices to assure a proper hydronic balance can be achieved.

- D. System Operation: Heating, ventilating, air conditioning equipment including filters, shall be completely installed, duct systems tested and passed for leakage, ceilings installed and in continuous operation as required to accomplish the adjusting and balance work specified. Test and Balance Contractor shall submit "Check List" with copy to Engineer, to the Mechanical and/or Sheet Metal Contractors which, when completed, and returned, will assure the systems are ready to be balanced.
- E. The Test and Balance Contractor shall visit the job site when each systems' installation are near complete, but prior to the installation of ceilings, to familiarize himself with the installation and to determine any potential problems in achieving a balanced system. This visit shall be scheduled by the Test and Balance Contractor and performed with the Mechanical Contractor. Submit report of each trip to Engineer.
- F. The Test and Balance Contractor shall review all duct pressure test reports and comment on the results and methods.
- G. The Test and Balance Contractor shall visit the job site when each hydronic loop is near complete, but prior to the installation of ceilings, to familiarize himself with the installation and to determine any potential problems in achieving a balanced system. This visit shall be scheduled by the Test and Balance Contractor and performed with the Mechanical Contractor. Submit report of each trip to Engineer.
- H. Readjustments
 - 1. Should corrective measures caused by faulty installation require retesting, adjusting, and balancing, such work shall be at no additional expense to the Owner.
 - 2. Corrective measures, other than the above, shall be made only as directed by the Engineer.

1.09 SYSTEM STARTUP AND INITIAL DUCT TESTING

- A. The Test and Balance Contractor shall attend scheduled pre-startup meetings.
- B. The Test and Balance Contractor shall participate in the startup of each system on the project.
- C. After successful startup of each air distribution system, perform an initial total air distribution test to determine the system duct leakage. The project requirement is a maximum allowable leakage of 5% total cfm. Should leakage exceed this amount, stop work on that system and notify the Engineer and the contractor. Reference Section HVAC Ducts and Casings, Section 23 31 00.

1.10 RE-INSPECTIONS

- A. Make four (4) return re-inspections and testing during a one (1) year warranty period. Each re-inspection shall include a check test of all critical balance conditions including correction or adjustment as required on each system. Coordinate these re-inspections with Owner. Two (2) of these shall be during weather extremes. Send written reports to the Owner and Engineer.

PART 2 - PRODUCTS

2.01 INSTRUMENTS

- A. Quality
 - 1. The minimum instrumentation for testing, adjusting and balancing shall be the "TABB", "AABC and/or NEBB Approved Minimum Field Instrumentation".
 - 2. Instruments used for testing and balancing must have been calibrated within a period of six (6) months and checked for accuracy prior to start of work.
 - 3. Instruments must be maintained and carried in such a manner to protect them from excessive vibration and moisture conditions.
- B. Approval: All products and instrumentation used shall be subject to approval of the Engineer.

2.02 EQUIPMENT DATA CARDS

- A. Record operating (typed) data for each piece of equipment on a card, laminated in plastic and attached to the equipment. Operating data should include all final appropriate data such as pressures, temperatures, amperages, revolutions per minute, which are significant to the normal operating points of the equipment.
- B. Cards shall be minimum 8-1/2 x 11 and shall include Balancing Contractor's name, address, phone number and date of test.

PART 3 - EXECUTION

3.01 GENERAL PROCEDURES

- A. Balance and adjust the systems to obtain the flow quantities shown on the drawings.
- B. Maintain coordination and communication with the Engineer, Owner, Suppliers and Contractors.
- C. Schedule work so that it may be done while the Contractors are on the job site.

- D. If a piece of equipment is not operating in a satisfactory manner, proactively assist the installing contractor in repairing or adjusting. After corrections have been made, proceed with balancing.
- E. Submit reports to the Engineer if a system or piece of equipment cannot be adjusted to operate satisfactorily.

3.02 BALANCING PROCEDURE: CONSTANT AIR VOLUME AIR HANDLING UNITS AND AIR DISTRIBUTION

- A. Check air handling unit supply fan:
 - 1. Check motor electric current and voltage supply and rated running amperage.
 - 2. Check initial fan and motor speed.
 - 3. Determine available adjustment tolerance.
- B. Drill probe holes for static pressure readings, duct velocity readings and temperature readings.
- C. Proceed through the entire duct system, opening all dampers to full open position. If dampers are missing, notify the Sheet Metal Contractor to add the dampers.
- D. Set the outside air and return air dampers to their normal positions (minimum outside air).
- E. Perform main system traverse to determine total air flow. Record initial readings including fan rpm, cfm, total static pressure, and motor amperage.
- F. Adjust fan to obtain specified total air flow (allow for maximum 5% total system duct leakage), using the adjustable pitched sheaves furnished with the unit.
- G. Determine which air handling units have variable pitch sheaves. After final balance has been achieved, and approved by the Engineer, size the final "fixed" sheaves. Obtain the final fixed sheave from the unit manufacturer and install.
- H. Upon obtaining specified air flow, proceed with balancing the air distribution System.
 - 1. Traverse all main zone ducts.
 - 2. Set all terminals at design air flow.
 - 3. Perform as many total system readings until a balance is obtained. Record all readings.
- I. Recheck main system traverse to verify total air flow. If the distribution system balance is inadequate, determine probable cause:

1. Check duct system for connection integrity and leakage. Notify Sheet Metal Contractor of deficiencies for correction.
 2. If tolerance in the fan is not available, size a new drive and coordinate the installation of new sheaves and belts with the installing contractor.
- J. Balance the outside air, return air and relief air dampers to the specified minimum outside air quantity. Verify proper indexing and modulation from control signal. Set and record minimum and maximum positions of dampers.
- K. Record the final operating conditions of the air handling unit including:
1. Fan rpm and cfm
 2. Motor run amperes and voltage
 3. Fan inlet and discharge static pressure.
 4. Cooling coil air pressure drop.
 5. Heating coil air pressure drop.
 6. Filter pressure drop.

3.03 BALANCING PROCEDURE: EXHAUST SYSTEMS

- A. Check exhaust fan:
1. Check motor electric current supply and rated running amperage and voltage.
 2. Check initial fan and motor speed.
 3. Determine available adjustment tolerance.
- B. Drill probe holes for static pressure duct velocity readings.
- C. Proceed through the entire duct system, opening all dampers to full open position. If dampers are missing, notify the Sheet Metal Contractor to add the dampers.
- D. Perform main system traverse to determine total air flow. Record initial readings including fan rpm, cfm, total static pressure and motor amperage and voltage.
- E. Adjust belt drive fans to obtain specified total air flow (allow for maximum 5% total system duct leakage). If adjustment in the fan is not available, size a new drive and coordinate the installation of sheaves and belts with the installing contractor.
- F. Upon obtaining specified air flow, proceed with balancing the distribution system.
1. Set all terminal devices at design air flow.
 2. Perform as many total system readings until a balance is obtained. Record all readings.
- G. Recheck main system traverse to verify total air flow.

- H. If the distribution system balance is inadequate, determine probable cause. Check duct system for connection integrity and leakage. Notify Sheet Metal Contractor of deficiencies for correction.
- I. Record the final operating conditions of the exhaust fan including:
 - 1. Fan rpm and cfm
 - 2. Motor run amperes
 - 3. Fan inlet and discharge (if applicable) static pressure

3.04 BALANCING PROCEDURE: FURNACES AND AIR DISTRIBUTION

- A. Drill probe holes for static pressure readings, duct velocity readings and temperature readings.
- B. Check unit fan: Check motor electric current and voltage supply and rated running amperage.
- C. Proceed through duct system, opening all dampers to full open position. If dampers are missing, notify the Sheet Metal Contractor to add the dampers.
- D. Where applicable, set the outside air dampers to their normal positions (minimum outside air).
- E. Record initial readings including fan rpm, cfm, total static pressure and motor amperage.
- F. Adjust fan speed to obtain specified total air flow (allow for maximum 5% leakage).
- G. Upon obtaining specified air flow, proceed with balancing the air distribution System.
 - 1. Set all terminals at design air flow.
 - 2. Perform as many total system readings until a balance is obtained. Record all readings.
- H. Recheck fan to verify total air flow. If the distribution system balance is inadequate, determine probable cause. Check duct system for connection integrity and leakage. Notify Sheet Metal Contractor of deficiencies for correction.
- I. Balance the outside air dampers to the specified outside air quantity. Verify proper indexing from control signal. Set and record minimum and maximum positions of dampers.
- J. Record the final operating conditions of the furnaces including:
 - 1. Fan cfm
 - 2. Motor run amperes and voltage
 - 3. Fan inlet and discharge static pressure.

4. Cooling coil entering and leaving air temperatures (DB & WB) in full cooling cycle (at specified outside air).
5. Entering and leaving air temperatures (DB & WB) in full heating cycle (at specified outside air)

3.05 DOMESTIC HOT WATER RETURN BALANCING PROCEDURE

- A. Verify that the contractor has:
 1. Installed all balancing stations.
 2. Opened all shut-off valves and balance valves to full open position.
- B. Test and record flow through each balancing station. See floor plans for flow requirements at each system.
- C. Domestic Hot Water Circulating Pumps
 1. Check pump rotation.
 2. Check and record water temperature leaving the pump.
 3. Check and record water temperatures before and after the thermostatic mixing valve.
 4. List all pump nameplate data.

3.06 TESTING OF CONTROLS

- A. Test each thermostat through the cooling range for proper operation. Set the thermostat at 78°F when complete.
- B. Test each zone's thermostat through the heating range for proper operation. Set the thermostat at 72°F when complete.
- C. Test each heating zone fan powered/VAV terminal unit individually upon completion of balance of the system for cooling. Set each heating fan to deliver design CFM.
- D. Test each zone humidistat through its control range for proper operation. Set the humidistat at 60% when complete.

3.07 TESTING OF DAMPERS

- A. In cooperation with the Temperature Control Contractor's representative, provide setting and adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. The Balance Contractor shall check all controls for proper calibrations and list all controls requiring adjustment by the Temperature Control Contractor.

3.08 OWNER'S INSTRUCTION

- A. Balancing Contractor shall arrange with the Commissioning Engineer, a time for the instruction to the Owner as to the unique balanced conditions of the project.

3.09 GENERAL COMPLETION REQUIREMENTS

- A. Reinstall belt guards on fan equipment.
- B. Install plugs in all holes drilled for traverse readings and static pressure readings.
- C. Repair insulation torn or removed as a result of obtaining readings.
- D. Upon completion of all water flow readings and adjustments at coils, tag and mark all settings and record data.

3.10 OPERATING TESTS

- A. Perform operating tests on all equipment and systems installed in this project at completion of each installation. Upon obtaining proper operation, perform demonstration of system sequences in the presence of the Commissioning Engineer and/or Owner's designated maintenance personnel.
- B. Operating tests are required on each system. The following are general tests required of certain systems. Not all equipment is listed which requires testing.
 - 1. Air handling systems
 - a. Test each control sequence and safety device associated with each system.
 - b. Control valves and dampers shall be observed for proper positioning in each sequence.
 - c. Safety shutdown devices (smoke detectors, low limit thermostats, etc.) shall be simulated for proper function.
 - d. Observe control interlocks with ancillary system equipment (exhaust fans, etc.) for proper operation.
 - e. Test water flow through each cooling and heating coil in full flow and full bypass. Record entering and leaving pressure and temperature.
 - 2. Gas Fired Heating Equipment
 - a. Test each control sequence (stages of heat) and safety device associated with each unit.
 - b. Test the performance output of each unit. Record the inlet and outlet temperatures in each stage. Confirm and/or obtain rated output of unit.
 - 3. Furnace
 - a. Test each control sequence and safety device associated with system.
 - b. Control dampers shall be observed for proper positioning in each sequence.

3.11 PERFORMANCE AND CAPACITY VERIFICATION

- A. Perform tests on all components to obtain and verify specified and scheduled capacities and performance.
- B. Submit capacity verifications as a part of the Test and Balance Report. Record the required capacity, capacity obtained, and the parameters used in determining compliance.
- C. Include, at least the following:
 - 1. Air Handling Systems
 - a. Determine BTUH output of cooling coil including sensible and total capacity.
 - b. Determine BTUH output of preheat and or heating coils.
 - 2. Propeller Unit Heaters, Cabinet Unit Heaters and Radiation:
 - a. Determine BTUH output.

END OF SECTION

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for ducts and related mechanical equipment in the heating, ventilating and air conditioning systems.
- B. Duct insulation shall be provided for the following systems.
 - 1. Conditioned air supply duct
 - 2. Return air duct
 - 3. Exhaust air ducts
 - 4. Kitchen exhaust duct

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. HVAC Ducts and Casings: Section 23 31 00
- C. Duct Lining: Section 23 33 53

1.03 QUALITY ASSURANCE

- A. Insulation shall be installed by skilled workmen regularly engaged in this type of work.

1.04 SUBMITTALS

- A. Submit product brochures in accordance with Specifications Section 23 05 01, General Provisions.
- B. Submit shop drawings which indicate complete material data, a list of materials proposed for this project and thickness of material for individual services.

1.05 JOB CONDITIONS

- A. Deliver material to job site in original non broken factory packaging, labeled with manufacturer's density and thickness.
- B. Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Repair insulation separated at joints or cracked due to thermal movement or poor workmanship.

1.06 SCHEDULING

- A. Work shall be scheduled by the Mechanical Contractor.
- B. Maintain communication with Construction Manager throughout construction period to assure coordination of the insulation installation with the progress of the duct systems.

1.07 DEFINITION OF TERMS

- A. Concealed: shall mean hidden from sight and/or access such as in trenches, chases, furred spaces, pipe shafts, or above suspended ceilings.
- B. Exposed: shall mean that duct or equipment is not "concealed" as defined above. Ductwork and equipment in service tunnels, mechanical equipment rooms, storage areas or unfinished rooms are to be considered as "exposed".
- C. Accessible: shall mean above suspended lay-in type ceilings.
- D. Inaccessible: shall mean above suspended ceilings not readily accessed from most areas.
- E. Conditioned Air: shall mean ducted air that has been filtered, cooled or heated in secondary air ductwork or constant airflow air handling units.

1.08 SCHEDULE OF DUCT INSULATION

- A. Service
 - 1. All concealed conditioned supply air: Type (1)
 - 2. All exposed conditioned supply air in conditioned spaces: Double walled ductwork.
 - 3. All exhaust ducts for ten (10) lineal feet upstream of the penetration thru exterior wall or roof: Type (1)
 - 4. All exposed outside and relief air in equipment rooms/areas: Type (3)
 - 5. All exterior supply, exhaust, and return ducts: Type 3 (See Section 3.06)
 - 6. Makeup air supply duct to kitchen hoods: Type (1)
 - 7. All combustion air: all pipe or vents upstream of damper or fan: Type (3)
 - 8. Kitchen exhaust ducts: Type (1) (see Section 3.07)
 - 9. All ductwork in uninsulated attice space: Type (3)

MATERIALS					
	<u>TYPE (1)</u>	<u>TYPE (2)</u>	<u>TYPE (3)</u>	<u>TYPE (4)</u>	<u>TYPE (5)</u>
Insulation	3/4# Flexible Fiberglass	#3 Rigid Fiberglass	#3 Rigid Fiberglass	#3 Rigid Fiberglass	2 Hour Fire Wrap
Jacket	FSK	FSK	FSK	FSK with field applied 8 ounce glass cloth jacket	-
Insulation thickness for all duct sizes	1-1/2"	1"	2"	1"	1-1/2"

- B. Do not externally insulate lined ductwork within the building unless specifically noted otherwise.
- C. Externally insulate all lined and unlined ductwork exposed to outdoors.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Duct insulation coverings and adhesives used shall have a flame spread rating not exceeding twenty five (25) and a smoke developed rating not exceeding fifty (50).

2.02 INSULATING MATERIALS - DUCTWORK

- A. Flexible Blanket: 3/4# density, lightweight, highly resilient, blanket-type thermal and acoustical insulation designed for use to 250°F faced with reinforced foil and paper FSK (foil-skrim-kraft).
- B. Rigid board fiberglass duct insulation: shall be .22 maximum "K" factor at 75 degrees F mean temperature, minimum density 3.00# per cubic feet with integral non-asphaltic fire resistant, laminated vapor barrier jacket of .001" thick aluminum reinforced foil facing glass fiber skim, flameproof laminate, UL approved.
- C. Adhesives: adhesives or mastics used in manufacturer of insulating materials or in application of same shall be fire retardant.

2.03 MISCELLANEOUS JACKET MATERIALS

- A. Flame Resistant: 2 layer laminate of flame resistant creped kraft laminated to .0007 aluminum foil.
- B. Reinforced foil and paper: FSK (foil-skrim-kraft) aluminum foil reinforced with

fiberglass yarn mesh and laminated to 40# chemically treated, fire resistant kraft.
UL rated.

- C. Exterior jackets: vinyl

2.04 ACCEPTABLE INSULATION MANUFACTURERS

- A. Owens-Corning
- B. Johns-Manville
- C. Armstrong
- D. Knauf

2.05 ACCEPTABLE INSULATION SUNDRIES/ADHESIVES MANUFACTURERS

- A. Benjamin Foster
- B. Childers
- C. Vimasco

2.06 ACCEPTABLE EXTERIOR MASTIC MANUFACTURERS

- A. Childers CP-10
- B. Benjamin Foster 3500

2.07 TWO HOUR RATED DUCT FIRE WRAP

- A. Description: Fire barrier duct wrap shall be a fire resistant double wrap system consisting of inorganic blanket encapsulated with a scrim-reinforced foil. The (non-asbestos) wrap shall contain a safer fiber construction. Silicone sealants shall be used in combination with fire barrier duct wrap to provide an effective firestop when the duct penetrates fire rated walls and floors.
- B. Performance: Fire barrier duct wrap tested in accordance with ASTM E2336.
- C. Manufacturer shall submit to installing contractor, the appropriate ESR report for installation and compliance of material to be used.

D. ESR Requirements per manufacturer:

APPROVED GREASE DUCT WRAP PRODUCT	ESR REPORT #	REQUIREMENTS
Thermal Ceramics Fire Master XL	ESR-2213	* 1.5" thick * 2 layers total thickness 3.0" * First layer butt joints * Second layer 3.0 overlaps
3M's Fire Barrier 20A	ESR-1255	* 2.0" thick * 2 layers total thickness 4.0" * First layer 3.0" overlaps * Second layer 3.0" overlaps
Unifrax's Fyrewrap Elite 1.5	ESR-2224	* 1.5" thick * 2 layers total thickness 3.0" * First layer 3.0" overlaps * Second layer 3.0" overlaps
Thermal Ceramics Pyroscat XL	ESR-2832	* 1.5" thick * 2 layers total thickness 3.0" * First layer butt joints * Second layer 3.0" overlaps
Morgan FireMaster® FastWrap® XL	ESR-2213	* 1.5" thick * 2 layers total thickness 3.0" * First layer butt joints * Second layer 3.0" overlaps
* ESR Reports verify from the Independent International Code Council (ICC) that the product meets the new ASTM E-2336		

PART 3 - EXECUTION

3.01 PREPARATION

- A. Apply insulation only after ductwork has been tested and cleaned.
- B. Protect furniture, equipment, ducts, pipes, etc. with tarpaulins. Keep premises clean.
- C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.02 GENERAL INSTALLATION

- A. Application of insulation materials to duct shall be performed in accordance with manufacturers' written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use.
- B. Provide removable sections of insulation at access points for servicing of the equipment or duct accessories.

- C. All insulation shall be continuous through wall and ceiling openings and sleeves. All covered ductwork is to be located a sufficient distance from walls, pipes, ductwork and other obstacles to permit the application of the full thickness of insulation specified. (If necessary, extra fittings are to be used).
- D. Vapor barrier jackets shall be applied with a continuous, unbroken vapor seal.

3.03 APPLICATION OF RECTANGULAR DUCT INSULATION

- A. Secure insulation without puncturing duct.
- B. Insulate ducts by attaching mechanical pins welded to bottom and sides of duct, applied on 12" centers, both directions. Install pins on a spacing no greater than 24" apart both directions on top of ducts. This requirement exceeds and supersedes the manufacturer's installation instructions. Secure insulation with metal disc. Mechanical pins shall be placed no further than 3" from butt joints or ends of duct runs.
- C. Seal all punctures on vapor barrier jacket with vapor barrier mastic.
- D. Clip all pins with appropriate tool to prevent injury on externally applied insulation.

3.04 APPLICATION FOR ROUND DUCT INSULATION

- A. Insulate ducts by wrapping the duct and securing the ends and sides with an overlap and staples no greater than 4" spacing. Tape joints.
- B. Install full perimeter band of .02 gauge aluminum (allow insulation thickness, do not compress insulation). Bands to be installed no greater than 24" spacing.

3.05 INSULATION AT TRAPEZE TYPE DUCT HANGERS

- A. Place weight-supporting insulation at bottom of ducts supported by trapeze hangers greater than 18" wide. Weight supporting insulation shall be rigid glass fiber insulation having minimum 6lb/ft³ density and 200 lb/ft² compression strength at 10% deformation (Type RR). Weight-supporting insulation shall be minimum 6" long for the width of the duct, and the same thickness as the insulation specified.
- B. Provide weight-supporting inserts by HAMFAB H-block by ICA Inc. or equal for trapeze mounted rectangular ducts less than 18" wide. Follow manufacturer's recommendation for quantity of inserts.

3.06 APPLICATION OF EXTERIOR DUCT INSULATION (EXPOSED TO OUTDOORS)

- A. Secure insulation by applying board to duct with pins on sides and bottom 12" on center both directions with approved type welded mechanical pins.

- B. All joints, cracks, punctures, edges, etc. shall be sealed with pressure sensitive FSK tape.
- C. Exposed ductwork shall have tack coat of vinyl acrylic mastic to maximum coverage of 15 square feet/gallon (trowel grade), cubed into wet tack coat, the glass fabric membrane, then apply finish coat to vinyl acrylic material membrane. Vinyl acrylic material shall be Childers CO-10, Benjamin Foster 3500, VentureTape Venture Clad 1577 CW.
- D. Tops of ductwork shall have a 2" crown to achieve positive water runoff.

3.07 APPLICATION OF TWO-HOUR RATED DUCT FIRE WRAP

- A. Installation of fire wrap shall be done by a certified installer of the manufacturer's product. Certificate shall be provided as requested by Engineer.
- B. Installation Techniques: Fire barrier duct wrap shall be installed in accordance with the manufacturer's installation instructions to be in complete compliance with a two hour rated protective enclosure. Follow manufacturer ESR report for installation procedures.
- C. Furnish and install a, manufacturer produced, access door system in compliance with the applicable codes and in specifically noted locations shown on the drawings.

END OF SECTION

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SECTION 23 07 19 - HVAC PIPE AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for the following piping systems:
 - 1. Refrigeration piping

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Assignment of Misc. Work: Section 23 05 02
- C. Basic Piping Requirements: Section 23 05 29
- D. Painting: Section 23 05 64
- E. Refrigerant Piping System: Section 23 23 00

1.03 QUALITY ASSURANCE

- A. Insulation shall be installed by skilled workmen regularly engaged in this type of work.

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Sections 23 05 01, HVAC General Provisions.
- B. Submit shop drawings which indicate complete material data, a list of materials proposed for this project and thickness of material for individual services.

1.05 JOB CONDITIONS

- A. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.
- B. Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.06 SCHEDULING

- A. Work shall be scheduled by the Mechanical Contractor.
- B. Maintain communication with Construction Manager Mechanical Contractor throughout construction period to assure coordination of the insulation installation with the progress of the piping systems.

1.07 DEFINITION OF TERMS

- A. Concealed: shall mean hidden from sight and/or access such as in trenches, chases, furred spaces, pipe shafts, or above suspended ceilings.
- B. Exposed: shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas or unfinished rooms are to be considered as "exposed".
- C. Accessible: shall mean above suspended lay-in type ceilings.
- D. Inaccessible: shall mean above suspended ceilings not readily accessed from most areas.

1.08 COOLING SERVICE - PIPE INSULATION

Thickness of insulation based upon Table 503.2.8 of 2009 IECC.

- A. Service
 - 1. For refrigerant piping; all locations
 - a. All suction piping: Type 1
 - b. All hot gas piping: Type 1
 - c. All liquid piping: Type 1
 - d. All superheated refrigerant piping: Type 1
 - e. When refrigerant line sets are utilized, if insulation thickness does not meet the requirements of this specification, insulation shall be installed to meet the requirements of this section.
 - 2. For condensate water piping: All locations indoors Type (1)
- B. Materials

	Type (1)
1. Insulation	Elastomeric foam
2. Jacket	(Not required)
3. Insulation thickness for pipe:	
a. Thru 2-1/2"	1-1/2"
b. 3" thru 5"	1-1/2"
c. 6" and above	2"
d. Refrigerant linesets, pipe size $\leq$ 5/8"	1" each piece

C. Special conditions

1. Hard copper refrigerant piping exposed outdoors shall be covered with an aluminum jacket.
2. Annealed soft copper refrigerant piping, lineset, exposed outdoors shall be covered with an aluminum jacket or Airex E-flex guard.
3. "All" piping is defined such that it includes all ancillary piping, stubs, thermowells, etc. subject to condensation.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All pipe insulation and coverings on pipe shall have a flame spread rating not exceeding twenty-five (25) and a smoke developed rating not exceeding fifty (50).
- B. Pipe insulation coverings and adhesives on pipes used in chases, shafts or other concealed spaces shall have a flame spread rating not exceeding twenty-five (25) and a smoke developed rating not exceeding one hundred fifty (150).
- C. Pipe insulation and coverings on pipe used in plenums and shafts serving as supply or return air ducts or exposed in finished areas shall have a flame spread rating not exceeding twenty-five (25) and a smoke developed rating not exceeding fifty (50).

2.02 INSULATING MATERIALS: PIPING AND EQUIPMENT

- A. Fiberglass
 1. Cold piping: a fine inorganic fibrous glass insulation with factory applied vapor barrier jacket, molded to conform to piping, "K" value at 75°F, maximum 0.24 btu inch/sq.ft./°F/hour.
 2. Hot piping: a fine inorganic fibrous glass insulation with factory applied general purpose jacket, molded to conform to piping, "K" value at 75°F, maximum 0.25 btu inch/sq.ft./°F/hour.
- B. Elastomeric foam: a closed cellular material, odorless, self-extinguishing, UL approved, maximum water vapor transmission of 0.20 perms; "K" value at 75°F, maximum 0.27 btu inch/sq.ft./°F/hour. All exterior elastomeric foam insulation shall include a UV protective coating or covering.
- C. Calcium silicate: rigid molded hydrous calcium silicate insulating pipe covering for use up to 1200°F. Density shall be 11# per cubic foot.

- D. Foamglass: a cellular glass insulation, resistant to water, non-corrosive, non-combustible and dimensionally stable. 0.00 permeability perm-inch. Absorption 0.2% by volume, flame spread 0, smoke develop 0 meeting ASTM E84. 0.29 BTU-inch /sq.ft./°F/hour @ 75°F thermal conductivity.
1. Cold piping (below ambient): Pittsburg Corning "Foamglass" with joint sealant of "Pittcote 300".
 2. Hot piping (ambient to 400°F): Pittsburg Corning "Foamglass"
 3. Underground piping: add 125 mil thick "Pittwrap" heat sealed multi-ply laminate, field applied, jacketing to above insulations.

2.03 MISCELLANEOUS JACKET MATERIALS

- A. Aluminum jacket: embossed aluminum with factory attached 30-9-30 duplex waterproof asphalt laminated paper as manufactured by ITW Pabco/Childers (0.016" thickness); ITW Pabco/Childers Ell-Jacs for fittings.
- B. Reinforced foil and paper: FSK (foil-skrim-kraft) aluminum foil reinforced with fiberglass yard mesh and laminated to 40# chemically treated, fire resistant kraft; UL listed.
- C. Flexible white PVC jacket, with a permanent non-adhesive dual bonded self-gripping integral fastening system as manufactured by Airex. Airex E-Flex Guard and fittings.
- D. High impact polyvinyl chloride (PVC) jacket minimum 0.020" thickness, Zestron product line as manufactured by Johns Manville.
- E. PVC lineset cover PVC, UV stabilized and fire resistant. Temperature range -4Â° F to 140Â°F. Fortress product line as manufactured by Rectorseal.

2.04 ACCEPTABLE INSULATION MANUFACTURERS

- A. Owens-Corning
- B. Johns-Manville
- C. Armstrong
- D. Knauf

2.05 ACCEPTABLE INSULATION SUNDRIES/ADHESIVES MANUFACTURERS

- A. Benjamin Foster
- B. Childers
- C. Vimasco

PART 3 - EXECUTION

3.01 PREPARATION

- A. Apply insulation only after piping and equipment have been tested and cleaned.
- B. Protect furniture, equipment, ducts, pipes, etc. with tarpaulins. Keep premises clean.
- C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating condition.

3.02 GENERAL INSTALLATION

- A. Application of insulation materials to piping shall be done in accordance with manufacturers' written recommendations.
- B. Provide removable sections of insulation or insulation boxes at all points where access is required for servicing the equipment.
- C. All insulation shall be continuous through wall and ceiling openings and sleeves. All covered pipe is to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full thickness of insulation specified. (If necessary, extra fittings and pipe are to be used.)
- D. Vapor barrier jackets shall be applied with a continuous, unbroken vapor seal.
- E. Pipe hangers shall be sized large enough to be installed over the outer surface of the insulation. Load distributing corrosion resistant #14 USG metal shields shall be installed around the lower one-third circumference of the insulation. Shields shall be 12 gauge for smaller sizes. Length of the shield shall be 12" and up through 6"; 16" for 6" through 12"; and 20" over 12" IPS. Secure shields to pipe insulation with adhesive.

3.03 APPLICATION OF PIPE INSULATION

- A. All pipe insulation shall be installed with joints butted firmly together.
- B. Seal all punctures in vapor barrier jacket with vapor barrier adhesive on cold piping.
- C. Jackets on pipe insulation shall be vapor sealed using self-sealing lap, lap-seal tape gun or adhesive such as 520.
- D. All fiberglass insulation ends are to be tapered at 45° and sealed regardless of service.
- E. Insulation of valves and fittings
 - 1. Valves and fittings
 - a. Provide mitered sections of fiberglass insulation of same thickness

- and density as adjoining pipe insulation or provide insulating type cement equal to adjoining pipe insulation thickness.
 - b. Cover insulation with vapor tight jacket of same jacket as adjoining pipe insulation.
 - c. Do not insulate valves and unions on heating water service piping.
2. Elbows
- a. Insulate elbows with fiberglass insulation of same thickness and density as adjoining pipe insulation.
 - b. Flexible fiberglass type insulation is not acceptable.
 - c. Insulate elbows with high temperature rated fiberglass insulation for steam and condensate piping.
 - d. Cover insulated elbows with pre-molded PVC elbow covers.
 - (i) PVC covers shall be rated for 25 fire/50 smoke develop maximum.
 - (ii) Manufacturer: Zeston; or approved equal
3. Mechanical couplings (mechanical contractor's option): Insulate all mechanical couplings in systems utilizing same (as determined by mechanical contractor) with manufacturer's molded fiberglass insulation sections. Insulation thickness shall be of same density, jacket, and thickness as adjoining pipe insulation.

3.04 APPLICATION OF PROTECTIVE JACKETS

- A. Provide minimum 0.016 thick aluminum metal rated jackets on all piping, as follows:
- 1. All insulated pipe installed outdoors.
 - 2. The metal jacket shall be retained with rivets or other suitable method that does not puncture the insulation.
- B. Provide minimum 0.016 thick aluminum metal rated jacket or minimum 0.020 PVC jacket on interior piping as follows:
- 1. In public and occupied areas where pipe is subjected to damage from normal traffic below 8'-0" AFF.
 - 2. All exposed vertical and horizontal piping below 6'-0" AFF in mechanical rooms or occupied non-finished rooms, such as storage, work rooms, etc. This includes elbows and fittings. Not included are valves or strainers.
 - 3. Provide flexible PVC jacket, with a permanent non-adhesive dual bonded self-gripping integral fastening system on all horizontal exterior exposed refrigerant line sets. Not required in areas where concealed by line set cover.
 - 4. Provide PVC line set covers on exposed interior line sets in finished areas and on exterior vertical line sets and on horizontal line sets installed on walls not within 5' of equipment.
 - 5. All jackets and line set covers to be installed per manufacturer installation requirements.

3.05 APPLICATION OF EQUIPMENT INSULATION

- A. General: Insulate all manholes, removable heads, and access doors so they may be removed.
- B. Round equipment: Secure insulation with 1/2" wide metal bands, 12" on center, or with mechanical pins welded to equipment 12" on center.
- C. Flat or irregular equipment (metal partitions, plenums, etc.): Secure insulation with mechanical pins welded to equipment 12" on center each way.

END OF SECTION

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SECTION 23 09 13.43 - TEMPERATURE CONTROL DAMPERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Control dampers shall be provided as required by the sequences of operation.

1.01 WORK INCLUDED

- ~~A.~~ Temperature control dampers and actuators shall be provided by the Mechanical Contractor.
- B. Size and capacity (air flow) shall be obtained from the drawings.
- C. Control dampers shall be provided as required by the sequences of operation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Packaged Heating and Cooling Units: Section 23 81 00

1.03 SUBMITTALS

- A. Submit shop drawings of all control dampers specified herein in accordance with Specifications Section 23 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 RETURN AIR TEMPERATURE CONTROL DAMPERS

- A. Temperature control dampers shall be the proportioning type with adjacent louvers rotating in opposite directions, except where shown as parallel blades on the drawings.
- B. Construction
 - 1. Frames shall be constructed of minimum 13-gauge galvanized steel.
 - 2. Louver blades shall be constructed of minimum 22-gauge galvanized steel, double layered sheets, welded together. Louver blades shall not exceed 6" in width.
 - 3. Bearings shall be nylon oil impregnated to provide constant lubrication.
 - 4. Seals: synthetic elastomer seals on frame top and bottom and on blade edges. The blade ends shall be independent self-compensating stainless steel.
 - 5. Linkage shall be zinc plated steel.
 - 6. Shafts shall be square and continuous length of damper (stubs not acceptable).

- C. Performance: the leakage rating shall not exceed 1/2% at 4.0" W.G. pressure differential. Testing for ratings shall be in accordance with AMCA Standard 500.
- D. Acceptable Manufacturers
 - 1. Johnson Controls, Inc. Model VD-1320
 - 2. Penn Ventilator OBD8
 - 3. Ruskin CD36
 - 4. Greenheck

2.02 INSULATED TEMPERATURE CONTROL DAMPERS (ALL DAMPERS THAT INTERFACE TO THE OUTDOORS)

- A. Temperature control dampers shall be the proportioning type with adjacent louvers rotating in opposite directions, except where shown as parallel blades on the drawings.
- B. Construction
 - 1. All welded construction.
 - 2. Frame fabricated of minimum 16-gauge galvanized steel, mill finish; integral top and bottom blade stops.
 - 3. Blades shall be double skin construction; 14-gauge channel reinforcement welded between skins forming a closed beam, filled with thermal insulation the full length.
 - 4. Both ends of each blade shall have polyurethane gaskets for tight seal.
 - 5. Frame shall be equipped with polyurethane gaskets to meet top and bottom blades.
 - 6. Both edges of top blade shall have polyurethane gaskets the full length for tight seal. All other blades shall have extruded neoprene seals on the top edge and polyurethane gaskets on the bottom edge, the full length for tight seal.
 - 7. Maximum blade deflection shall be 1/8" at center for a 72" long blade at 4" W.G.
 - 8. Blades shall pivot on 1/2" square shaft, cadmium plated CRS shaft in sintered bronze self-lubricating bearings.
 - 9. Blade linkage shall be enclosed in a side frame.
 - 10. Provide drive blade arm on the center of the blade for damper linkage connection.
- C. Performance: The maximum allowable leakage shall be 67 cfm (4.2 cfm/sq.ft.) based on a 48"x48" opposed blade damper when the applied torque is 87 in. lbs., the pressure differential is 4 in. W.G. and the damper is fully closed.
- D. Acceptable Manufacturers
 - 1. Louvers & Dampers, Inc. Model #IBD-O
 - 2. Ruskin TED50
 - 3. Tamco

2.03 FAN ISOLATION DAMPERS

- A. Fan isolation temperature control dampers shall be the proportioning type with adjacent louvers rotating in opposite directions.
- B. Construction
 - 1. Frames shall be constructed of minimum 16 gauge stainless steel.
 - 2. Louver blades shall be constructed of heavy gauge extruded aluminum or stainless steel, double layered sheets, in an air foil profile. Louver blades shall not exceed 6" in width. Axles shall be square or hexagonal (round not acceptable.).
 - 3. Bearings shall be non-corrosive molded synthetic.
 - 4. Seals: synthetic elastomer seals on frame top and bottom and compensating stainless steel.
 - 5. Linkage shall be concealed stainless steel.
 - 6. Shafts shall be square and continuous length of damper (stubs not acceptable).
- C. Performance: the leakage rating shall not exceed 4.2 cfm per sq.ft. at 4.0" W.G. pressure differential. Testing for ratings shall be in accordance with AMCA Standard 500.
- D. Acceptable Manufacturers
 - 1. Penn
 - 2. Ruskin
 - 3. TAMCO

PART 3 - EXECUTION

3.01 DAMPER INSTALLATION

- A. Dampers shall be installed square and plumb with proper alignment to obtain smooth operation of damper.
- B. Adjust the actuator after installation to obtain tight shutoff on closure.
- C. Provide shaft length required to mount damper actuators. Coordinate final length with actuator manufacturer.

3.02 PERFORMANCE VERIFICATION

- A. Demonstrate full operation(s) from control sequences to Engineer after Temperature Control Contractor has obtained successful operational tests.
- B. Assure adequate access and access doors have been installed in ductwork to view the operation of each duct mounted control damper.
- C. Assure a full closure and weathertight seal is obtained on all outside air and relief air dampers.

END OF SECTION

SECTION 23 09 93 - SEQUENCE OF OPERATION FOR CONTROLS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide the engineering and documentation required to obtain the sequence of operation for each system as described herein.
- B. All instruments, room sensors and thermostats shall be field calibrated.

PART 2 - PRODUCTS

2.01 BUILDING MANAGEMENT SYSTEM

- A. Software Installation: Provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
- B. Database Configuration: Provide all labor to configure those portions of the database that are required by the points list and sequences of operation.
- C. Status Reports: Configure status reports for the owner including those listed below:
 - 1. Air handling units
 - 2. Exhaust fans
 - 3. Miscellaneous equipment and systems
- D. Documentation: As built software documentation shall include the following:
 - 1. Descriptive point lists
 - 2. Application program listing
 - 3. Application programs with comments
 - 4. Printouts of all reports
 - 5. Alarm list
- E. Alarms: All monitors or control functions identified by the Owner as a critical alarm shall be programmed to report to the hard copy printers in the security office and control room, with instructions for appropriate action. Coordinate verbiage with Owner.
- F. Graphics: complete color graphics are required. See requirements in sequences following.

2.02 GRAPHICS

- A. Furnish custom color graphic of each system in this project. Graphic shall be unique to each system reflecting actual component makeup.
- B. Graphic representation shall allow a "point and click" format to access each controlled or monitored activity for readout, trending or adjustment.
- C. All point numbering of each system component shall include its location by room number, using the Architect's floor plan number system.

2.03 PORTABLE OPERATOR TERMINALS (POT)

- A. Provide two (2) Portable Operator Terminals to allow access to controller set points and analog values of the Terminal Controllers for the FPVAV/VAV Terminal Units.
- B. One POT shall be given to the owner and one shall be provided to the successful Testing & Balancing Contractor for his use in balancing the terminal units. (Subsequently, the Testing and Balancing Contractor shall turn over the POT to the owner's representative after completion of the balancing work.
- C. The POT may be connected into the Terminal Controller via a zone bus jack located in the space sensor, or at any equipment controller.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Installation Requirements:
 - 1. Each space thermostat and temperature sensor shall be labeled as to the terminal device controlled.
 - 2. Labels shall be as specified in Section 23 05 53.
 - 3. Label all variable frequency drives.
- B. Review labeling nomenclature, letter and plate size and mounting location with Engineer.

3.02 COMPLETION REQUIREMENTS

- A. The Temperature Control Contractor shall fully check out each system and component to ensure all sequences are working in accordance with the specification.
- B. After the contractor has fully checked out each systems and proven their operation, a letter shall be sent to the Engineer certifying this checkout and requesting a date to demonstrate the systems in front of the Engineer or Owner's representative.
- C. Note that all air handling systems and terminal units shall be demonstrated to the

full satisfaction of the Engineer/Owner.

- D. Testing and Follow-up demonstration of Variable Air Volume Terminal Units
 - 1. Operate the thermostat and unit actuator of each terminal unit through the full operating range.
 - 2. Assure that absolute full primary air supply shutoff is obtained from thermostat operation when scheduled.
 - 3. Assure heat operates correctly when sequenced.
- E. Upon successful completion of demonstrations with the Engineer, schedule and perform training of the Owner's maintenance personnel.

PART 4 - SEQUENCES

4.01 HVLS FANS

- A. Provide touchscreen controller for each fan. Touchscreen shall be capable of turning fan on and off, changing speed faster or slower, and changing direction of rotation.
- B. BMS Integration: None required.
- C. BMS Graphics: None required.

4.02 DUCTLESS SPLIT AIR CONDITIONERS

- A. Unit shall maintain room setpoints.
 - 1. Cooling Setpoint: 74F (adjustable)
 - 2. Heating Setpoint (where applicable): 68F (adjustable)
- B. The fan shall run continuously unless shutdown on safeties. The fan speeds shall be indexed as follows:
 - 1. Low speed shall run anytime the zone temperature is within setpoints.
 - 2. Medium speed shall run anytime the zone temperature is outside of setpoints.
 - 3. High speed shall run anytime the zone temperature is outside of setpoints and medium speed cannot achieve setpoints.
- C. The outdoor unit compressor shall modulate between air conditioning and heat pump (where applicable) modes to send refrigerant to the indoor unit to satisfy setpoints.
- D. BMS Integration: Yes, cooling and heating setpoints to be adjustable. Alarm when shutdown on safeties.
- E. BMS Graphics: Room temperature setpoint, room temperature, on/off status

4.03 DOAU

- A. All sequences described herein shall be part of the manufacturer's standalone controller.
- B. The unit shall run continuously unless shutdown on safeties.
- C. Outdoor air damper – The outside air damper shall open anytime the unit is commanded to run and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open.
- D. Exhaust air damper – The exhaust air damper shall open anytime the unit is commanded to run and shall close anytime the unit stops. The exhaust fan shall start only after the damper status has proven the damper is open.
- E. Energy Recovery – The total enthalpy energy recovery wheel shall rotate when unit is on and enthalpy conditions are sufficient such that rotating the wheel does not require the use of compressor cooling when unit could otherwise be in economizer mode.
- F. Supply air temperature setpoint – Fixed
 - 1. The unit controller shall monitor the supply air temperature and shall maintain a fixed supply air temperature setpoint of 70F (adj.) and a maximum of 55% RH. DX cooling, electric preheating, modulating gas heat, and hot gas reheat shall control the discharge air conditions.
 - 2. Wheel frost protection – Electric preheat coil shall be enabled to prevent frost on the energy recovery wheel.
 - 3. Cooling – The controller shall measure the supply air temperature and stage the cooling to maintain its setpoint. Compressors shall cycle as needed. To prevent short cycling, there shall be a delay between stages (length of time shall be determined by manufacturer's controller).
 - 4. Heating – The controller shall measure the supply air temperature and modulate the gas heat to maintain its setpoint.
 - 5. Dehumidification Cycle – The controller shall measure the supply air temperature and relative humidity. The controller shall stage the cooling to maintain supply air setpoint. When required to reduce humidity, compressors shall modulate to cool and dehumidify air to 52F and saturated condition. Air will then be reheated via hot gas reheat coil to raise temperature back to setpoint temperature, 70F (adj.).
 - 6. UNIT SHALL NOT RUN OFF A ROOM THERMOSTAT.
- G. BMS Integration: Yes, cooling and heating setpoints to be adjustable. Alarm when shutdown on safeties.
- H. BMS Graphics: Discharge air temperature and humidity setpoints, discharge air temperature and humidity, outdoor air temperature and humidity (both sides of the wheel), exhaust air temperature and humidity (both sides of the wheel), on/off status, compressor status, gas furnace status, electric heat coil status, freeze protection alarm

4.04 FURNACES 1-5

- A. Unit shall run continuously unless shutdown on safeties.
- B. Unit shall maintain room setpoints. Setpoints are controlled via thermostat located where shown on drawings.
 - 1. Cooling Setpoint: 72F (adjustable)
 - 2. Heating Setpoint: 68F (adjustable)
- C. Cooling – When cooling setpoint is not met, air cooled condensing unit compressor shall cycle to provide subcooled refrigerant to furnace evaporator coil. Unit shall stay in cooling mode until setpoint is met.
- D. Heating – When heating setpoint is not met, condensing gas furnace shall stage gas burner to provide heating. Unit shall stay in heating mode until setpoint is met.
- E. BMS Integration: Yes, cooling and heating setpoints to be adjustable. Alarm when shutdown on safeties.
- F. BMS Graphics: Room temperature setpoint, room temperature, on/off status, heating or cooling mode status

4.05 FURNACE 6

- A. Fan shall turn on when ambient air is $\leq 40F$.
- B. Heating – When moisture sensors detect moisture, unit heat shall turn on until sensors do not detect anymore moisture. See drawings for location of moisture sensors.
- C. BMS Integration: Yes. Alarm when shutdown on safeties.
- D. BMS Graphics: On/off status, discharge air temperature, moisture sensors positive or negative.

4.06 EXHAUST FAN EF-1, EF-3

- A. Fan to run continuously.
- B. BMS Integration: Yes.
- C. BMS Graphics: On/off status.

4.07 EXHAUST FAN EF-2

- A. Fan to be enabled in accordance with gas detection system. Fan shall turn on when:
 - 1. Carbon Monoxide (CO) is greater than 9 ppm.

- 2. Nitrous Dioxide (NO₂) is greater than 1.2 ppm.
- B. When fan is on, motorized dampers on Louvers LV-2 and LV-5 shall open.
- C. BMS Integration: Yes. Alarm when CO or NO₂ level is above setpoint. Alarm if dampers do not open.
- D. BMS Graphics: On/off status, CO level, NO₂ level.

4.08 HEATERS (GAS-FIRED UNIT AND RADIANT, ELECTRIC UNIT)

- A. Heating setpoint – 65F (adj.)
- B. When heating setpoint is not met, units shall cycle on until setpoint is satisfied. Once setpoint is satisfied, unit shall shut off.
- C. BMS Integration: Yes.
- D. BMS Graphics: Space temperature, on/off status

END OF SECTION

SECTION 23 21 13 - CONDENSATE DRAIN PIPING SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install cooling coil condensate drainpipe and fittings from equipment as shown on the drawings and as herein specified.
- B. All piping shall be installed in compliance with the current local Plumbing Code and as recommended by the International Code Council (ICC).

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Completion and Startup: Section 23 05 03
- C. Basic Piping Requirements: Section 23 05 29
- D. Identification for Piping and Equipment: Section 23 05 53
- E. Pipe and Equipment Insulation: Section 23 07 19

1.03 SUBMITTALS:

- A. Product data for each piping type specified.
 - 1. Submittals and shop drawings shall include the following data:
 - a. Equipment Manufacturer's recommended installation methods.
- B. Test reports specified in Part 3 of this Section.

PART 2 - PRODUCTS

2.01 CONDENSATE DRAIN PIPING

- A. 1" thru 4": DWV, hard drawn seamless copper tube and fittings 50-50 soldered joints; ASTM-306.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Verify obstacles, piping, equipment, and conditions, prior to installation.
- B. Examine rough-in requirements for equipment having drain connections to verify actual locations of piping connections, prior to installation.

3.02 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping system. Location and arrangement of piping layout take into account many design considerations. So far as practical, install piping as indicated.
- B. All horizontal condensates drain piping shall be installed with the minimum required pitch unless otherwise shown or specified. Slope as follows: 1-1/4" to 2-1/2" pipe slope at 1/4" per foot. 3" and larger pipe slope at 1/8" per foot. No piping shall be sloped less than 1/8" per foot.
- C. Condensate drains which are connected to drain/drip pans of various mechanical equipment units shall be connected with DWV piping. Each drain/drip pan shall be protected by a full size trap assembly at each unit with a minimum of a 2" depth plus a static seal of the size shown on the drawings. Provide a sanitary tee on the inlet side of the trap assembly with a removable threaded cleanout plug in the vertical position.
- D. Any pipe junction shall be made with a "Y" branch or combination "Y" and 1/8 bend. Cleanouts are to be provided at every change of direction including traps at the unit.
- E. Obtain dimensioned rough-in shop drawings from the equipment suppliers.
- F. Condensate drain lines are to terminate at locations where/as indicated on the drawings, with a code approved air gap.

3.03 TESTING - HYDROSTATIC METHOD

- A. The condensate drain system shall be tested by plugging the drainage outlets and filling the system with water which is then permitted to stand thus for one hour. A hydrostatic head of ten feet of water must be maintained for the entire test period.
- B. The system shall be considered satisfactory only if there is no loss of water or leakage for the duration of the test period.

END OF SECTION

SECTION 23 23 00 - REFRIGERANT PIPING SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install a complete refrigerant piping system(s) where shown on the drawings and herein specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Basic Piping Requirements: Section 23 05 29
- C. Prefabricated Roof Curbs and Supports: Section 23 05 30
- D. Vibration and Seismic Controls for Piping and Equipment: Section 23 05 48
- E. Identification of Piping and Equipment: Section 23 05 53
- F. HVAC Pipe and Equipment Insulation: Section 23 07 19
- G. Dedicated Outdoor Air Units: Section 23 74 13
- H. Ductless Split System: Section 23 81 11
- I. Furnace, Coil, and Split Systems: Section 23 82 20

1.03 COORDINATION

- A. Provide coordination with all other trades in the routing of piping prior to installation. No extra compensation for piping offsets or routing changes will be allowed due to lack of coordination.

1.04 SUBMITTALS

- A. Submit shop drawings of each piece of equipment specified herein per Specifications Section 23 05 01, General Provisions.
- B. Reference required submittals in 23 05 29 Basic Piping Requirements.

PART 2 - PRODUCTS

2.01 REFRIGERANT PIPING SYSTEM

- A. Service: Refrigerant 454B
- B. Maximum design: pressure 350 psig; temperature 200°F
- C. Piping (above ground): Type L, hard drawn, seamless copper, cleaned, dehydrated and sealed.
- D. Joints
 - 1. 1/4" thru 3/8" O.D.: flared
 - 2. 1/2" O.D. and larger: silver brazed; Handy-Harmon SIL-FOS; J.W. Harris Stay-Silv 15
- E. Fittings
 - 1. 1/4" thru 3/8": 45° flared, Full-Flo Refrigeration
 - 2. 1/2" and larger: wrought copper
- F. Flanges (7/8" and larger): flange unions, forged steel flanges, brass tailpieces, Henry Products
- G. Gaskets: 1/16" neoprene bonded sheet packing, Johns-Manville, Chicago Wilcox
- H. Nuts and bolts: machine bolts with hex nuts.
- I. Shutoff Valves
 - 1. Globe (1/4" thru 5/8")
 - a. Bronze body and trim, diaphragm packless type, screwed bonnet, metal diaphragm, composition seat disc, globe or angle pattern, solder
 - b. Manufacturers: 500# Henry 626 or 647; 500# Mueller Linemaster LMS-1-2
 - 2. Globe (7/8" and larger)
 - a. Bronze body and trim, threaded or bolted bonnet, packing gland, composition seat disc, with wing cap seal, solder, globe or angle pattern.
 - b. Manufacturers: 450# Henry 203 04 216; 500# Mueller Globemaster VS or VGA
 - 3. Ball (1/2" and larger)
 - a. Bronze body and chrome plated ball, Teflon seats and seals, wrench operated, cap cover, soldered.
 - b. Manufacturers: 500# Apollo 79-200

4. Service - charging and purging (1/4" through 5/8")
 - a. Bronze body and trim, diaphragm, packless type, screwed bonnet, metal diaphragm, seal cap and chain for flared charging connection, solder, globe or angle pattern
 - b. Manufacturers: 500# Henry 623 or 643; 500# Mueller III

2.02 REFRIGERATION PIPING CONDUIT

- A. Service: carrier pipe for underground refrigeration piping
- B. Pipe: Schedule 40 PVC, plain cut ends
- C. Joints: solvent weld
- D. Fittings: Schedule 40, long radius ells

PART 3 - EXECUTION

3.01 REFRIGERANT PIPING TESTING

- A. Any holding charge in the compressor used for shipping shall be purged.
- B. Perform an initial test on the refrigerant system, as follows:
 1. Bleed in small amount of refrigerant gas, preventing any liquid freon from entering system. Suction shutoff valve shall be turned to mid-position and charge valve opened. Admit freon gas to 10 psig.
 2. Disconnect freon supply and charge system with dry nitrogen gas to 100 psig.
 3. Hold the pressure for 12 hours and check for loss of pressure. Certify the readings. Notify the equipment manufacturer of test and allow observance.
 4. If a leak(s) is detected, entire refrigerant system shall be checked with a leak detector. Caution: Any freon that might be present in area can interfere with detectors. Area must be thoroughly ventilated.
 5. Repair any leaks and repeat above procedure. Repairing leaks under pressure shall not be done. Brazed joints shall be repaired by using new material.
- C. When ambient temperature is 60°F or above, after system is determined to be leak free and with oil sump heaters energized, entire refrigeration piping system and compressor shall be triple evacuated; twice to 1500 microns and the third time to 500 microns, breaking the vacuum each time with the refrigerant to be used in the system. Build to a positive pressure of at least 2 psig. Vacuum pump must be connected to both high and low sides through connections provided by the equipment manufacturer. Provide certification of the above procedures to the Engineer. Vacuum source for each evacuation shall maintain this vacuum reading for at least 1 hour continuously, to make sure all moisture has been removed from the system. Change vacuum pump oil after each evacuation.

- D. After completion of above steps, suction shutoff valve shall be back seated, vacuum source valves closed and vacuum storage disconnected, and system is ready to charge.

3.02 REFRIGERANT PIPING INSTALLATION

- A. Bleed dry nitrogen through piping during welding process.
- B. Piping system shall be installed as specified in Specifications Section 23 05 29, Basic Piping Requirements.
- C. Provide vibration isolation as specified in Section 23 05 48 - Vibration Isolation.
- D. Support piping on roofs on prefabricated supports. Pipe shall be run sloped at 1" in 10'-0" in direction of flow.
- E. When manufacturer's refrigerant line sets are utilized, if insulation thickness does not meet the requirements of the Energy Code, field installed insulation shall be required.

3.03 REFRIGERANT SYSTEM STARTUP

- A. Perform a preliminary check before charging the system.
 - 1. Check air handling equipment for design air flow conditions prior to refrigeration system startup.
 - 2. Compressors shall be checked for proper lubrication, oil levels, voltage and control sequences prior to startup.
- B. Charge the system completely and test the system through its steps of unloading. Check the system frequently to assure a proper refrigerant charge.
- C. Perform all system testing and startup in the presence of the Owner's Engineer and maintenance personnel.
- D. When all checks have been completed, the system shall be allowed to run normally for at least 72 continuous hours. A qualified service mechanic shall remain on the job for at least 24 of the 72 hours of run-in period. During this period, the system shall be checked for refrigerant leaks, compressor oil level and for proper operating pressures and temperatures.
- E. Provide follow up service and checks as directed by the Owner and required until system operates satisfactorily.

END OF SECTION

SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide equipment, specialties and accessories to provide ducted systems as shown on the drawings and herein specified.
- B. Systems in this section include:
 - 1. Air conditioning supply
 - 2. Air conditioning return
 - 3. Outside air
 - 4. Exhaust air
 - 5. Transfer air
- C. Ductwork shall be constructed to meet the following classification(s).
 - 1. Supply ductwork from DOAS units, furnaces: 2" W.G.
 - 2. Return air, exhaust air, outside air and mixed air ductwork: negative 2" W.G.
 - 3. Relief air and transfer air ductwork: 2" W.G.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Assignment of Misc. Work: Section 23 05 02
- C. Vibration and Seismic Controls for Piping and Equipment: Section 23 05 48
- D. Painting: Section 23 05 64
- E. Testing, Adjusting and Balancing: Section 23 05 93
- F. Duct Insulation: Section 23 07 13
- G. Sequence of Operation for Controls: Section 23 09 93
- H. Non-Metal Ducts: Section 23 31 16
- I. Air Duct Accessories: Section 23 33 00
- J. Duct Lining: Section 23 33 53
- K. Air Outlets and Inlets: Section 23 37 00

1.03 COORDINATION

- A. Provide coordination with all other trades in the routing of duct prior to

installation. No extra compensation for ductwork offsets or routing changes will be allowed due to lack of coordination.

- B. Provide coordination with the project Air Balance Contractor in furnishing and locating all necessary balancing dampers to obtain a properly balanced system.

1.04 REFERENCE MANUALS

- A. SMACNA - HVAC Duct Construction Standards, Metal and Flexible, second edition, 1995.
- B. ASHRAE Guide and Data Book, 2017 Fundamentals edition, Chapter on Air Duct Design.
- C. SMACNA HVAC Air Duct Leakage Test Manual

1.05 GENERAL REQUIREMENTS

- A. Ductwork shall be constructed of galvanized steel or aluminum as noted on the drawings.
- B. Dehumidification system ductwork shall be of all welded construction.
- C. All exhaust ductwork handling moist air or shower exhaust shall be constructed of aluminum.
- D. All exhaust and outside air plenums shall be constructed of aluminum.

1.06 SUBMITTALS

- A. Coordination Drawings are required on this project.
 - 1. Sheet metal fabrication drawings as defined below may be used. However, complete coordination with all other trades is required.
 - 2. No pay requests for installed work will be honored until fully coordinated drawings are accepted by the Owner.
- B. Fabrication Drawings
 - 1. Submit duct fabrication drawings for each system for Engineer's approval prior to fabrication or installation. Refer to Specifications Section 23 05 01, General Provisions and Division 1 for submission requirements.
 - a. Drawings shall be prepared utilizing AutoCAD or Revit. Contact the Architect to obtain generic floor plans. Engineer's drawings are not to be used as the sheet metal fabrication drawings.
 - b. Drawings shall be minimum scale of 1/4" = 1'-0" for floor plans. Include sections and elevations of all ductwork.

- c. Include all joints, duct sizes, dampers, diffusers, air quantities, bottom elevations, etc. to reflect a complete and coordinated system layout.
 - d. Coordinate the routing with all other trades and the structural/architectural drawings during drawing development period. Detail all areas requiring close or critical coordination points on the drawings.
2. Thoroughly review all construction documents to verify all routings, heights, and locations of all ductwork. Visit the jobsite and field verify all routings, heights, and locations. Notify the Engineer of any conflicts and proposed coordinated solutions.
3. For remodeled areas, the contractor shall visit the jobsite and verify all routings, heights, and locations of all existing piping, ductwork and other materials. Notify the engineer of any conflicts.
4. Completed drawings shall be prepared in conjunction with the General Contractor, Sprinkler Contractor, Mechanical Contractor, Temperature Control Contractor, and Electrical Contractor for their coordination and impact to the final duct layouts. Prepare any drawing corrections required to obtain a coordinated layout. Provide sufficient sets of drawings for distribution.
5. Submit duct fabrication drawings to the Balancing Contractor for that contractor's review and comments and acceptance before such drawings are submitted for approval.
6. Review and coordinate locations of all controlled dampers with the Temperature Control Contractor for installation criteria.

PART 2 - PRODUCTS

2.01 RECTANGULAR AND ROUND DUCT

- A. Construct duct of first quality materials in strict accordance with the SMACNA HVAC Duct Construction Standards Manual, Latest Edition, for pressure classification specified herein, unless a more stringent requirement is specified herein.
- B. Duct sizes 19" wide and larger, which have more than 10 square feet of unbraced panels shall be cross broken, unless ducts are noted to be internally lined. This requirement is applicable to 20 gauge or less thickness and 3" W.G. or less.
- C. Fittings
 1. Elbows (30" wide and less): use standard radius elbow. Inside radius shall be same as width of duct, unless specifically noted otherwise on the drawings. **Square or mitered inside throats are not allowed.**
 2. Elbows greater than (31" wide): use radius elbow where shown on drawings with inside radius the same as the duct width. Otherwise use square elbows with turning vanes. Elbows less than 36" wide shall have single bladed vanes. Elbows 36" and over shall have double blade vanes in airfoil pattern.

3. Main tee connections
4. Rectangular to rectangular: radius or 45° inlet
5. Round to rectangular: conical connection
6. Branch tee connections: 45° tap in. Provide balancing damper in branch duct to diffuser or grille.
7. Transitions, raises and drops: built so that change in direction does not exceed 20° angle measured at centerline of air flow.

2.02 ALUMINUM DUCTWORK CONSTRUCTION

- A. Apply the conversions applicable to a comparable steel duct gauge of the pressure classification specified, to determine aluminum thickness, reinforcement, and joint connectors.

2.03 T-24, T-24a and T-25b JOINT SYSTEMS

- A. Contractor has option to fabricate the duct system utilizing "Ductmate Industries, Inc."; Lockformers T.D.C., or Engles T.D.F. Joint Systems.
- B. Ducts: Lock forming quality steel with G-90/Z275 zinc coating to A.S.T.M. A525-79.
- C. Fabrication: Ducts and fittings configuration in accordance with performance requirements of SMACNA, and this specification.

2.04 FLEXIBLE CONNECTIONS

- A. Provide flexible connections at each inlet and outlet duct connection to every piece of fan equipment. Fabric fastened to metal with double lock seam. Fabric for ordinary heating, ventilating and air conditioning uses to be waterproof, fire retardant and suitable for temperature of 200°F.
- B. Refer to product Specification in Section 23 05 48, Vibration and Seismic Control for Piping and Equipment.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. All duct dimensions shown on the drawings are inside dimensions, including ducts insulated on inside.
- B. All ductwork shall be installed tight to walls, partitions or within the structure depth except where specific elevations are noted on the plans. Provide offsets to accomplish this and to avoid conflicts with other trades. Provide coordination with electrical, plumbing and sprinkler contractors prior to and during fabrication drawing period. No extra compensation from the Owner or Engineer will be approved for duct sizing and routing revisions required for structural or coordination purposes.

- C. Support ducts suspended from floor and roof structural members with band type hangers if maximum width is 47" or less and with trapeze type hangers if 48" and over. Do not support main ducts from roof decking. Hanger rods shall be minimum of 3/8".
- D. Duct support spacing shall comply with local seismic requirements and in accordance with SMACNA, but in no case greater than 6'-0" O.C.
- E. Furnish, locate and set suitable sleeves and trim flanges where ducts pass through walls, including walls above ceilings. Allow clearances for continuous thru-wall insulation.
- F. All ductwork at 7'-0" or below above floor, plus any ductwork which may come near ladders or walkways shall have flattened seams. In addition, this ductwork shall have no protrusions or sharp edges.
- G. Contractor to include all balancing dampers as shown on drawings and as required by the Balancing Contractor to obtain proper flow and noise requirements. Contractor to insure accessibility to all balancing dampers.

3.02 DUCT SEALING REQUIREMENTS

- A. All ductwork from constant volume air handling units and all secondary supply air ductwork in pressure classification 2" W.G., shall be sealed to SMACNA Seal Class B: all transverse joints and longitudinal seams.
- B. All return air, relief air and exhaust ductwork in pressure classification negative 2" w.g. shall be sealed to SMACNA seal Class B: all transverse joints and longitudinal seams.
- C. Neatly caulk all joints, slips and keys to ensure an absolutely tight system, suitable to the pressure classification specified.

3.03 DUCT PRESSURE TESTING

- A. Provide equipment and perform duct pressure tests on all completed air distribution systems, to ensure the systems are sealed adequately. The Sheet Metal Contractor shall include such tests in his bid.
- B. Maximum allowable total system leakage is 5% of the total air system volume, for each system, when duct is under the scheduled pressure classification.
- C. Provide temporary caps and seals as required to perform the test(s). The test shall be performed on each complete distribution system as follows:
 - 1. Primary supply from the air handling units thru the terminals. In VAV systems, "terminals" are defined as the VAV terminal units. In constant volume systems, "terminals" are defined as the outlet grilles.
 - 2. Return air systems from the inlets to the air handling units.

3. Exhaust air systems from the inlets thru the exhaust fans to the termination point. Note: perform an initial test and submit a report to the engineer prior to the chase wall construction.
 4. Perform a final test when the system is complete, and the construction is complete.
- D. Test procedure shall utilize a calibrated fan assembly to pressurize the duct and record the leakage flow rate in CFM.
- E. Record in report form for each system, the pressure maintained in the duct and the leakage flow rate. Include the date and time of the test and names of those present. Highlight a drawing reflecting extent and number of each test corresponding to the report.
- F. Should the initial air balance reflect that the total system duct leakage exceeds 5% of the total CFM, the contractor will be required to:
1. Determine the leakage source(s).
 2. Re-seal the duct.
 3. Reimburse the balancing contractor for the initial air balance testing.
- G. All duct pressure tests shall be witnessed by Owner, Engineer or Construction Manager. Reports shall be submitted to Engineer, Owner, TAB Contractor and Commissioning Engineer. Submit reports within 5 days of test date, complete with drawing reflecting tested duct system.

3.04 DUCTWORK EXPOSED TO VIEW IN OCCUPIED SPACES

- A. Exposed ductwork shall be installed in a neat workmanlike manner. Refer to the mechanical, architectural and structural plans, elevations and sections for routing and heights. A final coordinated, neat appearance is of utmost importance.
- B. Ductwork shall be internally insulated double walled with perforated interior liner. Exterior shall have paint grip finish.
- C. Do not initially place, or remove if placed, duct shop labels. Duct shall be free of adhesive.
- D. Provide support cables and fasteners in a manner which is unobtrusive.
1. Use stainless steel cables to support ductwork with single point connection where approved by SMACNA. Otherwise use dual cables. Cables shall attach to full perimeter sheet metal bands.
 2. Review support means and spacing with Architect and Engineer prior to fabrication and installation.
 3. Duct support spacing shall be coordinated with structural spacing and be of a consistent spacing in the room or area.
- E. Repair or replace duct sections containing indentures as required by the Architect or Engineer.

- F. Final duct installation shall be cleaned and free of grime, grease or dust suitable for field painting.
- G. Furnish, locate and set suitable sleeves and framed openings where ducts pass through floors, walls and other concrete or masonry materials. Provide trim rings at wall penetrations.
- H. All branch ducts or collars for termination with grilles or diffusers shall be sized to match the outside dimensions of the grille flange. Allow for this duct size when ordering balancing dampers.
- I. On galvanized steel ductwork, where galvanizing has been eradicated, it shall be sanded and painted with a 2 mil base coat of Carboline Co. Rust Bond Primer 36C, a second 2 mil coat of Carboline Polyclad #9.33-1 and a third coat same as second coat.

3.05 PROTECTION DURING CONSTRUCTION

- A. Ductwork delivered to the site and stored/staged prior to installation shall be placed in a dry location, and set on skids, etc. Cover ductwork subject to dirt, mud, dust, weather or building leaks.
- B. Schedule a field inspection with the Engineer, Construction Manager or Superintendent for all ducts delivered to the site having an interior liner for observation of liner attachment and sealants.
- C. During construction, provide and maintain temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. When fans are running, filters must be in place and maintained.
- E. Ductwork which becomes dirty during the construction period shall be externally and internally cleaned prior to system startup and acceptance.

3.06 COMPLETION REQUIREMENTS

- A. The contractor shall neatly caulk all joints to ensure an absolutely tight system. Neatly tape off straight edge lines on duct perimeter prior to applying sealant. Remove tape and trim excess caulking. Clean all exterior surfaces.

3.07 APPLICATION OF FIRE STOP SEALANTS

- A. Prepare and apply preparation sealing system in accordance with manufacturer's printed instructions.
- B. Employ installation techniques which will ensure that firestopping is deposited to fill and seal holes and openings.
 - 1. Provide flame (F) rating minimum one-hour, but not less than fire resistance rating of the assembly in which it is installed, per ASTM E-814.

2. Ensure effective smoke seal.
- C. Tool exposed surfaces of applied sealant smooth.

END OF SECTION

SECTION 23 31 16 - NON-METAL DUCTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install flexible duct only where shown on the drawings.
- B. This work is strictly limited to concealed vertical run-outs to ceiling mounted supply diffusers from low pressure metal ductwork and inlet connections to fan powered variable air volume terminal units.
- C. No single runout from a branch duct to a diffuser shall exceed five (5) feet duct length in any case.
- D. Inlet connections to fan powered variable air volume terminal units shall not exceed one (1) foot.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Air Duct Accessories: Section 23 33 00

1.03 SUBMITTALS

- A. Submit shop drawings in accordance with Specifications Section 23 05 01, General Provisions.

1.04 REFERENCE MANUALS

- A. SMACNA - HVAC Duct Construction Standards, Metal and Flexible, second edition, 1995.
- B. ASHRAE Guide and Data Book, 2017 Fundamentals edition, Chapter on Air Duct Design.
- C. Flexible Duct Performance & Installation Standards, Sixth Edition, published by Air Diffusion Council.

PART 2 - PRODUCTS

2.01 INSULATED FLEXIBLE DUCT

- A. Flexible duct shall be constructed of a resilient core of continuous inner air barrier with steel wire helix. Duct to be insulated with a resilient fiberglass insulation, a fiberglass skim, and extend vapor barrier jacket.
- B. The flexible duct shall qualify as a Class 1 air duct listed by UL 181 test standards and as required by NFPA-90A-B.

- C. Flexible duct shall not exceed a flame spread of 25 and smoke developed of 50.
- D. Thermal conductance at 75°F mean temperature shall not be less than R-6.0.
- E. Manufacturers
 - 1. Dundas-Jafine
 - 2. Flexmaster U.S.A.
 - 3. Genflex #SLR-25C
 - 4. Owens Corning #INL-25
 - 5. Wiremold
 - 6. Hart & Cooley

2.02 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Nylon strap in sizes 3 through 18 inches (75 through 460 mm], to suit duct size.
- B. Non-Clamp Connectors: Liquid adhesive plus tap.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install flexible duct as straight as possible, eliminating unnecessary bends but still allowing adequate flexible movement. In no case shall offsets exceed a 45° radius and in no case shall a single run of flex duct exceed (2) 45-degree offsets. If an offset is required, exceeding this criterion, provide sheet metal elbows.
- B. Flexible duct shall be supported from the horizontal branch duct. Ensure the duct is supported without bends or kinks.
- C. Flexible duct shall be connected with stainless steel band with cadmium plated hex screw to tighten band with a worm-gear action, in return air plenums, or nylon strap, in non-return air plenums, to secure the inner core to the duct and to the diffuser. Then extend the insulation over the banded core and seal the insulation to the duct and to the diffusers with appropriate tape.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide duct system accessories as shown on drawings and as specified herein.
- B. Accessories shall be constructed of the same material as the duct system served.
- C. Accessories included:
 - 1. Volume dampers
 - 2. Balancing dampers
 - 3. Access doors
 - 4. Test holes
 - 5. Turning vanes

1.02 ALLOWANCES

- A. Provide twelve (12) access doors of various sizes beyond the quantity defined in the project documents. Installation shall be where instructed by the Engineer and used where added or needed during construction. Stock unused access doors at end of project. Assume 24" x 24".

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Testing, Adjusting and Balancing: Section 23 05 93
- C. HVAC Ducts and Casings: Section 23 31 00
- D. Kitchen Hood Makeup Exhaust: Section 23 38 13.13

1.04 REFERENCE MANUALS

- A. SMACNA - HVAC Duct Construction Standards, Metal and Flexible, second edition, 1995.
- B. ASHRAE Guide and Data Book, 2017 Fundamentals edition, Chapter on Air Duct Design.
- C. SMACNA HVAC Air Duct Leakage Test Manual

1.05 SUBMITTALS

- A. Submit shop drawings on all accessories per Specifications Section 23 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 VOLUME DAMPERS

- A. Furnish and install opposed blade dampers where shown on drawings.
- B. Damper blade construction to be minimum 16-gauge die formed, galvanized steel. Shaft shall be steel with brass or nylon, bronze oilite bearings. Blades shall not exceed 6" wide and 48" long. Frames shall be minimum 16-gauge, die formed, welded channel.
- C. Damper Operators: volume dampers to have external, lock type damper operator and linkage as best suits construction and access conditions. Operators to be provided with locking damper quadrants complete with locking nuts and graduated scale.
- D. Operators to have standoff for thickness of insulation.
- E. Design Base:
 - 1. Low Pressure Rectangular: AWV Model VC-31
 - 2. Low Pressure Round: AWV Model VC-24
 - 3. Medium Pressure Rectangular: AWV Model DAA-P-3274
- F. Manufacturers
 - 1. Greenheck
 - 2. Nailor Industries
 - 3. Ruskin
 - 4. United Enertech

2.02 BALANCING DAMPERS (RECTANGULAR)

- A. Furnish and install where shown on the drawings and in each branch take off to diffusers or grilles.
- B. Dampers to be opposed blade.
- C. Damper blade construction shall be the same as the duct. Galvanized duct dampers to be minimum 16-gauge die formed, galvanized steel. Shaft shall be steel with brass or nylon, bronze oilite bearings. Blades shall not exceed 6" wide and 48" long. Frames shall be minimum 16-gauge galvanized, die formed, welded channel. Aluminum duct dampers shall be equivalent of all aluminum construction.
- D. Damper Operators: balancing dampers to have external, lock type damper

operator and linkage as best suits construction and access conditions.
Operators to be provided with locking damper quadrants complete with locking nuts and graduated scale.

E. Operators to have standoff for thickness of insulation.

1. Greenheck
2. Nailor Industries
3. Ruskin Model #MD35
4. United Enertech

Note: Model numbers will vary for aluminum.

2.03 BALANCING DAMPERS (ROUND)

A. Furnish and install where shown on the drawings and in each branch take off to diffusers or grilles.

B. Dampers to be opposed blade.

C. Damper blade construction shall be the same as the duct. Galvanized duct dampers to be minimum 20-gauge die formed, galvanized steel. Shaft shall be steel with brass or nylon, bronze oilite bearings. Blades shall not exceed 6" wide and 48" long. Frames shall be minimum 20 gauge galvanized, die formed, welded channel. Aluminum duct dampers shall be equivalent of all aluminum construction.

D. Damper Operators: balancing dampers to have external, lock type damper operator and linkage as best suits construction and access conditions.
Operators to be provided with locking damper quadrants complete with locking nuts and graduated scale.

E. Operators to have standoff for thickness of insulation.

F. Manufacturers

1. Greenheck
2. Nailor Industries
3. Ruskin
4. United Enertech

Note: Model numbers will vary for aluminum.

2.04 LOW PRESSURE BALANCING DAMPERS (ROUND)

A. Furnish and install where shown on the drawings low to medium pressure round balancing damper.

B. Dampers shall have a temperature rating of 250°F. blade.

C. Dampers shall have a minimum velocity rating of 3000 fpm.

D. Construction:

1. Frame and Sleeve: The damper frame and sleeve shall be of one piece design, made with 16 ga. galvanized steel and a groove for added strength.
 2. Blades: Galvanized steel.
 3. Blade Seals: Silicone mechanically secured to the blades.
 4. Axles: Minimum ½ in. dia., material is plated steel.
 5. Bearings: Axle bearings shall be bronze.
- E. Damper Operators: balancing dampers to have external, lock type manual damper operator. Operators to be provided with locking damper quadrants complete with locking nuts and graduated scale.
- F. Operators to have standoff for thickness of insulation.
- G. Manufacturers
1. Greenheck
 2. Nailor Industries
 3. Ruskin Model #CBD6
 4. United Enertech

2.05 COUNTERBALANCED BACKDRAFT DAMPERS

- A. Furnish and install counterbalanced type automatic backdraft dampers where shown on the drawings.
- B. Dampers assembly shall be heavy duty construction.
1. Frame shall be extruded aluminum with minimum wall thickness of .125".
 2. Blades shall be extruded aluminum with minimum wall thickness of .070". Blades shall be equipped with vinyl edge seals. Blades shall be linked with aluminum tie bars.
- C. Counterbalance shall be provided on each blade and shall be field adjustable. Damper shall be suitable for relieving at .02 inches w.g. and above.
- D. Operators to have standoff for thickness of insulation.
- E. Manufacturers
1. Greenheck
 2. Nailor Industries
 3. Ruskin Model
 4. United Enertech

2.06 DUCT ACCESS DOORS (A.D.)

- A. Furnish and install access doors at each fire damper, temperature control/motorized damper, upstream of duct mounted coils, and at air flow measuring stations. (Note: Not all access doors are depicted in the drawings.) Coordinate with wall access door locations needed for shafts with the General Contractor.
- B. Construction: double wall 24 gauge galvanized steel or aluminum (same construction as duct) with 1" fiberglass insulation, 1-1/2 lb./cu.ft. density between door and door liner.
- C. Polyurethane rubber or neoprene gasketing to be on inside of door frame and between duct and door frame. Door metals to be of sufficient gauge for minimizing leakage at various duct pressures. Provide continuous hinges and minimum of two handle type latches. Unhinged access panels are acceptable only where obstructions inhibit door swing.
- D. Access doors shall be 24" x 24" unless duct size is smaller. Access doors for ducts smaller than 24" shall be 2" less than duct size in length and 24" in width.
- E. Manufacturers
 - 1. Greenheck
 - 2. Ruskin
 - 3. United Enertech

2.07 ACCESS DOORS (FOR DUCT CLEANING)

- A. Fabricate and install access doors for internal duct cleaning, no further apart than 40 lineal feet of duct run, in accessible locations, and where shown on the drawings. Clearly mark all access door locations on the sheet metal fabrication drawings and the record drawings.
- B. Construction: double wall 24 gauge galvanized steel or aluminum (same construction as duct) with 1" fiberglass insulation, 1-1/2 lb./cu.ft. density between door and door liner.
- C. Polyurethane rubber or neoprene gasketing to be on inside of door frame and between duct and door frame. Door metals to be of sufficient gauge for minimizing leakage at various duct pressures. Doors shall be mounted with a duct collar and bolted.
- D. Access doors shall be 24" x 24" unless duct size is smaller. Access doors for ducts smaller than 24" shall be 2" less than duct size in length and 24" in width.
- E. Label these access doors: "ACCESS FOR CLEANING". A purchased glued-on label or stenciled paint may be used.

2.08 TEST HOLES

- A. Test holes shall be provided before and after coils, filters, mixing plenums and main duct traverse points.
- B. Manufacturer: Duro-Dyne Model TH-1 #8036. Note: Model number will vary for aluminum.

2.09 TURNING VANES

- A. Turning vanes (single vane) shall be utilized in low pressure duct with velocities less than 1500 FPM, constructed with 1" trailing edge and spaced as called for in Figures 2-3 and 2-4 of SMACNA HVAC Duct Construction Standards.
- B. Turning vanes (double vane airfoil profile) shall be utilized in ducts with velocities exceeding 1500 FPM, constructed with 1" trailing edge and spaced as called for in Figures 2-3 and 2-4 of SMACNA HVAC Duct Construction Standards
- C. Where shown on drawings, install vanes in short radius elbows as detailed in Figures 2-5 and 2-6 of SMACNA HVAC Duct Construction Standards.

PART 3 - EXECUTION NOT USED

END OF SECTION

SECTION 23 33 53 - DUCT LINING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide interior duct lining where specified herein and as shown on drawings.
- B. The following ductwork shall be internally lined:
 - 1. Other supply air ducts where symbolized on the drawings: 1" thick, 1.5 PCF density.
 - 2. All transfer air ducts: 1" thick, 1.5 PCF density

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Duct Insulation: Section 23 07 13
- C. HVAC Ducts and Casings: Section 23 31 00

1.03 REFERENCE MANUALS AND STANDARDS

- A. NFPA 90A and 90B
- B. ASTM C1071, Type 1
- C. ASTM G21 and G22
- D. SMACNA Application Standards for Duct Liners

1.04 SUBMITTALS

- A. Submit shop drawings of duct liner materials in accordance with Specifications Section 23 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 DUCT LINER

- A. Furnish and install fiberglass flexible duct liner of density and thickness scheduled in this section.
- B. Duct liner insulation shall be made of glass fibers bonded with a dark thermosetting resin.

- C. The air stream surface shall be protected with an acrylic surface coating formulated so it will not support the growth of fungus or bacteria, as determined by tests in accordance with ASTM C1071 and ASTM G21 and G22.
 - 1. The coating shall be able to resist damage from in-shop handling during fabrication and shipment to the job site.
 - 2. The coating shall be cleanable with commonly available cleaning equipment which follow procedures detailed in the North American Insulation Manufacturers Association (NAIMA) Duct Cleaning Guide.
 - 3. The coating shall be smooth to have minimum resistance to air flow.
- D. The liner thermal performance shall have a minimum R-value of 4.0 per inch thickness at a conductance 0.25 btu/(hr ft² °F). Temperature Limit: 250°F.
- E. The surface burning characteristics shall be as follows:
- F. Flame Spread: Not over 25
- G. Smoke Developed: Not over 50
- H. Sound Absorption Coefficients

Thickness	Frequency (cycles per second)						NRC
	125	250	500	1000	2000	4000	
1"	.09	.29	.67	.89	1.03	.99	.70

- I. Manufacturer: Manville Linacoustic with Permacote

2.02 MECHANICAL FASTENERS

- A. Duct liner fasteners shall consist of Type 2 welded pins with integral head or Type 3 welded pins with press-on head.
- B. Fasteners shall be of materials having a corrosion resistance capable of withstanding a 96-hour salt spray test per ASTM B-117.
- C. Fasteners shall be resistant to the effects of temperatures 250°F when tested as assembly in accordance with ASTM C-411.
- D. Retaining head or washer shall be sufficient in size to hold the liner firmly in place without tearing or cutting the liner.

PART 3 - EXECUTION

3.01 GENERAL

- A. The net free area of the duct dimensions given on the drawings shall be maintained. Increase duct dimensions to compensate for the liner thickness.

- B. Duct liner shall be adhered to the sheet metal with full coverage of an adhesive conforming to the Standard for Adhesives for duct liner of the Adhesive and Sealant Council, Inc.

3.02 LINER APPLICATIONS

- A. All portions of ducts designed to receive liner shall be completely covered. Liner shall be cut to assure tight, overlapped corner joints. Top pieces shall be supported by the side pieces.
- B. Liner shall be additionally secured with mechanical fasteners.
- C. Mechanical fasteners shall be spaced to not exceed 12" on center, both directions. Fasteners shall start at no less than 2" from liner edges.
- D. Mechanical Fasteners exposed to view through return, exhaust, supply or transfer grilles shall be painted flat black.
- E. All exposed leading edges and transverse joints shall be neatly butted without a gap. Coat all shop and field cuts, liberally, with the approved adhesive or edge seal.
- F. Duct work designed to exceed 2000 fpm duct velocity shall use metal nosings on every leading edge. Nosing may be formed on the duct or be a channel or zee attached by screws or welds.

3.03 MATERIAL HANDLING AND STORAGE

- A. Ducts with liners shall be kept clean and dry during transportation, site storage and staging, and during installation.
- B. Protect liner from exposure to the elements or damage by abuse.
- C. Protect installed open ducts to prevent moisture and dust from entering the system.

3.04 LINER APPLICATION RESTRICTIONS

- A. Do not install liner in ducts within six (6) feet of electric resistance duct coils.
- B. Do not install liner in ducts or plenums within six (6) feet of an outside/or relief air louver.

END OF SECTION

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SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install fans as scheduled on the drawings and specified herein.

1.02 DESIGN BASE

- A. The construction drawings indicate a system based on the information available to Engineer by a selected manufacturer of equipment. Electrical services, size, configuration and space allocations are consistent with that manufacturer's information.
- B. This manufacturer and other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the manufacturer for any different services, space, clearances, etc.

1.03 COORDINATION

- A. Provide coordination with the project Air Balance Contractor in the final balance of the fans.
- B. Fan Speed Adjustment: external resistance (static pressure loss) for each fan system has been estimated and noted on the drawings. Fan speed and fan to motor drive will be selected based on this estimated static pressure loss. The static pressure loss is an estimate; actual loss of completed system may vary above or below estimate. Mechanical Contractor shall change pulleys or sheaves, as required, to suit actual job conditions at no additional cost to the Owner. Refer to Specifications Section 23 05 93, Testing, Adjusting and Balancing, for other requirements.
- C. Should corrective work be required after the initial balance, the Contractor shall reimburse the Balancing Contractor for re-balancing. Refer to Specifications Section 23 05 93, Testing, Adjusting and Balancing.

1.04 SPARE PARTS

- A. Furnish a spare set of belts for each, belt driven, fan in the project. Store the belts, clearly marked, as to the fan served, in the respective nearest mechanical room to the fan.

1.05 QUALITY ASSURANCE

- A. Fans shall bear AMCA Certified Ratings Seal for both air and sound performance.

1.06 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Assignment of Misc. Work: Section 23 05 02
- C. Completion and Startup: Section 23 05 03
- D. Prefabricated Roof Curbs and Supports: Section 23 05 30
- E. Vibration & Seismic Controls for Piping and Equipment: Section 23 05 48
- F. Identification for Piping and Equipment: Section 23 05 53
- G. Painting: Section 23 05 64
- H. Sequence of Operations for Controls: Section 23 09 93
- I. Temperature Control Dampers: Section 23 09 13.43
- J. Variable Frequency Drives: Section 23 10 00
- K. Electrical: Division 26

1.07 SUBMITTALS

- A. Submit shop drawings for each fan to be furnished on this project in accordance with Specifications Section 23 05 01, General Provisions.
- B. Submittals shall include fan curve (graphic) for each fan with the design conditions plotted. (Tables are not acceptable). Forward a copy of each fan curve to the project Balancing Contractor.
- C. Submit installation instructions, parts lists and operation/maintenance data for each fan size and type.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL CEILING EXHAUST FAN

- A. Provide, where shown on the drawings, direct drive exhaust fan with an acoustically lined steel housing of the size and capacity shown on the schedule.
- B. Fans shall have a removable centrifugal blower with an automatic back-draft damper at the fan discharge. The damper shall have cushioned stops.
- C. Steel housing shall have adjustable mounting brackets and a white aluminum or plastic ceiling grille.
- D. Fan wheel, drive and motor shall be mounted on neoprene isolators.
- E. Direct drive fans shall have a unit mounted solid state speed controller.

- F. All motors shall be lifetime lubricated, thermally protected, and rated at 120 volt, 1 phase, 60 hertz.
- G. Furnish Amotorized damper@ and actuator, where called for on the drawings, operable with the fan start/stop.
- H. Manufacturers
 - 1. Greenheck
 - 2. Jenn-Air
 - 3. Loren Cook
 - 4. Penn Ventilator
 - 5. Twin City

2.02 PROPELLER WALL EXHAUST FAN

- A. Provide, where shown on the drawings, a completely assembled axial, belt driven, exhaust fan unit. Unit size and capacity shall be as scheduled on the drawings.
- B. Fan shall be propeller type and belt drive. Fan blades shall be die-formed steel or aluminum.
- C. Fan assembly shall be constructed of galvanized steel.
- D. Furnish a wall mounting collar, automatic back-draft damper and fan inlet guard.
- E. Furnish an UL approved safety disconnect switch.
- F. Motors shall be continuous heavy duty ball bearing type. Motors shall be installed on adjustable base.
- G. Manufacturers
 - 1. Greenheck Model SBP
 - 2. Jenn Air
 - 3. Loren Cook
 - 4. Penn Ventilator
 - 5. Twin City Fans

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Refer to drawings for location, size, capacity, mounting arrangement, and electrical characteristics for fans.

- B. All fans shall be installed, aligned, lubricated, started and balanced all in accordance with the manufacturer's published instructions.
- C. Maintain the cleanliness of the fans throughout the construction period, internally and externally. At completion, clean and restore the fans to new condition.
- D. Single speed motor starters shall be furnished by Electrical Contractor. Coordinate electrical characteristics with Electrical Contractor.
- E. Fans shall be installed with vibration isolators (where suspended from or supported on structure) and leveled.
- F. Provide a roof curb of the same manufacturer as the fan. Refer to Specifications Section 23 05 30, Prefabricated Curbs and Equipment Supports, for requirements.
- G. Install motorized dampers and actuators. Include all wiring, conduit and control from the fan starter.

3.02 STARTERS

- A. Provide starters for exhaust fans scheduled to be two-speed.
- B. Starters shall comply with requirements of Division 26 of the Specifications.

END OF SECTION

SECTION 23 34 24 - HIGH VOLUME LOW SPEED CEILING FANS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. The provisions of the General Conditions, Supplementary Conditions, Sections included under Division 1, General Requirements, and Division 23 are included as a part of this Section as though bound herein.

1.02 DESCRIPTION OF WORK:

- A. The Contractor shall furnish all the labor, materials, equipment, appliances, services and drayage, and perform all the operations in connection with the construction and installation of the Work. All Work to be as herein specified and as denoted on the accompanying Drawings.
- B. This Section of the Work includes the furnishing and installation of the following fans and hardware, etc., as herein specified and/or indicated in the Drawings, that results in a complete and workable system.
 - 1. High Volume Low Speed (HVLS) Fans

1.03 QUALITY ASSURANCE:

- A. Electrical Component Standard - Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. Installation shall comply with NFPA 13.
- C. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum five years documented experience.
- D. Installer Qualifications: Approved in writing by manufacturer with documented experience on at least five projects of similar nature in past five years.
- E. Equipment shall be listed by ETL or UL.

1.04 SUBMITTALS:

- A. General - Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
- B. Product Data - for selected models, including specialties, accessories, and the following:
 - 1. Air volume flow rates, air speed, and sound power ratings.
 - 2. Motor ratings and electrical characteristics plus motor and fan accessories.

3. Materials gauges and finishes, including color charts.
4. Motor controller and accessories description and features including electrical characteristics and associated wiring diagrams. Clearly show recommended BMS interconnection means of fire alarm shutdown of fan.
5. Shop Drawings: Submit drawings indicating fabrication and erection of fans including plans, elevations and large-scale details.
 - a. Show anchorage, critical installation clearances, connections, and accessory items.
 - b. Provide location template drawings for items supported or anchored to permanent construction.
6. Informational Submittals: Submit following:
 - a. Manufacturer's Installation Instructions.
 - b. Draft of manufacturer's warranty.
7. Closeout Submittals: Submit following in accordance with Division 1 sections:
 - a. Maintenance data.
 - b. Warranty: As specified elsewhere in this section.

PART 2 - PRODUCTS

2.01 HIGH VOLUME LOW SPEED (HVLS) FANS:

- A. Design Requirements: Provide high volume low speed fan capable of cooling personnel and/or circulating air within a building structure, which has been manufactured, fabricated, and installed to maintain performance criteria stated by manufacturer without defects or failure.
 1. Provide infinite speed control to maximum operating speed and reversing action.
 2. Physical characteristics and minimum performance as scheduled on Mechanical Schedules. Provide the same number of fans shown, of size performance needed to meet or exceed the scheduled design criteria of air velocity and radius from fan.
- B. Acceptable Model and Manufacturers: The following manufacturers are acceptable, contingent on providing fans having features and performance as specified herein and as scheduled:
 1. Altra Air by Envira-North Systems, Ltd.
 2. BAF: Model: 1(877)BIG-FANS
 3. 4Front Engineered Solutions – Kelley. Model: Fusion, KF16XL1006. (Contact Brandon Emmel, 972-814-1569)
 4. Z-Tech by Go Fan Yourself
 5. Macroair Airvolution
 6. Rite-Hite Model: Revolution (Basis of Design). 16-foot blade diameter.
www.ritehitefans.com
 7. RuppAir (Altra Air)

8. Serco (4Front Engineered Solutions)
 9. Big Ass Fans
- C. Performance as scheduled on Mechanical Schedules, count, location, and other requirements as shown on Mechanical floor plans.
- D. Fan Assembly:
1. Structural steel mounting frame, 1/4-inch diameter steel wire rope, 1/8-inch diameter steel wire rope (guy wires), structural steel blade links and structural steel hub support.
 2. Extruded or formed aluminum blades. Provide corrosion resistance coating, anodized finish acceptable.
 3. Support Frame: Welded A36 steel frame with powder coated finish.
 4. Gearbox: 2 stage helical, lifetime lubrication.
 5. Motor: Volts, Phase, Amps and HP as scheduled. NEMA Rating IP55.
 6. Controller:
 - a. Fused service disconnects (with lock-out/tag-out per OSHA)
 - b. UL/CE rated variable frequency drive (VFD)
 - c. Solid state overload protection per NEC
 - d. Enclosure rating: NEMA 4X
 - e. CE compliant integral control wiring and EMI/RFI connectors. Shielded motor cable / remote wire / input filter on the VFD.
 - f. Provide suitable amount of cable as needed for fan and remote-control station locations shown on the drawings.
- E. Remote Control Wall Mounted Switch.
1. NEMA 4/4X Fan speed control feature with infinite speed control from zero to maximum fan operating speed. Provide suitable amount of cable as needed for fan and remote-control station locations shown on the drawings.
 - a. Provide contactor/relay interface for remote control at BMS front end.
 - b. Provide contactor/relay for remote stop command from fire alarm system.
- F. Disconnect switch.
- G. Options:
1. Mounting plates and extension(s) as required for installation at locations shown.

PART 3 - EXECUTION

3.01 GENERAL:

- A. This Section is responsible for mounting units and coordinating with fire protection contractor as needed to ensure conformance with FM Global requirements.
- B. Check all units for proper performance, fan and/or motor rotation, and adjust as required.

3.02 INSTALLATION:

- A. Fan to be installed in accordance with manufacturer's installation requirements.
- B. Coordinate location and installation of the HVLS Fan with fire protection system components. This Section is responsible for mounting units and coordinating with fire protection contractors as needed to ensure conformance NFPA Standard 13 and with FM Global (Data Sheet 2-0) requirements.
 - 1. The vertical clearance from fan to sprinkler deflector shall be minimum of 36".
 - 2. Fan shall be approximately centered between four sprinkler heads.
- C. Ensure building structural members and means of attachment are sufficient to support the weight and operation of the fan. Installation per manufacturer's recommendations. Consult project professional engineer as required.
- D. All safety and support features must be installed. These include any guy wires and safety cables as well as blade locking features.
- E. Adjust unit as required for proper operation in accordance with manufacturer's installation instructions.

3.03 STARTUP:

- A. The manufacturer's factory approved representative shall be present for verification of proper installation at time of startup and shall assist in fan startup.
- B. Verify shut down of fans by fire alarm system.

3.04 INSTRUCTION OF OWNER'S PERSONNEL:

- A. Manufacturer's factory approved representative shall instruct Owner's personnel in operation and maintenance of installed units. Provide bound copy of manufacturer's operation and maintenance manual at time of instruction.
- B. Provide two hours of Owner Training. Schedule with Owner at least two weeks in advance.

3.05 WARRANTY

- A. Standard warranty: One-year parts and labor.
- B. Extended warranty:
 - 1. 3-year parts and 3-year labor warranty
 - 2. 10-year structural integrity warranty
 - 3. Lifetime warranty on workmanship of blades & hub.

END OF SECTION

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SECTION 23 35 10 – VEHICLE EXHAUST SYSTEM

PART 1 - GENERAL

1.01 RELATED SECTIONS:

- A. Drawings, general provisions of the Contract, including General and Supplementary Conditions, and Division-1 Specification Sections and Division 20 Specification Sections, apply to work of this Section.

1.02 WORK INCLUDED:

- A. This is a delegated design specification for a vehicle exhaust system, for the base and alternate bids. Circle Design Group provides this information for coordination purposes only. Electrical work and roof penetrations are not included, but coordination with the roofing contractor to install roof curb and equipment rails is included.
- B. Extent of work required by this Section is indicated on drawings and schedules, and by requirements of this Section. Products include, in part:
 - 1. Straight Rail System
 - 2. Exhaust fans with support frames, roof curb, equipment rails, backdraft damper and silencer
 - 3. System ductwork, fittings, adapters, and dampers
 - 4. Exhaust hose packs with magnetic grabbers
 - 5. Exhaust drops with suspension system
 - 6. Control system, including sensors, wireless receiver w/3 relays, remote transmitter, wiring, etc.
- C. Refer to Division 26 Sections for the following work; not work of this Section.
 - 1. Power supply wiring from power source to power connection on fan motor. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
 - 2. Interlock wiring between fans and field-installed control devices.
- D. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections:
 - 1. Control wiring between field-installed controls, indicating devices, and fan starters.
- E. Refer to Section 23 05 93 for testing, adjusting, and balancing work required in conjunction with centrifugal fans; not work of this Section.

1.03 QUALITY ASSURANCE:

- A. Submit manufacturer's technical product data for exhaust fans, including specifications, capacity ratings, fan performance curves with operating point clearly indicated; provide fan curves with specified operating point clearly plotted.
- B. Submit technical data for gauges and finishes of materials, dimensions, weights, accessories furnished, and installation instructions.
- C. Shop Drawings: Submit assembly-type shop drawings showing ductwork dimensions, construction details, and field connection details. Submit manufacturer's installation instructions.
- D. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- E. Maintenance Data: Submit maintenance instructions, including lubrication instructions, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 1.

1.04 OPERATION AND MAINTENANCE DATA:

- A. Submit operation and maintenance data.
- B. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver products to site, store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 - PRODUCTS:

2.01 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide all materials and labor necessary to furnish and install the components of the vehicle exhaust systems specified herein. All components shall be provided by a single source as a complete package to ensure the integrity of the system.
 - 1. Plymovent USA

2.02 COLLECTION DUCTWORK:

- A. Duct shall be galvanized spiral pipe with 3" through 7" diameter being 24 gauge and 8" and larger being 22 gauge.
- B. Elbows shall be a minimum of two gauges heavier than straight pipe of equal diameter. One-piece machine rolled elbows are acceptable provided the inside radius is sealed to prevent air leaks. Elbows exposed to the elements must be full weld type. All elbows through 12" diameter shall have a centerline radius of 1.5 times the pipe diameter. Elbows larger than 12" diameter shall have a centerline radius of 2.5 times the pipe diameter.
- C. All branch connection fittings shall be constructed so the branch enters the main at the large end of the fitting with the angle of entry not less than 30 degrees. Branch connection fittings which involve change of diameter shall have a minimum of 1" graduating increase in diameter per 8" in length. Diametrically opposed branch entries are not permitted.
- D. Reducers and increasers shall have a minimum of 1" graduating increase in diameter per 8" in length.

2.03 HAZARDOUS FUME EXHAUST FANS:

- A. Hazardous fume exhaust fans shall be licensed to bear the AMCA seal for certified performance in accordance with AMCA Standard 210. Fans shall be single inlet, single width, Arrangement 10 and shall have a backward inclined fan wheel with single thickness flat blades. Fan wheels shall be statically and dynamically balanced before assembly. Any required balance weights shall be welded to the outside of the shroud or back plate; no weights are to be installed in the blade air stream. All surfaces of the centrifugal fan shall be painted completely with an acid-resistant powder coating.
- B. The bearings shall be of the pillow block type with cast steel frame and shall be bolted to the structural angle bearing supports. The fan shaft shall be fabricated of ground and polished cold drawn steel with machined centers and key slots for both the fan wheel and the drive sheave. It shall be given a rust inhibitive asphaltic coating after assembly. The V-belt drive shall be adjustable. The variable pitch sheave shall be factory set at the appropriate position to provide the specified capacity in the approximate midpoint of the adjustment range. All fans shall be provided with a belt guard enclosing both sheaves and V-belts. The belt guard shall have a tachometer hole. All drives shall be rated for no less than 150% of motor load.
- C. The scroll and side sheets of the fan housing shall be fabricated of cold rolled steel of 12-gauge minimum thickness. The scroll and side sheets shall be joined through continuous welding. Spot welded or standing seam construction is not acceptable. The fan housing shall have a minimum of 8 attachment studs. Any bolts, self tapping screws or fasteners that protrude into the housing interior are not acceptable. The fan base shall be fabricated of cold rolled steel of 12-gauge minimum thickness. The bearing supports within the base shall be fabricated of cold rolled steel angles having a minimum 3/16" thickness and they shall be

welded to the sides of the base. All seams in the individual components shall be continuous welded. The motor base shall be fabricated of cold rolled steel of 12-gauge minimum thickness. Its position shall be adjustable through the use of bolts that travel in slots in the sides of the fan base. A non-hardening, high elasticity caulking shall be applied during assembly between the mating surfaces of the inlet cone and the fan housing and of the fan housing and the fan base.

- D. The assembled fan shall be test run before shipment with "total frequency" vibration measured at each bearing in both the vertical and horizontal planes. Any fan having an average reading of over 3 mils deflection is not acceptable. Balance report to be provided with installation and maintenance instructions.

2.04 EXHAUST FAN PLATFORM:

- A. Furnish fan platform as required to match specified fan. The platform shall include vibration rail base with suitable vibration isolation for weight load and distribution.
- B. Frame shall be of heavy duty, all welded construction using a minimum 2" x 3" x 3/16" angle iron frame and 3" x 4.1 lb. base channel for the vibration rails that shall be an integral part of the platform assembly.
- C. Fan accessories shall include a weather/dust cover, housing drain, and inlet tee with flex connection.

2.05 FLEXIBLE HOSE:

- A. The hose shall be a minimum of 6.3" diameter abrasion resistant type, constructed of a fire retardant heat resistant fabric utilizing a high tensile strength weave that is process-saturated with specially formulated polymeric resins and heat cured to withstand exhaust temperature up to 680°F.
- B. The hose wall shall be of two-ply, triple overlap construction and shall be complete with a bonded exterior scuff strip to provide additional abrasion resistance. The hose shall have an interior steel spring wire reinforcing spiral encased within the fabric laminations to prevent the collapsing of the tubing and to help retain its shape.
- C. Flange sets shall be provided for bolting to ductwork.

2.06 TELESCOPING DROP ASSEMBLIES:

- A. The telescoping hose assembly shall be complete with attachment flange set, impact deflector, storage canister, and two sections of heat resistant, crush-resistant hose, with a maximum extended length from duct connection to tailpipe adapter of 17 feet. TLC assembly to be flange connected to duct saddle or tee fitting via 6" diameter factory supplied matching flange.
- B. The exhaust adapter shall be molded of an advanced resin EPDM compound, creating a no-scratch fitting with a heat tolerance for normal automobile and light

truck testing. The oval adapter shall be suited to fit typical exhaust pipe configurations.

- C. The complete three section telescoping drop shall be assembled and tested at the factory to maintain the integrity of the equipment. Field assembly is not acceptable.

2.07 SUSPENSION SYSTEM:

- A. The flexible hose suspension system shall support the flexible hose from overhead when not in use, allowing it to be lowered to the operating level when required.
- B. The lifting device shall be a single spring retractor with ratchet stop and 1/4" steel suspension frame with cast eyelet and heavy-duty snap ring.
- C. The retractor shall be capable of lifting at least 15 pounds with 15' of travel.
- D. The hose sling shall be constructed of a powder coated steel lifting platform with high tensile safety clip, flexible tubular piping loops, and load handling eye bolts. It shall be manufactured to fit the diameter of the hose specified.

2.08 EXHAUST ADAPTERS:

- A. A magnet type exhaust adapter shall be used to keep the nozzle and hose assembly attached to the vehicle.
- B. The adapters and flanges are to match the hose diameter as indicated on plans and specifications and shall be attached to the hose at the factory to maintain the integrity of the assembly. Field assembly is not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install equipment level and plumb, in accordance with manufacturer's written instructions.
- B. Arrange installation of units to provide access space around units for service and maintenance.
- C. Duct and elbow joints shall be secured with a minimum of three self-tapping sheetmetal screws no longer than 5/8" or stainless-steel pop rivets and be positioned at 12, 4, and 8 o'clock.
- D. Seal all joints in the duct with either caulk or hardcast type of sealant. Duct tape is not acceptable.
- E. Support the ductwork sufficiently to place no load on the equipment connections. Maximum support spacing is 8 feet, otherwise, as required to prevent joint stress or unsafe conditions.

3.02 FIELD QUALITY CONTROL:

- A. Manufacturer's Field Inspection: Arrange and pay for a factory authorized service representative to perform the following:
 - 1. Inspect the field assembly of components and installation of collection equipment including ductwork, and electrical connections.
 - 2. Prepare a written report on the findings and recommended corrective actions.

3.03 COMMISSIONING:

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 - 1. Verify fan is secure on mountings and supporting devices, and that connections for ductwork and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 - 2. Verify fan wheel free rotation and smooth bearings operations.
 - 3. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

3.04 DEMONSTRATION:

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
 - 1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
- B. Schedule training with at least 7 days' advance notice.

END OF SECTION

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide diffusers and grilles as specified herein and as shown on the drawings.
- B. Each diffuser and grille type specified herein lists one or two manufacturers and associated model numbers of the required device and accessories. The following manufacturers are also acceptable if the product is equal to that specified:
 - 1. Nailor Industries
 - 2. Titus
 - 3. Price
- C. All diffuser and grille selections shall be based on a maximum NC value of 20 in any of the octave bands 2 thru 7 except where noted otherwise.
 - 1. Criteria shall be based on a room absorption of 10 dB, re 10-12 watts.
 - 2. Grilles shall be selected at the operating deflection noted in specification.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. HVAC Ducts and Casings: Section 23 31 00

1.03 SUBMITTALS

- A. Submit shop drawings on each type of grille and diffuser for approval per Specifications Section 23 05 01, General Provisions.
- B. Include manufacturers' sound power level ratings indicating compliance with acoustic criteria.
- C. Submittals and shop drawings shall include the following:
 - 1. Dimensions
 - 2. Materials of construction
 - 3. Finish
 - 4. Performance data
 - a. Throw and drop
 - b. Static-pressure drop
 - c. Noise ratings
 - 5. Accessories furnished
 - 6. Mounting details

- D. Submit a schedule of units which includes the following data for each unit:
 - a. Unit designation
 - b. Room location
 - c. Model number
 - d. Unit size
 - e. Accessories furnished
- E. Where specified herein, submit samples of diffusers, registers, and grilles of manufacturer's standard color and construction for review by the project Architect/Engineer.

PART 2 - PRODUCTS

2.01 ARCHITECTURAL CEILING DIFFUSER - D

- A. Capacity and neck size: as noted on the drawings
- B. Construction: steel face panel mounted to heavy gauge seamless backpan
- C. Finish: baked enamel
- D. Color: Color by Architect
- E. Face Panel:
 - 1. Smooth flat face free of visible fasteners, exposed edges hemmed.
 - 2. 18"x18" face panel on 24"x24" diffusers
 - 3. Panel shall be field removable.
- F. Neck: round
- G. Frame: Refer to Room Finish Schedule
 - 1. Lay-in for suspended T-bar ceilings
 - 2. Surface mount for drywall ceilings
- H. Manufacturers: Price Model SPD

2.02 EGG CRATE GRILLE - E

- A. Capacity and size: as noted on drawings
- B. Construction: aluminum
- C. Finish: baked enamel
- D. Color: Color by Architect
- E. Louvers: 1/2" x 1/2" x 1/2" aluminum grid

- F. Frame: aluminum with 1-1/4" framed border for surface mount on ceiling tile or drywall ceilings.
- G. Manufacturers: Price Model 80

2.03 SUPPLY GRILLE - F

- A. Capacity and size: as noted on the drawings
- B. Construction: steel
- C. Finish: baked enamel
- D. Color: Color by Architect
- E. Louvers: double deflection, 3/4" spacing, front louvers parallel to long dimension, individually adjustable.
- F. Frame: steel with 1-1/4" border
- G. Manufacturers: Price Model 520

2.04 RETURN GRILLE - G

- A. Capacity and size: as noted on the drawings
- B. Construction: steel
- C. Finish: baked enamel
- D. Color: Color by Architect
- E. Louvers: one set fixed louvers parallel to long dimension; louvers (at 35 degrees) 3/4" spacing
- F. Frame: steel with 1-1/4" border
- G. Manufacturers: Price Model 530

2.05 EXHAUST GRILLE - H

- A. Capacity and size: as noted on the drawings
- B. Construction: aluminum
- C. Finish: baked enamel
- D. Color: Color by Architect
- E. Frame: aluminum with 1-1/4" border
- F. Louvers: one set fixed louvers parallel to long dimension; louvers (at 35

degrees) 3/4" spacing.

- G. Manufacturers: Titus Model 530

2.06 TRANSFER GRILLE - J

- A. Capacity and size: as noted on the drawings
- B. Construction: steel
- C. Finish: baked enamel
- D. Color: Color by Architect
- E. Louvers: one set fixed louvers parallel to long dimension; louver (at 35 degrees) 2" spacing.
- F. Frame: steel with 1-1/4" border
- G. Manufacturers: Price Model 530

2.07 PLENUM SLOT DIFFUSER - K

- A. Capacity, length and number of slots: as noted on the drawings
- B. Construction
 - 1. Casing shall be constructed of minimum 24 gauge galvanized steel, with 1/4" thick, 2 lbs. density internal insulation (matt-coated). Casing shall include a round 1-1/8" inch inlet collar for duct connection.
 - 2. Diffuser shall be designed to mount directly on and integrate into 24"x24" with cross notch and 24" x 48" T-Bar grid ceiling systems.
 - 3. Individual pattern controllers with 180° adjustment of discharge direction with volume control, from the face of the diffuser.
- C. Finish: baked enamel
- D. Color: white on T-bars, black on pattern controllers, verify color with Architect.
- E. Slots: 1" wide
- F. Outside T-bars
- G. Manufacturer: Titus Model TBDI-80

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 23 37 50 - LOUVERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide weather louvers as shown on drawings and specified herein.
 - 1. 6" extruded aluminum louver for exterior use.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Assignments of Miscellaneous Work: Section 23 05 02

1.03 SUBMITTALS

- A. Submit shop drawings on each louver type to be used on this project per Specifications Section 23 05 01, General Provisions.
- B. Submit two (2) color charts to Engineer for selection.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Greenheck is specification basis. The following manufacturers are acceptable:
 - 1. Nailor Industries
 - 2. Ruskin
 - 3. United Enertech

2.02 6" EXTRUDED ALUMINUM LOUVER

- A. Furnish and install where indicated on the drawings extruded aluminum horizontal line louvers. Louvers shall be AMCA licensed.
- B. Frame and blades to be 6063-T5, extruded aluminum sections, minimum .080 inch thick with reinforcing members.
- C. Louvers to be supplied with anchorages. All blades to be supported and aligned with heavy gauge extruded aluminum blade braces, positively interlocked to each blade and mechanically secured to flangeless structural angles by aluminum and stainless steel fastenings.
- D. Blade angle shall be no less than 37.5 degrees, J-style.
- E. Structural supports to be designed to carry a wind load of not less than 140 mph.
- F. Allowance for expansion to be provided at jambs, sill and head.

- G. Louvers shall be furnished with 3/4" mesh, .051 inch wire intercrimp bird screen secured within a 12 B & S gauge extruded aluminum frame, independent of louvers. Screening shall be replaceable within extruded frames.
- H. All louvers shall be free of scratches and blemishes and shall be finished in a Kynar 500 coating in one of the manufacturer's full range of colors, including premium colors, as selected by the Architect.
- I. Manufacturers
 - 1. Greenheck ESD-635

PART 3 - EXECUTION

3.01 LOUVER INSTALLATION

- A. Louver installation by Contractor.
- B. Anchor louver to wall as recommended by louver manufacturer and as detailed on the drawings.
- C. Caulk the entire perimeter (inside and outside) of the louver, weathertight.
- D. Identify removable sections with posted instructions for removal (future equipment access).

END OF SECTION

SECTION 23 40 00 - HVAC AIR CLEANING DEVICES (FILTERS)

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide filters and filter gauges for air handling unit (s).
- B. System filter types as follows:
 - 1. Rigid high efficiency deep pleated air filters (MERV13)
 - 2. 2" medium efficiency disposable pre-filters (MERV8)

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Ducts and Casings: Section 23 31 00
- C. Dedicated Outdoor Air Units (Packaged): Section 23 74 13
- D. Packaged Heating and Cooling Units: Section 23 81 00

1.03 SUBMITTALS

- A. Submit shop drawings for each type filter in accordance with Specifications Section 23 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 RIGID HIGH EFFICIENCY DEEP PLEATED AIR FILTERS

- A. Filters shall be as follows:
 - 1. Filters shall be high performance, 12" deep pleated, totally rigid and totally disposable type. Filter shall consist of non-woven reinforced cotton fabric media, media support grid, contour stabilizers and enclosing frame.
 - 2. Media shall have anti-microbial coating.
 - 3. Held rigid in airstream by retainer device.
 - 4. Exhibit mean efficiency of MERV13 when tested in accordance with ASHRAE Standard 52-76.
 - 5. Have UL 900, Class II, approval.
- B. Furnish two (2) complete sets for each unit. Filters used during construction do not count as one of the complete sets.
- C. Manufacturers
 - 1. Airguard
 - 2. American Air Filter

3. Camfil
4. Farr Riga-Flo 100 and Type 8 Holding Frame
5. Flanders
6. Koch

2.02 MEDIUM EFFICIENCY DISPOSABLE PRE-FILTERS

- A. Filter shall be as follows:
 1. 2" pre-formed, collapsible and pleated of non-woven reinforced cotton fabric.
 2. Media shall have anti-microbial coating.
 3. Held rigid in airstream by retainer device.
 4. Exhibit mean efficiency of MERV8 when tested in accordance with ASHRAE Standard 52-68.
 5. Have UL 900, Class II, approval.
- B. Furnish three (3) complete sets for each unit. Filters used during construction do not count as one of the complete sets.
- C. Manufacturers
 1. Airguard
 2. American Air Filter
 3. Camfil
 4. Farr 30/30
 5. Flanders
 6. Koch

PART 3 - EXECUTION

3.01 INSTALLATION

- A. During construction period all systems shall be equipped with 2" thick MERV-8 disposable filters. Change filters throughout construction period as needed. The system shall never be operated during construction without filters installed.
- B. During balancing and through startup period, all filter housings shall be equipped with the permanent filters.
- C. At completion of balancing and startup, replace all permanent filters with new clean filters.
- D. Filters shall be contained in factory assembled housing furnished by packaged air handling unit manufacturer. Airtight polyurethane foam gasketing shall be furnished between filters and around plenum walls. Filter assemblies shall consist of holding frame and fasteners assembly, filter cartridge, mounting frame and PVC coated retainers.

3.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery

1. Inspect cartons and filters for damage when received at the job site.
2. Reject cartons with damaged corners, punctures, water damage or not stacked with up arrow in proper position. Cartons shall not be stacked higher than 6 feet.
3. Open cartons and inspect filter face for sagging pleats and separators, cracks, pinholes or breaks. Check gaskets for position and full adhesion to the frame. Use flood lamp during inspection.
4. Filters packed in sealed plastic bags shall not be opened during inspection unless the filter is obviously damaged.
5. Do not attempt to repair damaged filters at the job site.

B. Handling

1. Handle filters and cartons so pleats remain vertical. Arrow on carton indicates direction of pleats.
2. Handle filters in sealed cartons until installed.
3. Do not handle with chains, slings or hooks.
4. Do not drop or jar the carton or filter.
5. Do not lift filter from carton. Fold carton tops back and invert carton. Withdraw the carton from the filter.
6. Unpackaged filters shall be lifted only by the outer surface of cell frame.

C. Storage

1. Repack filter after inspection and seal carton.
2. Store cartons with pleats in a vertical position and in a dry, heated area.
3. Do not stack more than 6 feet high.

END OF SECTION

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SECTION 23 51 23 - FLUES AND VENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide an approved flue vent system of the type and classification as specified herein.
- B. System shall be installed in compliance with AGA and NFPA specifications for venting of equipment and/or appliances as specified for this project.
- C. System shall be capable of developing a positive flow to adequately exhaust all flue gases to outside atmosphere without condensation within the vent or spillage at any appliance draft hood.
- D. All fittings, elbows, connectors and flue pipe shall be UL listed.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Domestic Water Heaters: Section 22 34 00
- C. Gas Fired Heating Equipment: Section 23 55 33

1.03 SUBMITTALS

- A. Submit shop drawings for flue vent system per Specifications Section 23 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 CONDENSING TYPE FURNACE VENTS

- A. Combustion air intake shall be 100% outside air supplied through Schedule 40 PVC pipe routed to the roof or wall as shown on the drawings in strict accordance with the furnace or boiler manufacturer's instructions.
- B. The products of combustion shall be vented to the outdoors through Schedule 40 CPVC pipe routed to the roof or wall as shown on the drawings in strict accordance with the furnace or boiler manufacturer's instructions.
- C. Provide terminal plates suitable for terminating exhaust and intake pipes at through-the-wall installations.
- D. Combination intake and exhaust terminals may be used in lieu of individual pipes in thru-wall.

2.02 HIGH EFFICIENCY WATER HEATERS

- A. Combustion air intake shall be 100% outside air supplied through Schedule 40 PVC pipe routed as shown on the drawings in strict accordance with the water heater manufacturer's instructions. Use CPVC when routing in return air plenums or shafts.
- B. The products of combustion shall be vented through Schedule 40 CPVC pipe routed as shown on the drawings in strict accordance with the water heater manufacturer's instructions. Manufacturer's approval to use PVC pipe for vent is hereby superseded.

PART 3 - EXECUTION

3.01 GENERAL

- A. All portions of gas vents shall be adequately supported for the design and weight of the materials employed. Listed vents shall be supported and spaced in accordance with their listings and manufacturer's instructions.
- B. Terminate flue vent through roof with an AGA/UL approved roof flashing assembly.
- C. Install rain cap on vent.
- D. Install flue vent condensate drain assembly. Pipe to nearest floor drain.
- E. Flue vent shall extend to a minimum of six feet above the roof surface and at least two feet higher than any duct, object or portion of the building roof within a horizontal distance of ten feet.

3.02 INSTALLATION OF CONDENSING FURNACE VENT PIPING

- A. Both air supply and exhaust vents must be routed as directly as possible with minimum number of elbows/fittings.
- B. Both air intake and exhaust vents shall be sloped toward the unit with a pitch of at least 1/4" or more per foot.
- C. On horizontal runs, the vents shall be supported to prevent possible sagging that can result in a condensate trap. The maximum spacing between vent supports shall not exceed five feet. For long horizontal runs, continuous support, closer spacing of supports or increased pitch of the piping run shall be employed to avoid traps.
- D. In supporting vents when routing through a ceiling or wall, use vibration eliminating hangers or rubber sleeves around piping to prevent transmission of pulsations. Do not allow rigid connections between vents and structural members.
- E. Carefully prepare and cement all plastic pipe and fittings together. Use proper

solvent cementing techniques. Remove all burrs and shavings from the ends of cut pipe to cementing.

- F. At transitions from horizontal to vertical vents, sufficient support shall be provided to prevent sagging at the end of the horizontal run and support the weight of the vertical riser.
- G. When installing air/supply exhaust piping through an outside wall:
 - 1. Select locations where prevailing air currents allow for dissipating and removal of flue products.
 - 2. Do not vent into narrow alleyways, at mechanical equipment, in alcoves, at windows, through shrubbery or in any window well.
 - 3. The vent terminals shall be located at least 12" from any opening in the building and the bottom of the terminal must be at least 12" above grade.
 - 4. The air supply inlet and exhaust outlet on the outside of the structure shall be separated vertically from 18" minimum to 8' maximum on the same wall. The exhaust outlet shall be installed above the air supply inlet. Utilize 12" CPVC extensions on exhaust outlet to prevent exhaust re-circulation.

3.03 INSTALLATION OF WATER HEATER VENT PIPING

- A. Both air supply and exhaust vents must be routed as directly as possible with minimum number of elbows/fittings.
- B. Both air intake and exhaust vents shall be sloped toward the water heater with a pitch of at least 1/4" or more per foot.
- C. On horizontal runs, the vents shall be supported to prevent possible sagging that can result in a condensate trap. The maximum spacing between vent supports shall not exceed four feet. For long horizontal runs, continuous support, closer spacing of supports or increased pitch of the piping run shall be employed to avoid traps.
- D. In supporting vents when routing through a ceiling or wall, use vibration eliminating hangers or rubber sleeves around piping to prevent transmission of vibration. Do not allow rigid connections between vents and structural members.
- E. Carefully prepare and cement all plastic pipe and fittings together. Use proper solvent cementing techniques. Remove all burrs and shavings from the ends of cut pipe to cementing.
- F. At transitions from horizontal to vertical vents, sufficient support shall be provided to prevent sagging at the end of the horizontal run and support the weight of the vertical riser.
- G. When installing air/supply exhaust piping through the exterior:
 - 1. Select terminations where prevailing air currents allow for dissipating and removal of flue products.

2. The air supply inlet and exhaust outlet on the outside of the structure shall be separated vertically from 18" minimum to 8' maximum. The exhaust outlet shall be installed above the air supply inlet. Utilize 12" extensions on exhaust outlet to prevent exhaust re-circulation.

END OF SECTION

SECTION 23 55 33 - GAS FIRED HEATING EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide material and labor to furnish and install gas fired heating equipment as scheduled on the drawings and specified herein.
- B. Equipment Includes:
 - 1. Gas fired infra-red heaters

1.02 DESIGN BASE

- A. The construction drawings indicate a system based on the information available to Engineer by a selected manufacturer of equipment. Electrical services, size, configuration and space allocations are consistent with that manufacturer's information.
- B. This manufacturer and other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the manufacturer for any different services, space, clearances, etc.

1.03 RELATED WORK

- A. General Provisions: Section 23 05 01
- B. Identification for Piping and Equipment: Section 23 05 53
- C. Testing, Adjusting and Balancing: Section 23 05 93
- D. Natural Gas Piping System: Section 22 70 16
- E. Flues and Vents: Section 23 51 23

1.04 COORDINATION

- A. Provide coordination with the project Air Balance Contractor in the final balance of the fans.
- B. Fan Speed Adjustments: external resistance (static pressure loss) for each fan system has been estimated and noted on the drawings. Fan speed and fan to motor drive will be selected based on this estimated static pressure loss. The static pressure loss is an estimate; actual loss of completed system may vary above or below estimate. Mechanical Contractor shall change pulleys or sheaves, as required, to suit actual job conditions at no additional cost to the Owner. Refer to Specification Section 23 05 93, Testing, Adjusting and

Balancing, for other requirements.

- C. Should corrective work be required after the initial balance, the Mechanical Contractor shall reimburse the Balancing Contractor for rebalancing. Refer to Specification Section 23 05 93.

1.05 SUBMITTALS

- A. Submit shop drawings in accordance with Specifications Section 23 05 01, General Provisions, including temperature control diagrams and component specifications.

PART 2 - PRODUCTS

2.01 GAS FIRED INFRARED HEATERS

- A. General: furnish and install non vented type gas fired infrared heaters of quantity and capacity as shown on the drawings.
- B. Infrared heaters shall be certified by AGA in accordance with ANSI Standard Z83.6 and approved for ductless operation with natural gas.
- C. Burner housing: housing shall be constructed of heat resistant stainless steel.
- D. The heater element shall consist of a high temperature ceramic grid behind an alloy mesh reverberatory screen. The ceramic grid shall be cushioned for shock resistance.
- E. The unit shall contain a polished aluminum reflector.
- F. Controls: control operation and components shall include a combination gas valve (Robert Shaw Model #7100DER or approved equal) with automatic gas ignition control (Model #SP715A or approved equal). Gas ignition shall incorporate a cycling pilot, lit by a spark igniter and monitored by a sensing probe and safety switch. Furnish a 120/24V control transformer.
- G. Manufacturers
 - 1. Enerco Model 8060 with control option DSP-5 control sequence
 - 2. Space-Ray Model NXS
 - 3. Or engineer-approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Suspended units shall be installed level (from side-to-side and end-to-end) from a suitable support from the structure and completely independent of the gas piping.
- B. Units shall be installed within clearances to combustibles as recommended by

manufacturers.

- C. All control device wiring and conduit shall be furnished and installed by the Mechanical Contractor.
- D. Remote mounted thermostat and vent switch shall be installed by Mechanical Contractor.
- E. Provide adequate signage posted in the area of use, which specifies the maximum allowable stacking height allowable to maintain clearance to combustibles. Utilize manufacturers' recommendation.

3.02 GENERAL - INFRARED HEATERS

- A. Units shall be installed level from suitable rigid structural support from the roof structure.

3.03 CLEANING

- A. Refer to drawings for location, size, capacity, mounting arrangement and electrical characteristics for fan coil units.
- B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials available from manufacturer.

END OF SECTION

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SECTION 23 74 13 - DEDICATED OUTDOOR AIR UNITS (PACKAGED)

PART 1 - GENERAL

1.01 RELATED WORK

- A. Vibration and Seismic Controls for Piping and Equipment: Section 23 05 48
- B. Duct Insulation: Section 23 07 13
- C. HVAC Air Cleaning Devices (Filters): Section 23 40 00
- D. Wiring Devices: Section 26 27 26

1.02 SECTION INCLUDES

- A. Packaged outdoor air unit.
- B. Dehumidification/Cooling.
- C. Heating.
- D. Electrical Ratings and Connections
- E. Unit Controls
- F. Powered Exhaust
- G. Execution

1.03 REFERENCES

- A. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration. (all)
- B. ANSI/ASHRAE/IESNA 90.1-2013 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.
- C. ANSI Z21.47/UL1995 - Unitary Air Conditioning Standard for safety requirements.
- D. ANSI/NFPA 70-1995 - National Electric Code. (all)
- E. International Fuel Gas Code (g/e)
- F. NFPA 90 A & B - Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems. (all)

1.04 SUBMITTALS

- A. Submit unit performance data including capacity, nominal and operating performance.

- B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.
- C. Submit drawings indicating overall dimensions as well as installation, operation and services clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
- D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.
- E. Drawings submitted for approval shall be accompanied by a copy of the purchase agreement between the Contractor and an authorized service representative of the manufacturer for check, test and start up and first year service.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory shipping covers in place until installation.
- C. Units to be secured via base rail tie-down locations.

1.06 WARRANTY

- A. Provide parts warranty extending either 12-months from date of unit start-up or a maximum of 18-months from unit ship date.
- B. Provide twenty-five year heat exchanger limited warranty from unit ship date.
- C. Extended parts and labor by manufacturer to be provided to the owner for a period up to 5 years.

1.07 REGULATORY REQUIREMENTS

- A. Unit shall conform to the appropriate standards listed in Section 103 as well as be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for compliance with the following applicable standards.
 - 1. Standard for Safety Heating and Cooling Equipment-Fourth Edition, UL 1995/CSA C22.2#236 Issue: 2011/10/14
 - 2. Standard for Gas Unit Heaters and Gas-Fired Duct Furnaces ANSI Z83.8-2013, CSA 2.6-2013, Third Edition – 2006 (indirect gas-fired/e)
 - 3. Standard for Non-Recirculating Direct Gas-Fired Industrial Air Heaters, ANSI Z83.4 / CSA 3.7 - Issued: 2013/03/01 Ed: 3
 - 4. In the event the unit is not approved by an NRTL for compliance with the appropriate standards, the manufacturer shall, at manufacturer's

expense, provide for a field certification and labeling of unit by an NRTL to the appropriate standards. Manufacturer shall, at manufacturer's cost, complete any and all modifications required by NRTL prior to certification and field labeling. Manufacturer shall include coverage of all modifications in unit warranty.

PART 2 - PRODUCTS

2.01 DEDICATED OUTDOOR AIR UNITS (PACKAGED)

A. SUMMARY

1. The contractor shall furnish and install packaged outdoor air unit(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. GENERAL UNIT DESCRIPTION

1. Unit(s) furnished and installed shall be packaged outdoor air unit(s) as scheduled on contract documents and described in these specifications. Unit(s) shall be designed for dehumidification, cooling and/or heating of 100% Outdoor Air. For dehumidification and cooling modes, the evaporator temperature shall be monitored, reported at unit controller. Compressor controls shall modulate capacity to maintain evaporator leaving set point. Hot Gas Bypass shall not be used to control compressor capacity. Compressor Hot Gas Reheat (HGRH) shall be factory installed. To prevent rehydration of evaporator condensate the reheat coil face shall be located a minimum of 6" downstream from the leaving face of the evaporator coil. Heating system shall include modulating controls. Compressor on-off only or primary heating on-off only controls shall not be acceptable control strategies.
2. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.
3. Unit discharge airflow configuration shall be:
 - a. Horizontal discharge through side of unit with vertical return

C. CABINET

1. Cabinet panels: 2" double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed.
2. Insulation: 2" polyisocyanurate foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness.
3. Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Cabinet base pan shall be insulated with 2" thick polyisocyanurate foam. Foam insulation shall be fully enclosed with galvanized steel insulation cover. Insulation shall not be applied to underside of unit base.
4. Cabinet Base Rails: Side and end base rails shall include openings for

- forklift and tie-down access. To protect unit base from fork damage side rails shall include removable heavy gauge fork pockets.
5. Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping.
 6. Cabinet material interior and base rails: shall be G-90 zinc-coated galvanized steel. Material gauge shall be a minimum of 14-gauge for base rails, 16-gauge for structural members and 20-gauge for access doors and cabinet panels.
 7. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with both exterior and interior surfaces cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Unit's surface shall be in compliance with ASTM B45 salt spray testing at a minimum of 672 hour duration.
 8. Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service.
 9. Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.
 10. Hinged Access Panels: Water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, optional ERV and power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Insulated doors shall be constructed to allow the hinges to be reversed in the field.
 - a. Hold-open devices shall be factory installed on all hinged access doors. Chains shall not be used as hold-open devices.
 - b. Latches with locking hasps or tool operated closure devices shall be factory installed on all hinged access panels.
 11. Drain Pan material shall be Type 430 Stainless steel drain and constructed to sloped in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2". Base of drain pan shall be insulated with 1" thick foam insulation.
 12. Provide openings either on side of unit or thru the base for power, control and gas connections.
 13. Cabinet shall include optional interior liner constructed of Type 304 stainless steel with sealed seams.
 14. Air inlet hood shall be factory installed and shall not require field assembly. Hood shall include 2" thick removable aluminum mesh mist eliminators sized for a velocity not to exceed 500 FPM at maximum unit rated airflow. Service access shall be hinged and held in place with thumb latches that shall not require tools for service access.
 15. Unit shall be equipped with a 6" filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.

D. AIR FILTERS

1. Unit inlet hood shall include 2" thick aluminum mesh removable mist eliminators with hinged access cover. Inlet velocity shall not exceed 500

FPM.

2. Evaporator Inlet shall include a full complement of pleated media air filters. Filters shall be:
 - a. 6" deep combination of 2.0" MERV 8 and 4.0" MERV13

E. DAMPERS

1. Unit shall include a motor operated outdoor air damper constructed of galvanized steel.
2. Damper blades shall be air foil design with rubber edge seals designed not to exceed a 4 CFM/SQ FT leakage rate exceeding ASHRAE 90.1 damper leakage requirements.
3. Damper actuator shall be factory mounted and wired sealed spring return and either two-position or fully modulating.
4. Dampers air velocity shall not exceed 2000 fpm.
5. Return Air damper shall be of same material, construction and leakage rate as outdoor air damper. Return air damper actuator shall be factory mounted and wired sealed spring fully modulating and operate based on outdoor air damper feedback signal to properly regulate RA airflow.

F. DEHUMIDIFICATION/COOLING

1. Compressors
 - a. All units shall have direct-drive, scroll type compressors.
 - b. Digital Scroll Compressor
 - c. Circuit One and Circuit Two
 - d. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage.
 - e. Internal overloads shall be provided with the scroll compressors.
 - f. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
 - g. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.
 - h. Provide each unit with hermetically sealed refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve.
 - i. Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.
2. Coils
 - a. Evaporator, Condenser and Hot Gas Reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins.
 - b. Coils shall be factory leak tested in accordance with ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG.
 - c. The condenser coil shall have a fin designed for ease of cleaning.
 - d. Evaporator coil shall include (six / four) rows of cooling interlaced

for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning.

- e. Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature.
- f. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated by a minimum of six inches.
- g. The unit(s) must comply per above - spray coatings not acceptable
- h. Condenser coil hail guards shall be factory installed.
- i. OPTIONAL UVC Emitters/Lamps: Ultraviolet light (C band) emitters/lamps shall be incorporated downstream of evaporator coils, upstream of hot gas reheat coils, and above all drain pans to control airborne and surface microbial growth and transfer. Applied fixtures must be specifically manufactured for this purpose. Safety interlocks/features shall be provided to limit hazard to operating staff.

3. CONDENSER SECTION

- a. Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets.
- b. Fans shall be statically and dynamically balanced.

4. COMPRESSOR CAPACITY CONTROL

- a. Electronic Control: Requires Digital Scroll Compressor be selected in compressor section of this specification. Compressor output capacity shall be controlled by the Main Control Module. (refer to unit control and sequence sections of this specification)

G. HEATING

1. Modulating Indirect Gas Fired Heating System

- a. Completely assembled and factory installed heating system shall be located in the primary heating position located beneath the indoor fan assembly and be integral to unit and approved for use downstream from refrigerant cooling coils in units mounted outdoors. Threaded gas connection shall terminate at manual shut-off valve. Provide capability for sidewall or thru-base gas piping.
- b. Heaters shall include high turn-down burners firing into individual stainless steel tubular heat exchangers. Heat exchangers shall be constructed of type 439 stainless steel and be of a high efficiency dimpled tubular design capable of draining internal condensate. Units with multiple heaters shall include one fully modulating high turndown heater with additional on-off heater sections. Total heater turndown shall be 10:1 when minimum.
- c. Heater outdoor air inlet shall be hooded and include internal baffle system to prevent rain blow thru. To prevent recirculation of flue

- gas and to prevent flue gas condensate from draining onto and obstructing the heater air inlet the inlet shall be hooded and shall be located a minimum of 11" beneath the flue outlet. Inlet hood shall include bird screen.
- d. Heater flue outlet(s) shall include hooded outlet with wire cloth all constructed of Type 430 stainless steel. Hooded outlet shall be sealed to prevent flue gas recirculation.
 - e. Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, continuous air proving monitoring following ignition and continuous electronic flame supervision.
 - f. Unit controls shall monitor heat output and shall discontinue all heating attempts and or unit operation in the event the heating section fails to ignite or fails to maintain programmed supply air temperature/time.
 - g. Inducer fan shall be direct drive high pressure centrifugal type with two speeds and shall include built- in thermal overload protection.
 - h. Limit controls: High temperature automatic reset limits shall be located on blower wall and in indoor fan chamber to shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow, or loss of indoor airflow.
 - i. Flame roll-out safeties shall provide continuous monitoring of proper burner operation.

H. ELECTRICAL RATINGS AND CONNECTIONS

- 1. All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be listed as touch-safe design.
- 2. Field wiring access to be provided thru unit base into isolated enclosure with removable cover.
- 3. Power wiring to be single point connection.
- 4. Wiring internal to the unit shall be colored and numbered for identification.
- 5. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.
- 6. Factory wired main power disconnect and overcurrent device shall be rated for total unit connected power
- 7. Unit SCCR rating shall be a minimum of 65kA
- 8. Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically.
- 9. Phase Unbalance Protection: Factory set 2%
- 10. Over/Under/Brown Out Voltage Protection: +/-10% of nameplate voltage
- 11. Phase Loss/Reversal
- 12. Factory to mount and wire optional 120 volt convenience outlet. Field wiring of convenience outlet not acceptable.
- 13. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

I. UNIT CONTROLS

1. Main Unit Controller (MCM) shall be a microprocessor based controller with resident control logic. Controller program logic shall include
 - a. Include single program with field selectable
 - (1) Discharge Air control with unit conditioning modes enabled based on outdoor air conditions and controlled to maintain discharge air setpoints.
2. MCM shall:
 - a. Prevent simultaneous operation of any conditioning modes.
 - b. Accept separate setpoints for Occupied and Unoccupied states.
 - c. Call for Dehumidification based on dew point setpoints. When no call for Dehumidification is present MCM shall control calls for Cooling, Heating and Economizer modes based on sensible or enthalpy temperature setpoints. MCM shall have onboard clock and scheduling function for occupancy.
 - d. Include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - e. Enable HGRH dehumidification and cooling modes and control modulation to maintain (discharge air temperature / space temperature).
 - f. Unit shall include minimum discharge air control.
3. Optional MCM Touch Screen shall include full color display and shall be (factory installed in unit control compartment / field mounted remote from unit and field wired up to a maximum of 300 ft.) and provide a full list of points included in the MCM. The display shall provide a list and history of all unit alarms.
4. System Sensors shall include Factory installed and wired Outdoor Air Temperature, Outdoor Air Humidity and Evaporator Leaving Air Temperature and factory furnished, field installed Discharge Air Temperature.
 - a. Space Control or Single Zone VAV: Factory shall furnish Space Temperature and Space Humidity sensor for field installation and connection to the unit
 - b. Economizer Option includes Return Air Temperature and Humidity sensor
 - c. ERV Option includes exhaust air leaving temperature sensor
 - d. Powered Exhaust with Economizer includes duct pressure sensor to be field installed.
5. System controls shall include:
 - a. Anti-cycle timing.
 - b. Minimum compressor run/off-times.
6. Optional Smoke Detectors to sense (Return Air / Discharge Air / Return and Discharge Air) stream(s) shall be factory installed and wired.

J. APPROVED MANUFACTURERS

1. Trane: Horizon™ Model OAU (Packaged Outdoor Air Unit)

2. CaptiveAire
3. Greenheck
4. Daikin

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall verify that roof is ready to receive work and opening dimensions are as shown on drawings.
- B. Contractor shall verify that proper power supply is adequate to supply the unit.

3.02 INSTALLATION

- A. Contractor shall install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

3.03 MANUFACTURERS' FIELD SERVICES

- A. Unit start-up and commissioning shall be completed by a Factory-trained and factory-certified technician.
- B. Manufacturer must have twenty factory-authorized and factory-trained technicians within a 50 mile radius of job site.
- C. The contractor shall furnish manufacturer complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

END OF SECTION

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SECTION 23 81 11 - DUCTLESS SPLIT SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install equipment and accessories to provide complete
 - 1. DUCTLESS SPLIT SYSTEM

1.02 COORDINATION

- A. Provide coordination with the project Air Balance Contractor in final operational and performance testing.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Completion and Startup: Section 23 05 03
- C. Identification for Piping and Equipment: Section 23 05 53
- D. Testing, Adjusting and Balancing: Section 23 05 93
- E. Refrigerant Piping System: Section 23 23 00

1.04 SUBMITTALS

- A. Submit shop drawings on each unit specified herein in accordance with Specifications Section 23 05 01, General Provisions.

1.05 WARRANTY

- A. The units shall have a manufacturer's parts and defects warranty for a period five (5) year from date of installation. The compressor shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

1.06 DESIGN BASE AND COORDINATION

- A. The construction drawings indicate a system based on the information available to Engineer by a selected manufacturer of equipment. Electrical services, size, configuration and space allocations are consistent with that manufacturer's information.

- B. This manufacturer and other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the manufacturer for any different services, space, clearances, etc.

PART 2 - PRODUCTS

2.01 DUCTLESS SPLIT SYSTEM

- A. System Description: The system shall consist of a horizontal discharge, single phase outdoor unit, a matched capacity indoor section and shall be equipped with a wall mounted controller.
- B. Outdoor Unit
1. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.
 2. The outdoor unit shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
 3. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
 4. Outdoor unit sound level shall not exceed 51 DB.
 5. Cabinet
 - a. The casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.
 - b. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability.
 - c. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
 - d. Cabinet mounting and construction shall be sufficient to withstand 155 MPH wind speed conditions.
 6. Fan
 - a. The outdoor unit shall be furnished with AC fan motor(s).
 - b. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.
 - c. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent external contact with moving parts.
 7. Condenser Coil
 - a. The condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.

- b. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be control by a microprocessor controlled step motor,
- c. All refrigerant lines shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated with flexible, closed-cell, CFC-free elastomeric material with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and fire ratings of Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50.

8. Compressor

- a. The compressor shall be a Scroll compressor with Variable Speed Inverter Drive Technology.
- b. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings.
- c. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
- d. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

9. Electrical

- a. The electrical power of the unit shall be as scheduled on drawings.
- b. Power for the indoor unit shall be supplied from the outdoor unit.
- c. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC.
- d. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

C. Wall Mounted Indoor Unit

- 1. General: the indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit, in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

2. Unit Cabinet: The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. The unit shall be wall mounted by means of a factory supplied, pre-drilled, mounting plate.
3. The indoor unit fan shall be high performance, double inlet, forward curve, direct drive fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of three (3) speeds: Low, Mid, and Hi and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature. Indoor unit sound level shall not exceed 49 DB (A) at high speed.
4. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower sound levels and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement.
5. Return air shall be filtered by means of an easily removable washable filter.
6. The evaporator coil shall be of nonferrous construction with pre-coated aluminum fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.
7. Electrical: The electrical power of the unit shall be as scheduled on drawing. The power to the indoor unit shall be supplied from the outdoor unit.
8. System Control: The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD). There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Cool /Auto /Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).

D. Cooling Only Wall Mounted Indoor Unit

1. General: The wall-mounted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

2. Unit Cabinet: The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. The unit shall be wall mounted by means of a factory supplied, pre-drilled, mounting plate.
3. The indoor unit fan shall be high performance, double inlet, forward curve, direct drive fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of three (3) speeds: Low, Mid, and Hi and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature. Indoor unit sound level shall not exceed 49 DB (A) at high speed.
4. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower sound levels and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement.
5. Return air shall be filtered by means of an easily removable washable filter.
6. The evaporator coil shall be of nonferrous construction with pre-coated aluminum fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. A drain pan level switch, designed to connect to the control board, shall be provided, if required, and installed in the condensate pan to prevent condensate from overflowing.
7. Electrical: The electrical power of the unit shall be as scheduled on drawing. The power to the indoor unit shall be supplied from the outdoor unit.
8. System Control: The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD). There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Cool /Auto /Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).

E. 4-way Ceiling Recessed Cassette Indoor Unit

1. General: The ceiling-recessed indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute

time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

2. Unit Cabinet:
 - a. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - b. Branch ducting shall be allowed from cabinet.
 - c. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
 - d. The grille vane angles shall be individually adjustable from a wired remote controller to customize the airflow pattern for the conditioned space
 - e. The grille shall allow the unit to be serviceable from the bottom, without the need for an access panel.
 - f. Where scheduled, provide a compact 22-7/16" wide x 22-7/16" deep cabinet, to fit within a standard 24" square suspended ceiling grid.
3. Fan:
 - a. The indoor fan shall be an assembly with a statically and dynamically balanced turbo fan direct driven by a single motor with permanently lubricated bearings.
 - b. The indoor unit shall include an AUTO fan setting capable of maximizing energy efficiency by adjusting the fan speed based on the difference between controller set-point and space temperature. The indoor fan shall be capable of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
 - c. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
 - d. The indoor unit fan logic must include multiple setting that can be changed to provide optimum airflow based on ceiling height and number of outlets used.
 - e. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
 - f. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.
 - g. Grille shall include a factory-installed "3D i-see" sensor, or equal, to work in conjunction with indoor unit control sequence to prevent unnecessary cooling or heating in unoccupied areas of the zone without decreasing comfort levels. Sensor must detect occupancy (not simply motion) and location of occupants by measuring size & temperature of objects within a 39' detecting diameter (based on 8.8ft mounting height) with 1,856 or more measuring points.
4. Return air shall be filtered by means of an easily removable washable filter. Multi-Function Casement accessory shall install between the unit and the ceiling and allow for additional filtered outside air intake. Filter

- shall be rated MERV 10 when tested in accordance with ANSI/ASHRAE 52.2 Standard Rated Class 2 under U.L. Standard 900.
5. The evaporator coil shall be of nonferrous construction with pre-coated aluminum fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. A drain pan level switch, designed to connect to the control board, shall be provided, if required, and installed in the condensate pan to prevent condensate from overflowing. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.
 6. Electrical: The electrical power of the unit shall be as scheduled on drawing. The power to the indoor unit shall be supplied from the outdoor unit.
 7. System Control:
 - a. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system.
 - b. The wired controller shall have a large multi-language DOT liquid crystal display (LCD). There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Cool /Auto /Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button.
 - c. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).
 - d. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in heat mode. Disabling compensation shall be possible for individual units to accommodate instances when compensation is not required.
 - e. A factory-installed drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur.

F. Manufacturers: Mitsubishi, or approved equal

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field assembled components and equipment installation, including connections, and to assist in field testing.
- B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label. All wiring shall be in accordance with the National Electrical Code (N.E.C.). The units shall be manufactured in a facility registered to ISO 9001 and ISO14001.

3.02 DELIVERY, HANDLING AND STORAGE

- A. Unit shall be stored and handled according to the manufacturer's recommendation.

3.03 INSTALLATION

- A. Install all piping, fittings, and insulation to meet manufacturer's requirements. Install units' level and plumb. Evaporator-fan components shall be installed using manufacturer's standard mounting devices securely fastened to building structure. Install and connect refrigerant tubing and fittings.
- B. Installer shall supply isolation ball valves for refrigerant isolation. Installer shall supply Isolation ball valves with Schrader connection for isolating refrigerant charge and evacuation at each connected air handling unit and condensing unit. Isolation ball valves, with Schrader connection, are required for instances of air handling unit isolation for troubleshooting, repair or replacement without affecting the remainder of the system.

3.04 START UP

- A. Engage manufacturer or factory-authorized service representative to perform startup service. Manufacturer shall provide on-site startup and commissioning assistance through job completion. Complete installation and startup check list according to manufacturer's written instructions.

3.05 DEMONSTRATION

- A. Engage manufacturer or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain individual units and complete system.

END OF SECTION

SECTION 23 82 20 – FURNACE, COIL, AND SPLIT SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install equipment and accessories to provide complete packaged heating and cooling systems as shown and scheduled on the drawings and herein specified.
- B. Air cooled split system includes:
 - 1. Gas fired furnace (upflow condensing) and DX cooling coil
 - 2. Outdoor DX condensing unit
 - 3. Indoor thermostat

1.02 DESIGN BASE

- A. The construction drawings indicate a system based on the information available to Engineer by a selected manufacturer of equipment. Electrical services, size, configuration and space allocations are consistent with that manufacturer's information.
- B. This manufacturer and other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the manufacturer for any different services, space, clearances, etc.

1.03 COORDINATION

- A. Provide coordination with the project Air Balance Contractor in the final balance of the fans.
- B. Fan Speed Adjustment: external resistance (static pressure loss) for each fan system has been estimated and noted on the drawings. Fan speed and fan to motor drive will be selected based on this estimated static pressure loss. The static pressure loss is an estimate; actual loss of completed system may vary above or below estimate based upon field ductwork installation.

1.04 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Completion and Startup: Section 23 05 03
- C. Identification for Piping and Equipment: Section 23 05 53
- D. Testing, Adjusting and Balancing: Section 23 05 93

1. Applicable only to systems which are not installed in residential units.

1.05 DEFINITIONS AND MINIMUM PERFORMANCE STANDARDS

- A. SEER (Seasonal Energy Efficiency Ratio): All equipment listed herein is required to have minimum SEER rating as specified and certified to ARI in accordance with ARI Standard 210.81.

1.06 SUBMITTALS

- A. Submit shop drawings for each piece of equipment specified herein in accordance with Specification Section 23 05 01, General Provisions.
- B. Submit installation instructions, parts lists and operating/ maintenance data. Submittals shall include noise data.

PART 2 - PRODUCTS

2.01 AIR COOLED, OUTDOOR CONDENSING UNITS

- A. General: Furnish and install outdoor pad mounted, air cooled, split system air-cooled condensing unit. Unit shall be completely factory assembled including hermetic compressor, refrigerant coil, condenser fan and motor, prewired and have a holding charge of refrigerant.
- B. Quality Assurance:
 1. Unit will be rated in accordance with the latest edition of AHRI Standard 240.
 2. Unit will be certified for capacity and efficiency and listed in the latest AHRI directory.
 3. Unit construction will comply with latest edition of ANSI/ ASHRAE and with NEC.
 4. Unit will be constructed in accordance with UL standards and will carry the UL label of approval. Unit will have C--UL approval.
 5. Unit cabinet will be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test.
 6. Air-cooled condenser coils are pressure tested and the outdoor unit is leak tested.
 7. Unit constructed in ISO9001 approved facility.
- C. Casings: panels shall be constructed of heavy gauge steel, cleaned, bonderized and coated with powder coat paint
- D. Air Cooled Split System unit with specified evaporator coil shall have minimum SEER of 13.0 at the scheduled conditions. Units will be used in a refrigeration circuit to match up to a packaged fan coil or coil unit.
- E. Compressor: hermetically sealed, high efficiency compressor with special lubrication system, bearing surfaces and motor insulation. Internal over current, over temperature and over pressure protection. Compressor shall be approved

for continuous operation down to 55°F in cooling mode. Compressor shall be mounted on rubber isolators.

- F. Refrigerant and Circuit: Complete factory operated charge of refrigerant in both indoor and outdoor coils. Refrigeration circuit components will include liquid line shutoff valve with sweat connections, vapor-line shutoff valve with sweat connections, system charge of Puron (R-410A) refrigerant, POE compressor oil, accumulator, and filter dryer.
- G. Condenser Coil: Aluminum fin surface mechanically bonded to copper tubing. Condenser coil shall be protected by a heavy duty grille.
- H. Condenser Fan: direct drive propeller fan configured for draw through vertical outdoor air flow. Condenser fan motors will be totally enclosed, 1 phase type with class B insulation and permanently lubricated bearings. Shafts will be corrosion resistant. Fan blades will be statically and dynamically balanced. Condenser fan openings will be equipped with steel wire safety guards.
- I. Unit Circuit Breaker: All single-phase outdoor units shall contain an internal unit circuit breaker. Provide complete internal wiring and unit mounted diagram.
- J. System Design Summary:
 - 1. Intended for outdoor installation with free air inlet and outlet. Outdoor fan external static pressure available is less than .01" wc.
 - 2. Minimum outdoor operating air temperature without low-ambient operation accessory is 55°F.
 - 3. Maximum outdoor operating air temperature for cooling mode is 125°F.
 - 4. For reliable operation, unit should be level in all horizontal planes.
 - 5. System manufacturer is responsible for refrigerant pipes sizing, when interconnecting refrigerant tube lengths greater than 80 ft and/or elevation differences between indoor and outdoor units greater than 20 ft.
 - 6. If any refrigerant tubing is buried, provide a 6 in. vertical rise to the valve connections at the unit. Refrigerant tubing lengths up to 36 in. may be buried without further consideration. Do not bury refrigerant lines longer than 36 in.
 - 7. Use only copper wire for electric connection at unit. Aluminum and clad aluminum are not acceptable for the type of connector provided.
 - 8. Do not apply capillary tube indoor coils to these units.
 - 9. Factory-supplied filter drier must be installed.

2.02 INDOOR FURNACES:

- A. General: Units shall be completely factory assembled, piped, wired and test fired. Units shall be AGA certified and shall conform to the latest ANSI standards. Unit shall be operational with natural gas.
- B. Casing: Casing shall be die formed, minimum 20-gauge galvanized steel and finished in baked enamel. The front panel shall be easily removable for service access to burner, controls and filter.

- C. Heat exchanger: Heat exchanger construction shall consist of a seam welded, 20-gauge aluminized steel tubes and 18-gauge aluminized steel header. The heat exchanger and draft hood assembly shall carry a non-pro-rated warranty to be free from defective material and workmanship for a period of ten (10) years from date of system startup.
- D. Sealed construction (direct vent) system: The combustion system shall utilize outdoor air introduced directly to the combustion chamber. The condensing heat exchanger extracted heat shall be lowered in temperature to allow use of vent pipe products suitable for low temperature air (below 115°F).
- E. Burners: Burners shall be die formed corrosion resistant aluminized steel with stainless steel port protectors. Port protectors shall prevent scale or foreign matter from obstructing the burner ports. Burners shall be individually removable for ease of inspection and servicing. Each burner shall be provided with an individually adjustable, manually rotated air shutter adjustment.
- F. Fans: Fans shall be centrifugal type. Fan shall be statically and dynamically balanced. Provide rubber-in-shear isolators between fan/motor assembly and the unit casing. Motors shall be 115V, 60 Hz, single phase, totally enclosed with built-in thermal overload protection. ECM fan motors.
- G. Refrigerant evaporator coil
 - 1. Coil assembled in an "A" configuration with aluminum fins machined to copper tubes.
 - 2. See plans for scheduled capacities.
 - 3. Drain pan shall be constructed of heavy gauge galvanized steel with drain connection.
 - 4. Expansion valve shall be rapid equalizing type, like Sporlan #RPB.
- H. Filters: Furnish three sets of 1" throwaway type filters.
- I. Flues and Intake Vents: Per manufacturer's instructions and per spec section 23 51 23.
- J. Controls
 - 1. A factory installed junction box shall be provided for all power connections.
 - 2. Units shall be provided with a 24-volt combination single or dual stage automatic gas valve (see schedule), including main operating valve and pilot safety shutoff, pressure regulator, filter, manual main and pilot shutoff valve and adjustable pilot valve. Gas valve shall be suitable for a maximum inlet pressure of 0.5 psi (14-inch W.C.) on natural gas.
 - 3. A 24-volt control transformer, high limit, fan time delay relay and pressure differential switch shall be provided. The fan time delay relay shall delay the fan start until the heat exchanger reaches a predetermined temperature. It should also allow the fan to operate after the burner shutdown, removing residual heat from the heat exchanger.
 - 4. Intermittent pilot ignition control: Solid state ignition control system shall ignite the pilot by spark during each cycle of operation. When pilot flame

is proven, the main burner valve shall open to allow gas flow to burners. Pilot and burners shall be extinguished during off cycle.

- K. Warranty: One (1) year entire unit. Four (4) additional years for compressor and controls.
- L. Manufacturers:
 - 1. Bryant/Carrier/Payne
 - 2. Trane/American Standard
 - 3. Lennox/Armstrong Air
 - 4. Goodman/Daikin

2.03 THERMOSTATS:

- A. Thermostat: Provide a programmable electronic night setback type thermostat with and light fan auto-on switch and automatic changeover cooling/two stage heating. Night setback control to contain all components necessary to provide a completely automatic means of providing heating mode setback and cooling mode setup. Automatic temperature setback/setup shall be adjustable in both time and duration.
- B. Control wiring between air cooled condensing units and respective fan coil units shall be provided by Mechanical Contractor.
- C. Manufacturer: Honeywell or the approved equipment manufacturer's unit thermostat.

PART 3 - EXECUTION

3.01 HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units on site from damage. Leave factory shipping covers in place until installation.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate installation with all other trades to affect routing of conduit, piping, ductwork, etc. away from access to filters, coils and fan assembly.
- C. Protect unit openings with covers and filter media during balance of construction.
- D. Install filters for construction period, then change to clean for balancing. Install new final filters at project completion.

3.03 CONDENSING UNIT ANCHORAGE

- A. All units shall be mounted level.
- B. For grade mounted units, anchor all condensing units' concrete pad, in a manner to deter theft.
- C. For roof mounted units, anchor all condensing units to support curbs or timbers to prevent overturn from wind.

3.04 CLEANING

- A. Maintain a protected unit from construction atmosphere and debris, throughout the entire construction period.
- B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials available from manufacturer.

3.05 CONTROLS

- A. Install all controls furnished by the unit manufacturer, and as required for a complete control installation.

END OF SECTION

SECTION 23 83 40 - ELECTRIC TERMINAL HEATING UNITS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install material, labor and accessories required for the following pieces of equipment as shown on the drawings and specified herein.
 - 1. Propeller unit heaters
 - 2. Architectural wall heaters
 - 3. Ceiling mount heater

1.02 DESIGN BASE

- A. The construction drawings indicate a system based on the information available to Engineer by a selected manufacturer of equipment. Electrical services, size, configuration and space allocations are consistent with that manufacturer's information.
- B. This manufacturer and other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the manufacturer for any different services, space, clearances, etc.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 23 05 01
- B. Completion and Startup: Section 23 05 03

1.04 SUBMITTALS

- A. Submit shop drawings on each piece of equipment specified herein per Specification Section 23 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 PROPELLER UNIT HEATERS

- A. Unit heater capacity, motor size, rpm and mounting type shall be as shown and scheduled on the drawings. Units shall be UL labeled.
- B. Casings shall be constructed of heavy gauge steel fitted with threaded hanger rod connections, and painted with finished enamel at factory, in a standard color.
- C. Propeller fans shall be statically and dynamically balanced and vibration free. Fan blades shall be of heavy gauge construction.

- D. Fan motors shall be mounted in rubber to prevent vibration transfer. Motors located within the airstream shall be totally enclosed. Open motors may only be used where protected from the airstream.
- E. Horizontal throw unit heaters shall have adjustable discharge louvers.
- F. Coils: replaceable steel finned metal sheath electric heating elements. Elements to be enclosed, non-glowing type. Unit to be UL labeled. Voltage shall be as scheduled on the drawings.
- G. Control: unit shall be factory wired with built-in power disconnect switch, control circuit transformer, contactors, automatic reset thermal cut-out and integral thermostat. All control knobs and adjustable devices to be concealed. Heater wiring diagram shall be permanently attached to unit.
- H. Manufacturers
 - 1. Markel
 - 2. Qmark
 - 3. Trane

2.02 ARCHITECTURAL WALL HEATERS

- A. General: unit to consist of steel cabinet, totally enclosed permanently lubricated motor and electric heating elements.
- B. Cabinet shall be heavy gauge steel housing with aluminum trim and shall have baked enamel finish. Unit to have removable front and heavy duty 16 gauge steel bar grilles. Finish shall be as directed by the Architect.
- C. Coils: steel finned metal sheath electric heating elements. Elements to be enclosed, non-glowing type. Unit to be UL labeled. Voltage to be as scheduled on the drawings.
- D. Control: unit to factory wired with built-in power disconnect switch, contactors, automatic reset thermal cut-out and integral thermostat. All control knobs and adjustable devices to be concealed.
- E. Mounting: recessed type cabinet approximately 15" wide x 20" high with overlapping type front cover projecting a maximum of 2" from wall surface.
- F. Manufacturers:
 - 1. Q-Mark
 - 2. Markel
 - 3. Trane

2.03 CEILING MOUNTED HEATER

- A. Capacity, size and cabinet arrangement shall be as hereinafter specified and as shown and scheduled on the drawings.

- B. The heating equipment shall include an electric, ceiling-mounted fan-forced air heater. Heater shall be UL listed. The heater shall be designed for surface, recess, or T-Bar mounting. The heaters shall be factory wired for single-phase operation and field convertible to three-phase operation by removing one jumper wire. The heaters should be factory wired for full wattage and field convertible to 75% or 50% wattage by the removal of one or two wires respectively. Cabinet types shall be as noted on the drawings or as described below.
- C. The heater section shall consist of a 20 gauge steel chassis on which are mounted the heating elements, fan motor and blade, fan control, thermal cutout, and 3-pole contactor. Heater section shall be completely prewired.
- D. The heating elements shall be guaranteed for five years and shall be of non-glowing design consisting of 80/20 NiCh resistance wire, enclosed in a steel sheath, to which steel plate fins are brazed. The elements shall cover the entire air intake area to ensure uniform heating of all discharged air.
- E. The fan motor shall be impedance protected, permanently lubricated, and with totally-enclosed rotor. Fan control shall be bi-metallic, snap-action type and shall activate the fan immediately and continue to operate the fan after the thermostat is satisfied and until all heated air has been discharged. Thermal cutout shall be bi-metallic snap-action type designed to automatically shut off the heater in the event of overheating and reactivate the heater when temperature returns to normal.
- F. Thermostat, disconnect switch, and all interlock relays shall be installed within the heater enclosure. Optional remote SPST thermostat shall be installed as noted on drawing.
- G. The back box shall be designed for duty as a recessed rough-in box in masonry, T-Bar, or frame ceiling construction. The back box shall be 20 gauge galvanized steel and shall contain knockouts through which field wiring leads are brought. Enclosures to recess into a maximum 7 inches of ceiling space. The louvered recess faceplate shall be of 20 gauge cold rolled steel, phosphatized, then electrostatically painted to one of the standard colors by a baked enamel process.
- H. The surface mounting plate shall be designed for duty as a rough-in box on masonry, T-Bar, or frame ceiling construction. The surface mounting plate shall be 20 gauge galvanized steel and shall contain knockouts through which field wiring leads are brought. Enclosure to extend a maximum of 6 inches into the heated space. The louvered surface wrapper shall be contoured aluminum extrusion and 20 gauge sheet metal combination with rounded corners. The surface wrapper shall be electrostatically painted to one of the standard colors by a baked enamel process.
- I. Manufacturers:
 - 1. Markel
 - 2. Qmark
 - 3. Trane

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Electric heaters shall be installed in accordance with manufacturers' instructions and wired in accordance with the National Electric Code (NEC).
- B. Coordinate location with trade constructing wall to ensure proper location and mounting. Cabinet heaters and architectural wall heaters when installed in entry vestibules shall be centered on the wall horizontally.

3.02 STARTUP

- A. At initial and subsequent startups, the duct and heater shall be cleaned of all trash and dirt or dust. Assure design airflow is obtained across the heater.

END OF SECTION

SECTION 26 05 01 - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. The requirements of the General Conditions, General Requirements, Special Conditions, Instructions to Bidders, Contract Documents and other information bound herewith form a part of and shall govern all work performed under these specifications.
- B. The accompanying electrical drawings are issued as part of this project manual. Any specifications requirements shown on the drawings are equally affective as if included herein. Any omissions of specification are not to be a basis for failure on the part of the Contractor, from installing electrical components required by the systems to operate in the intended manner.
- C. The drawings depict the systems' components and distribution method. Every attempt is made to complete the distribution; however discrepancies may develop in the process. The contractor, within reason, is required to prepare his bid and construction to develop complete and operable systems. (This includes obvious omitted conduit and wire to equipment and fixture connections). In the event of discrepancies in sizes from drawing to drawing, the contractor shall include the cost for the larger size.
- D. Should any work be called for on the drawings, specifications or in the codes, in such a manner that the Contractor cannot, in his judgment, comply with the requirements, then the Contractor shall bring the matter to the attention of the Engineer before proceeding with the work.
- E. The Contractor shall receive, unload, store, protect and install all electrical equipment whether supplied by the Contractor or by the other trades. Equipment furnished by others and received prior to the start of work by the Contractor will be unloaded and stored by others. During the progress of the work, the Contractor shall load and transport such material and equipment to the job site as required. The Contractor shall keep all stored materials clean and protected from the weather.
- F. The Contractor shall be responsible for complete assembly and wiring of all equipment which is purchased disassembled or disassembled for shipping purposes.
- G. Work includes the installation of equipment, conduit and wire and components for complete and operable systems.
- H. Should a coordination study be called for on the drawings, specifications or in the codes, the Contractor shall provide the coordination study and bear the cost to make required changes to the electrical systems to achieve coordination.

1.02 DEFINITIONS AND TERMS USED IN DIVISION 26 SPECIFICATIONS AND ELECTRICAL DRAWINGS

- A. The word "Owner" shall mean the party mentioned in the prime contract agreement, or any representative of his party duly authorized to act in his behalf in the execution of the work.
- B. The word "Construction Manager" shall mean the person, firm or corporation entering into a contract with the Owner to manage construction operations.
- C. The word "Contractor" shall mean the person, firm or corporation entering into a contract to construct and complete the work as specified herein.
- D. The word "Engineer" shall mean Circle Design Group and their representatives assigned to this project.
- E. The word "Architect" shall mean Studio Axis and their representative acting as the Owner's appointed agent.
- F. The words "Commissioning Agent or Engineer" shall mean the Owner's Agent and their representatives, hired to commission or verify performance of all or portions of the work included in the contract documents.
- G. The word "furnish" or "supply" shall mean to purchase and deliver to project site, ready for unloading, unpacking, assembly, installation and similar subsequent requirements.
- H. The word "install" shall mean operations at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar requirements.
- I. The word "provide" shall mean to furnish , install complete and testing and ready for intended use.

1.03 CODES, FEES AND MISCELLANEOUS COSTS

- A. All materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards and utility company regulations.
- B. In cases of difference between building codes, specifications, state laws, local ordinances, industry standards and utility company regulations and the Contract Documents, the most stringent shall govern. The Contractor shall promptly notify the Engineer in writing of any such differences.

- C. Non-Compliance: Should the 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 for correction of non-complying items.
- D. Applicable Codes and Standards shall include all state laws, local ordinances, utility company regulations and applicable requirements of following nationally accepted codes and standards. These requirements are to be considered as a minimum and are to be exceeded when so indicated on the drawings or herein specified.
 - 1. Governing Agencies
 - a. Fire Prevention and Building Safety Commission
 - b. Indiana Department of Health
 - 2. Applicable Codes
 - a. Indiana Building Code (IBC), 2014, consisting of:
 - (1) International Building Code, 2012
 - (2) Indiana Amendments
 - b. Indiana Electrical Code (IEC), 2009, consisting of:
 - (1) NFPA 70, National Electrical Code, 2008
 - (2) Indiana Amendments
 - c. Indiana Mechanical Code (IMC) 2014 consisting of:
 - (1) International Mechanical Code 2012
 - (2) Indiana Amendments
 - d. Indiana Plumbing Code (IPC), 2012 Edition consisting of
 - (1) International Plumbing Code, Second Printing
 - (2) Indiana Amendments
 - e. Indiana Energy Conservation Code (IECC) 2010, consisting of:
 - (1) American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. Standard 90.1, 2007 Edition
 - (2) Indiana Amendments
 - f. Indiana Fire Code (IFC), 2014, consisting of:
 - (1) International Fire Code, 2012
 - (2) Indiana Amendments
 - 3. Standards
 - a. ASTM: American Society of Testing Materials
 - b. ANSI: American National Standards Institute
 - c. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
 - d. NEC: National Electric Code
 - e. NECA: National Electrical Contractors Association
 - f. NEIS: National Electrical Installation Standards
 - g. NEMA: National Electrical Manufacturers Association
 - h. NFPA: National Fire Protection Association
 - i. OSHA: Occupational Safety and Health Act

- j. UL: Underwriters Laboratories
- k. ADAAG: Americans with Disabilities Act Accessibility Guidelines
- l. NFPA 101: Life Safety Code
- m. ASCE: American Standard Code for Information Exchange
- n. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. - 90.1 – 2013
- o. EIA: Electronic Industry Testing Standards
- p. FM: Factory Mutual
- q. IES: Illuminating Engineering Society of North America Tenth Edition Handbook and associated Recommended Practice documents

- E. The Contractor shall be responsible for obtaining all permits, payment of all fees, necessary drawings and arranging and paying for all inspections, tests, etc. which may be required by any governing authority or utility company in connection with the furnishing or installation of any of his work.

1.04 WORK AND WORKMANSHIP

- A. All materials and equipment shall be of the highest quality in every respect. All materials and equipment shall be new and of the latest design and free of defects.
- B. Workmanship shall be by skilled workmen of highest standard in strict accordance with all applicable manufacturers' printed specification (which, by reference, are made completely a part of these specifications as though herein repeated), performed under supervision of competent foremen at all times.
- C. The Owner has full power to condemn or reject any work, materials or equipment not in accordance with these specifications and construction drawings or are not in compliance with the manufacturers' specifications or drawings which were approved by the Owner or Engineer.
- D. 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 Engineer.
- E. Such decisions that the Owner or Engineer may make with respect to questions concerning the quality, fitness of materials, equipment and workmanship shall be binding upon the parties thereto.
- F. 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.

1.05 DEVIATIONS FROM DRAWINGS

- A. Electrical drawings show the intended arrangement of all equipment and appurtenances. They shall be followed as closely as actual building construction and work of other trades will permit.
- B. The Contractor shall investigate structural and finish conditions affecting his work and shall coordinate his work accordingly. Provide any such fittings, offsets and accessories which may be required by such conditions.
- C. The Contractor shall coordinate with other trades and provide any fittings, offsets and accessories required to obtain the coordinated installation, in addition adjustment shall be made for reasons to improve the installation or performance, etc., made upon receiving the approval of the Engineer. The Contractor shall document that adjustments have been coordinated with all parties concerned.

1.06 OCCUPATIONAL SAFETY AND HEALTH ACT

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

1.07 COORDINATION BETWEEN CONTRACTORS

- A. The Contractor and his Subcontractors shall study all drawings and specifications for this project so that complete coordination between trades will be affected. Special attention shall be given to points where conduits cross ducts, piping or telephone cables, where lights fit into ceilings and where conduits pass through walls and structural elements.
- B. It is the responsibility of the Contractor and his Subcontractors to leave necessary room for other trades. No extra compensation will be allowed to cover the cost of removing conduits, or equipment found encroaching on space required by others.
- C. The Contractor shall review the electrical requirements of the final equipment selections to ensure such items receive proper electrical services or connections.
- D. The Contractor shall provide complete information and cooperation to the other Contractors and trades pertaining to his work to accomplish coordination of the complete project.
- E. The Contractor shall coordinate with the General Contractor in providing the necessary sleeved openings, excavations, etc. Cutting and patching shall be held to a minimum.

- F. The Contractor and his Subcontractor shall be required to attend the periodic progress meetings to accomplish coordination with the Owner, Architect and Engineer.

1.08 MECHANICAL SYSTEMS STARTUP

- A. The Electrical Contractor shall attend pre-startup meetings and shall be present at each mechanical system startup.

1.09 INSPECTION

- A. At the appropriate intervals of the electrical installation, the Contractor shall inform the local and state authorities to arrange inspections of this work. Provide Certificates of Inspection when completed.

1.10 REPORTS AND FINAL SUBMISSIONS

- A. The Contractor shall submit, for attachment to the Substantial Completion Certificate, a letter certifying that the electrical system wiring is in accordance with the latest adopted edition of The National Electrical Code.
- B. Submit all other test reports, as hereinafter specified.

1.11 COORDINATION WITH COMMISSIONING

- A. The purpose of the commissioning process is to provide the Owner of the facility with a high level of assurance that the mechanical and electrical systems have been installed in the prescribed manner and operate within the performance guidelines set in the Construction Documents.
- B. Each trade contractor shall review the procedures in the specification sections and include the necessary cooperation and coordination.

PART 2 - PRODUCTS

2.01 PRODUCT AND MATERIAL APPROVAL

- A. When Manufacturer's model numbers are listed, they are for reference only and are not to be considered a basis of design. The model numbers listed are the best information made available to the designer by the manufacturer and not intended to supplant or be inclusive of the criteria defined in the specifications and drawings. The Contractor/Manufacturer shall review the complete construction documents to ensure the products proposed are appropriate and meet the system design criteria.
- B. The performance requirements listed in the specifications or shown on the drawings are the basis of design and will be the benchmark used for submittal review and approval as well as determining if work is accepted or rejected.

- C. A specification followed by one or more manufacturers is limited to those manufacturers. Names of other proposed manufacturers may be submitted for approval to the Engineer a minimum of ten (10) days prior to receiving bids. Approval will be granted only if issued by Addendum (no exceptions).
- D. A specification followed by one or more manufacturers and "or approved equal" is open to equal products or materials. However, the Contractor shall supply one of the listed manufacturers at no additional cost if Engineer determines substituted product unsatisfactory.
- E. Any substituted equipment offered for consideration shall be stated as a separate item with the bid. State any additive or deductive cost.
- F. If changes in conduit, wiring, equipment layout or electrical service are brought about by the use of equipment which is not compatible with the layout shown on the drawings, the Contractor shall include the cost of the necessary changes in his bid.

2.02 SUBCONTRACTORS AND MATERIAL LIST

- A. The Contractor shall submit, with his bid, a fully completed list of subcontractors, manufacturers and suppliers of each item listed. No substitutions will be allowed by the Contractor, after award of contract.
- B. Failure to submit a fully completed list within the stated time may be cause to reject the bid.
- C. Remove or copy the following list and attach it to the bid form.

2.03 LIST FOR ELECTRICAL CONTRACTOR

A. The Contractor

Sub-Contractors	Subcontractors and Materials
Fire Alarm Subcontractors	_____
Sound System Subcontractors	_____
Tele-Comm	_____
Trench/Backfill/Compact Subcontractors	_____
Testing Subcontractors	_____

B. Material and Suppliers List:

Section	Manufacturer	Supplier
26 05 26 Ground Rods	_____	_____
26 05 33 Sleeve assemblies	_____	_____
26 05 33 Conduit	_____	_____
26 05 33 Outlet and Junction Boxes	_____	_____
26 05 36 Cable Tray	_____	_____
26 24 16 Panelboards	_____	_____
26 24 15 Switchboards	_____	_____
26 27 17 Handholes	_____	_____
26 27 26 Wiring Devices	_____	_____
26 27 27 Floor Boxes	_____	_____
26 27 28 Fire Rated Poke-Thru	_____	_____
26 28 00 Overcurrent Protection	_____	_____
26 29 15 Motor Starters	_____	_____
26 29 00 Safety Switches	_____	_____
26 32 13.13 Diesel Engine Generator	_____	_____
26 36 23 Automatic Transfer Switch	_____	_____

C. Material and Suppliers List:

Section	Manufacturer	Supplier
26 43 13 Surge Prot Devices (TVSS)	_____	_____
26 51 00 Light Fixtures		
Type '_____' List all Types	_____	_____
26 56 00 Exterior Fixtures		
Type '_____' List all types	_____	_____
27 11 00 Communications Equipment		
Room fitting	_____	_____
27 15 10 Structure cabling	_____	_____
27 41 33 Master MATV	_____	_____
28 31 00 Fire Detection System	_____	_____
28 13 00 Physical Access	_____	_____
28 23 00 Video Surveillance	_____	_____

2.04 EQUIPMENT DELIVERY SCHEDULE

- A. Submit at Engineer's request a schedule listing equipment and materials for complete installation, quantity ordered, date of placing order and the promised delivery dates.
- B. Any and all probable delivery delays shall be identified at the pre-construction meeting.

2.05 SUBMITTALS

- A. The Contractor shall submit shop drawings, fabrication drawings, and specific product literature for all products specified and shown on the drawings.
- B. Approval of submittals does not relieve the Contractor of the responsibility for ordering proper quantities and miscellaneous appurtenances required for operation and/or installation of the respective material or equipment.
- C. The following general information is required with each submittal as applicable:
 - 1. Contractor's stamp, signature and data shall be affixed to the submittal with indication of his review and approval.
 - 2. The full manufacturer's model number of each item
 - 3. Identification of each item's performance, physical size and construction data.
 - 4. Identification of finishes. Furnish two (2) color chips for items requiring color/finish selections.
 - 5. Indicate any modifications made to manufacturer's standard design which are required by these specifications.
 - 6. Rough-in, foundation and support point dimensions.
 - 7. Complete wiring diagrams and connection identifications, specific to this project.
- D. When manufacturer's information contains multiple model numbers and capacities on the same data sheet, specific equipment to be provided shall be identified by highlighting or clouding relevant data or striking non-relevant data.
- E. Unit equipment designations from the plans and schedules (unit tags) shall be identified for each piece of equipment.
- F. In addition, submit any detailed or specific information as stated in the respective specification sections.

2.06 RECORD DRAWINGS

- A. The Contractor shall submit record drawings as stated in the General Conditions, and as specified herein.

- B. During construction, maintain a complete and legible set of drawings, at job site showing changes and deviations between actual construction and Engineer's drawings. Submit marked-up set to Engineer for review at each project meeting.
- C. Submit to Engineer for review at the 25%, 50%, 75% and 100% completion of the work a complete, accurate and neat set of mark-ups blue-line drawings showing the complete "record drawings" construction.
- D. This marked-up set shall be returned to the Contractor as many times as necessary in order to obtain desired results.

2.07 MAINTENANCE MANUALS

- A. The Electrical Contractor shall submit maintenance manuals as stated in the General Conditions and as described in further detail herein.
- B. Maintenance Manuals are to include all information relative to maintenance and operating instructions for all new electrical equipment including equipment furnished by Owner and installed by Electrical Contractor.
- C. Maintenance manuals shall be assembled in the following sections:
 - 1. Section 1
 - a. Title of project
 - b. Name and address of Owner, Contractor and Engineer
 - c. Completion date of project
 - 2. Section 2: Index of complete contents
 - 3. Section 3:
 - a. Listing of all equipment with model number, serial number.
 - b. Warranty of each piece of equipment with start and completion dates.
 - 4. Sections 4 thru ____ (as applicable for each piece of equipment)
 - a. Drawings or data sheets on each piece of equipment which was submitted for approval.
 - b. Installation instructions.
 - c. Operating instructions
 - d. Maintenance manuals and parts list
- D. Each section shall be separated by a pasteboard tabbed divider. Each section tab shall identify equipment by same name as listed in the index. Tabs shall extend outside of sheet size.
- E. All information shall be arranged in as many three-ring (3" D configuration) vinyl coated notebooks as necessary. Do not overload capacity of binder.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle equipment and components carefully to prevent damaging, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.
- B. Store equipment and components in clean dry place. Protect from weather, theft, dirt, fumes, water, construction debris and physical damage at all times.

3.02 UTILITY START-UPS

- A. Facilitate the startup of new utility services for this project and ensure the proper operation of utility metering for billing and energy management.

END OF SECTION

SECTION 26 05 02 - ASSIGNMENTS OF MISC. WORK

PART 1 - GENERAL

1.01 PAINTING

- A. Painting of exposed electrical system in public areas shall be by General Contractor.

1.02 WALL OPENINGS

- A. Wall openings for electrical work not noted on the Architectural or Structural drawings shall be arranged for and provided by the Electrical Contractor.
- B. Lintels for wall openings required by electrical work will be furnished and installed by the Contractor constructing the wall. Electrical Contractor is responsible for notifying that Contractor of locations and sizes of openings requiring lintels prior to wall construction. Openings not coordinated and provided shall be arranged for and provided by the Electrical Contractor.
- C. Final sizes and locations of electrical penetrations in walls are the responsibility of the Electrical Contractor.
- D. Provide approved fire stops for fire rated wall and floor openings.
- E. Common room walls with electrical outlets, shall include fire putty pads to maintain fire rating of wall.

1.03 ROOF AND FLOOR OPENINGS

- A. Roof and floor openings for electrical work shall be provided by Electrical Contractor. Miscellaneous framing required and cutting of openings, shall be furnished and installed by the contractors constructing the roof or floor structure. Electrical Contractor is responsible for notifying those Contractors of exact locations and sizes prior to construction of the framing. Openings not coordinated and provided shall be arranged and paid for by the Electrical Contractor.
- B. Final sizes and locations of electrical penetrations through the roof and floor structures are the responsibility of the Electrical Contractor requiring the opening.
- C. Roof curbs and supports for electrical penetrations shall be provided by the Electrical Contractor requiring same.
- D. Counterflashing shall be provided by the Electrical Contractor. Roof flashing shall be provided by the roofing contractor.
- E. All roofing work required on the existing building (openings, flashing, etc.) shall be performed by the Roofing Contractor maintaining the warranty.

- F. Provide fire retardant plywood sheets when roof areas are completed during operations for walkways and work areas. The Contractors working on the completed new roof shall be responsible for roof protection and assuring the warranty on the roof system is maintained.

1.04 WALL AND CEILING ACCESS PANELS

- A. Wall and ceiling access panels shall be furnished by the Electrical Contractor.
- B. Electrical Contractor is responsible for coordinating and assisting in locating all access panels, for installation by the General Contractor prior to his wall or ceiling construction. to obtain access to equipment, junction boxes, etc.
- C. Access panels shall be required for all controls or other components requiring periodic maintenance. Panels shall be located to be accessible without causing damage to final finishes. Coordinate items requiring access including with other trades so that the quantity of access panels is kept to a minimum.
- D. The panel locations shall also be coordinated with, and receive the approval of, the Architect and Engineer.

1.05 CUTTING AND PATCHING

- A. Cutting and patching of finished areas for electrical work shall be provided by the General Contractor. Electrical Subcontractors shall coordinate responsibility for cutting and patching with Electrical Contractor prior to bidding.
- B. Cutting and patching of finished areas shall be provided by the Contractor requiring same, however, the work shall be performed by the trade responsible for this type of work.
- C. Patched surfaces shall be finished to match existing unless the surface is scheduled for that type of work.

1.06 CONCRETE PADS

- A. Concrete pads for electrical equipment shall be provided by Electrical Contractor in accordance with Specifications Section 26 05 05, Concrete Pads and Curbs.
- B. Concrete pads shall be provided for the MDP, Transformers, generator, ATS and electrical panels.

PART 2 - PRODUCTS NOT USED.

PART 3 - EXECUTION

3.01 PLATFORMS AND SUPPORT STANDS

- A. Platforms and supporting stands shall be provided by the Electrical Contractor for their respective equipment.
- B. Each piece of equipment or apparatus suspended from ceiling or mounted above floor level shall be provided with suitable structural support, platform or carrier constructed in accordance with best recognized practice in a neat and workmanlike manner.
- C. Contractors shall exercise extreme care that structural members of building are not overloaded by such equipment. In all cases, details of such hangers, platforms and supports together with total weights of mounted equipment shall be approved by Structural Engineer.
- D. Support raceways on accepted types of wall brackets, specialty steel clips or hangers, ceiling trapeze hangers or malleable iron straps. Plumber's perforated straps are not permitted. Acceptable manufacturers' bracket or hangers are "Kindorf", "Elcan", "Blinkley", "Multi-Frame", "Power-Strut" or "Unistrut". Do not suspend raceways or equipment from steam, water or other piping or ductwork, and/or pre-stated system supports, except as otherwise permitted. Provide independent and secure support methods.
- E. Provide all structural supports for the proper attachment of electrical equipment supplied and also for equipment such as motor controllers, supplied under other sections or by Owner for mounting connection and installation under this section.
- F. Equipment and conduit supports shall be attached to structural members (beams, joists, etc.) rather than to floor or roof slabs.
- G. Support equipment suspended from structure by adjustable threaded steel rods of adequate diameter and strength anchored to the floor arch of the structural steel. Support auxiliary steel, if required, from the building steel. Secure no hangers to furred ceilings or ductwork.
- H. Where equipment is suspended from existing concrete or masonry construction, use expansion shields to attach supports to construction. Expansion shield bolt diameter shall be the same size as support rod diameter, hereinafter specified.
- I. 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 Architect and/or Engineer.
- J. Raceways or light fixtures shall not be suspended from ceiling suspension system. The Electrical Contractor shall be responsible for providing adequate support for raceways or fixtures. All supports shall be secured to a structural member of the facility.
- K. Mount wall-mounted equipment directly to wall by means of steel bolts. Maintain

at least 1/4-inch air space between equipment and supporting wall. Mount groups or arrays of equipment on adequately sized steel channels, such as those manufactured by Kindorf and Unistrut.

- L. Secure equipment and steel to solid masonry by means of screw and bolt anchors and expansion bolts. On structural steel use clamps, approved by the Engineer, which do not depend primarily on set-screw pressure for security.
- M. Where supports are attached to structural members coated with fireproofing, the Contractor shall clean the fireproofing, attach the support and patch the fireproofing with like material.

3.02 ELECTRICAL CONNECTIONS TO EQUIPMENT

- A. In the event that equipment furnished by other Contractors or Subcontractors requires a larger motor starter, disconnect, or feeder circuit (conduit, wire, and necessary appurtenances), than that which is indicated on the documents, the Contractor supplying said equipment is responsible to reimburse the Electrical Contractor for supplying the larger starter, disconnect for the difference in labor and material cost.
- B. Connections and wiring diagrams shown on the drawings or described in the specifications are general and are for bidding purposes only. Detailed diagrams and instructions shall be provided by Contractor supplying equipment. Contractor shall notify the Electrical Contractor prior to start of his related work.
- C. Relays, switches, contactors, etc. which may be required in addition to those specified for and indicated on the electrical drawings shall be provided by Mechanical Contractor for installation by the Electrical Contractor. These devices shall be mounted by the Electrical Contractor at the apparatus to be installed and the Mechanical Contractor supplying these additional devices shall reimburse the Electrical Contractor for his labor and material costs. Electrical Contractor shall provide all additional conduit, wire and electrical connections without additional charge to the Owner.
- D. In event that several pieces of mechanical equipment from different suppliers are combined into one system, Mechanical Contractor shall furnish complete wiring and control diagram to enable Electrical Contractor to make proper connection. Diagrams shall be submitted to Engineer for approval prior to actual wiring.
- E. Mechanical Contractor shall furnish to Electrical Contractor written notice of approval and acceptance of all control wiring installed for mechanical systems by Electrical Contractor. Such approval shall be given within thirty (30) days of completion of all such control wiring. Two (2) copies of letter shall be sent to Engineer.

END OF SECTION

SECTION 26 05 03 - COMPLETION AND STARTUP

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish material and labor required to perform startup of equipment and systems installed in this project and provide operating and maintenance instructions to the Owner. Coordinate, schedule and perform this work with the Commissioning Engineer.
- B. Furnish labor and material required to inspect the installed systems and correct deficiencies as specified herein.
- C. Furnish labor and equipment required to maintain clean work areas throughout the project and to perform final cleanup.

1.02 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Assignment of Miscellaneous Work: Section 26 05 02

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.01 COMPLETION REQUIREMENTS

- A. Remove rust, scale and foreign materials from equipment and renew any defaced surfaces. If equipment is badly marred, Engineer shall have authority to request that new materials be provided.
- B. Provide continuing adjustment services as necessary to ensure proper functioning of all electrical systems after building occupancy and during warranty period.

3.02 STARTUP

- A. A pre-startup construction meeting shall be scheduled by the Mechanical Contractor for the specific purpose of achieving a coordinated systems startup with the Commissioning Engineer and Owner.

- B. The Commissioning Engineer, Owner, Mechanical Contractor, Sheetmetal Contractor, Temperature Control Contractor, Balancing Contractor and Electrical Contractor shall be present at the pre-startup meeting and at the initial startup of each mechanical system and air handling unit.
- C. Check for proper electrical services and usage during the startup procedure.

3.03 TEMPORARY USE OF NEW EQUIPMENT

- A. The warranty on the equipment will not begin until the date of Owner's final acceptance at the completion of the project.
- B. Should the Owner elect to receive beneficial operation of the equipment prior to final acceptance, he may do so. The warranty period may begin then upon the Contractor receiving written approval from the Owner accepting the equipment with conditions of any incomplete portions of the work.

3.04 TOUCH-UP

- A. All electrical equipment, cabinets, panels and other enclosures shall be cleaned and 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 by the installing contractor to match original finish or shall be replaced before final acceptance.

3.05 CLEANING

- A. Maintain a clean project site throughout the construction period. Provide personnel to regularly remove debris and unused materials. Coordinate this cleaning effort with your subcontractors.
- B. Remove all debris and unused materials from job site created by electrical work.
- C. Clean all electrical equipment to a "like new" condition in preparation of final inspection. Vacuum clean all internal components.
- D. Clean all mechanical and electrical rooms and/or areas of debris and unused material.

END OF SECTION

SECTION 26 05 05 - CONCRETE PADS AND CURBS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install cast-in-place concrete pads and curbs for equipment where shown on the drawings and as specified herein.

1.02 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Assignment of Misc. Work: Section 26 05 02
- D. Concrete work

1.03 SUBMITTALS

- A. Submit complete shop and setting drawings in accordance with Specifications Section 26 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 CONCRETE FORMWORK

- A. Design criteria: conform to tables for form design in APA Form V345, including strength.
- B. Lumber: construction standard grade.
- C. Plywood: exterior type softwood plywood, PS 1.
- D. Ties: carbon steel, snap ties, 1" break back, 1/4" maximum diameter.
- E. Form coatings: non-staining
- F. Form Joint Tape: closed cell foam.

2.02 CONCRETE REINFORCEMENT

- A. Materials
 - 1. Bars: deformed billet steel: ASTM A615, Grade 40.
 - 2. Wire:
 - a. Cold drawn steel: ASTM A82

- b. Deformed steel: ASTM A496
- 3. Tie Wire: FS-QQ-W-461, annealed steel, black 16-gauge, min.
 - 4. Welding Electrodes: AWS A5.1, low hydrogen, E70 Series.
 - 5. Splice Devices: sized to develop 125% of yield strength of bar.
 - 6. Bar support conforms to "Bar Support Specifications", CRSI Manual of Standard Practice, Chapter 3.
 - 7. Wire Fabric: welded steel, ASTM A195
- B. Placement: Set reinforcing accurately and tie all items securely.
- C. Pin all interior pads and curbs to floor slabs, with dowels or bars (exception: do not pin to post tensioned slabs).

2.03 EXPANSION AND CONTRACTION JOINTS

- A. Joint Filler: Pre-molded, treated, non-bituminous, non-extruding wood fiber in concrete color and compatible with specified sealants. Filler shall conform to the performance requirements of ASTM D1752, Type 1.
- B. Acceptable Manufacturers
 - 1. Construction Gaskets
 - 2. Everlastic
 - 3. Homasote
 - 4. Homex 300
 - 5. Rescor
 - 6. Sponge Rubber
 - 7. Williams Products
 - 8. W.R. Meadows

2.04 CAST-IN-PLACE CONCRETE

- A. Interior: 4000 PSI, ready mix, to conform to ASTM C94.
- B. Exterior and Below Grades: 4000 PSI with 4% - 6% air entrainment.
- C. Slump: 5 inches maximum, tolerance, zero plus and minus 2 inches.
- D. Concrete shall be thoroughly consolidated without honeycombed finish surface.
- E. Provide 1" chamfered edges on perimeter of all pads.

2.05 CONCRETE FINISHING

- A. Interior Pads
 - 1. Provide smooth (floated) sides and top.
 - 2. Grind smooth all chamfered edges
- B. Exterior Pads

1. Provide smooth (troweled) sides
2. Provide broom finish top
3. Grind smooth all chamfered edges

2.06 CONCRETE CURING

- A. Apply concrete curing compound only at exposed slab.
- B. Acceptable Manufacturers
 1. Curetox - Toch Brothers
 2. Promulsion 100 - Protex
 3. Sealtight AR-30C - W.R. Meadows

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide 3-1/2" (Nominal 4") concrete housekeeping pads under all floor mounted Electrical Equipment and ATS, MDP and electrical panels.
- B. Provide a minimum of 18-inch concrete pad for generator.
- C. Coordinate location and size of pads with other concerned contractors.
- D. Expansion joints will not be permitted to cross the limits of a piece of equipment.
- E. The concrete pad shall extend 6" past all sides of equipment.
- F. For exterior pads, all preparation and grading is the responsibility of the Electrical Contractor. Pad preparation includes grading, leveling, stone backfill, reseeding as necessary for a completely installed pad.

END OF SECTION

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish wire, cable, connectors and associated products specified herein for electrical work as indicated in Contract Documents, except for wires and cables specified otherwise under specific sections.
- B. Section Includes:
 - 1. Building wire rated 600 V and less.
 - 2. Metal-clad cable, Type MC.
 - 3. Photovoltaic cable, Type PV.
 - 4. Connectors, splices, terminations and related products rated 600 V and less.

1.02 QUALITY ASSURANCE:

- A. Wire and cable provided shall be NRTL certified and shall meet referenced requirements.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Reference Standards:
 - 1. Review the Drawings and all sections of the Specifications for equipment furnished by other Contractors and the Owner throughout the entire project.
 - 2. See references noted in Specification Section 26 05 01.
 - 3. UL Standard 44 - Requirements for single-conductor and multiple-conductor thermoset-insulated wires and cables.
 - 4. UL Standard 50 - Enclosures for electrical equipment intended to be installed and used in non-hazardous locations.
 - 5. UL Standard 83 - Requirements for 600 V, single-conductor, thermoplastic-insulated wires and cables.
 - 6. UL Standard 486D - Sealed wire connector systems.
 - 7. Federal Specification J-C-30B – Cable and Wire, Electrical.

1.03 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and other Division 01 Specifications Sections, apply to this Section.
- B. Related Requirements:

1. Division 7 "Fire Stopping"
2. Section 26 05 01 "General Provisions"
3. Section 26 05 02 "Assignment of Miscellaneous Work"
4. Section 26 05 13.16 "Medium-Voltage, Single and Multi-Conductors Cable"
5. Section 26 05 26 "Grounding and Bonding"
6. Section 26 05 33 "Raceways and Boxes"
7. Section 26 08 01 "Performance Testing"
8. Section 27 13 13 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.

1.04 SUBMITTALS

- A. Action Submittals:
 1. General: Submittals shall be in accordance with Specification Section 26 05 01, General Provisions
 2. Product Data: For each type of product.
 3. Manufacturer Installation Instructions: For each type of product.
- B. Information Submittals:
 1. Field quality-control reports. (Test reports)
- C. Closeout Submittals:
 1. Warranty.
 2. Record Documentation.

1.05 PROJECT CONDITIONS:

- A. Deliver, store and handle materials in accordance with Section 26 05 01.
- B. Sequence and Schedule work in accordance with Division 01 and Section 26 05 01.
- C. Install all wire and cable in conduit, unless specifically indicated otherwise.
- D. Environmental Conditions Defined per NEC with following clarifications:
 1. Dry Locations:
 2. Damp/Wet Locations:
 - a. Exterior
 - b. Non-Conditioned spaces subject to exterior ambient air conditions. (Naturally and mechanically ventilated building.)
 - c. Refrigerated Buildings/Rooms and areas adjacent entry / exit to Refrigerated Buildings/Rooms. (PDC's / GDC's)
 - d. Wash bays and areas subject to periodic hose down.
 - e. Parking Garages
 - f. Below grade vaults, basements and similar.
 - g. Shower Rooms and similar
 - h. Swimming Pools and similar

1.06 WARRANTY:

- A. Warranty in Accordance with requirements of Division 01 and Section 26 05 01.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Insulation:
1. Color coded.
 2. Rated 600 Volts, unless noted otherwise.
 3. Dual rated 75C/90C unless noted otherwise.
- B. All materials shall have been manufactured within two years of installation.

2.02 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, soft drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.
- B. Manufacturers:
1. Aetna Insulated Wire Company
 2. American Insulated Wire Corp.; a Leviton Company
 3. Belden
 4. Cerro Wire and Cable Company, Inc.
 5. Encore Wire and Cable.
 6. Phelps Dodge International Corp.
 7. Republic Wire, Inc.
 8. Southwire Company
 9. The Okonite Company.
 10. Prysmian Group (General Cable)
- C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
 3. Comply with NEMA WC 70.
- D. Conductors:
1. Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 and ASTM B496 for stranded conductors.
 2. 98 percent conductivity Copper.
- E. Conductor Insulation:
1. Type NM: Comply with UL 83 and UL 719.
 2. Type USE-2 and Type SE: Comply with UL 854.

3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type UF: Comply with UL 83 and UL 493.
7. Type XHHW-2: Comply with UL 44.

F. Shielded Cable for ASD Applications:

1. Type TC-ER: Cable designed for use with ASDs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.
2. Extra-flexible stranded for all sizes.

2.03 ALUMINUM BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Aluminum conductor shall be compact stranded 8000 Series "Stabiloy" or equivalent.
- C. Manufacturers:
1. Southwire Company
 2. Prysmian Group
 3. Encore Wire and Cable.
 4. Republic Wire, Inc.
- D. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
 3. ASTM B836.
 4. NEMA WC 70
- E. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.
- F. Conductor Insulation:
1. Type USE-2 and Type SE: Comply with UL 854.
 2. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 3. Type THHN and Type THWN-2: Comply with UL 83.
 4. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 5. Type XHHW-2: Comply with UL 44.

2.04 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Manufacturers:
 - 1. AFC Cable Systems (Atkore)
 - 2. Cerrowire
 - 3. American Wire Group
 - 4. Encore
 - 5. General Cable
 - 6. Prysmian Group
 - 7. Okonite
 - 8. Southwire
 - 9. Engineer approved equal.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
 - 4. UL 1063
 - 5. Tested and comply with UL 1479 test procedure for through penetration fire rating.
 - 6. Comply with NEMA WC 70.
- D. Circuits:
 - 1. Single circuit with color-coded conductors. Single phase, multi-phase with and without neutral and with ground. Color-coded per identification requirements herein.
 - 2. Mult circuit with color-coded conductors. Derating as applicable per manufacturers tables for greater than six conductors. Color-coded per identification requirements herein.
 - 3. Weatherproof. Exterior PVC coating and UL listed for installation in damp/wet locations.
 - 4. Healthcare Rated. Include redundant grounding path with UL rated assembly.
 - 5. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Conductors:
 - 1. Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
 - 2. Size #12 minimum through 6 AWG maximum.
 - 3. Type THHH circuit conductors rated 90C.
- F. Ground Conductor:

1. Bare.
2. Full sized 8000 series aluminum grounding conductor.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

H. Armor: **Steel or Aluminum**, interlocked.

I. Jacket:

1. Weatherproof - PVC applied over armor.
2. Healthcare Rated – Green color tint of exterior armor.
3. Identification - Factory applied color identification stripe cable system.

2.05 PHOTOVOLTAIC CABLE, TYPE PV

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 2000 V.
- B. Manufacturers:
1. Encore Wire
 2. Prysmian Group
 3. Southwire
- C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation: Comply with UL 44 and UL 4703.

2.06 FLEXIBLE CORD

- A. Comply with NEMA WC 70 for Type SO.

2.07 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers:

1. Ideal Industries
 2. 3M
 3. ECM Industries (IlSCO)
 4. NSI Industries
 5. ABB /Thomas & Betts Corporation
 6. Hilti
 7. AFC Cable Systems, Inc. (Atkore)
 8. Hubbell Power Systems, Inc.
 9. Emerson / Appleton /O-Z/Gedney; EGS Electrical Group LLC.
 10. TE Connectivity (Tyco Electronics Corp.)
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Aluminum.
 2. Type: Two hole with long barrels.
 3. Termination: Crimp.
- D. Pigtail Adapters:
1. Crimp on, barrel-to-pigtail adapters that are UL 486B 90C listed and CSA certified.
 2. 600 V rated
 3. Rated for use with Copper or Aluminum conductors.
 4. ILSCO Model CMP Series or approved equal.
 5. Clear shrink wrap for inspection of crimp on connector.
- E. SMALL WIRE AND CABLE CONNECTORS #8 AWG AND SMALLER
1. Dry Locations:
 - a. Solderless pre-insulated twist-on spring tension wire connectors.
 - b. UL/CSA Certified, 600 Volt rated, 60C temperature rated.
 - c. Connectors shall be Ideal "Wire-Nut", Ideal "Wing-Nut, 3M "Scotchlok", or approved equal.
 - d. Push-on connectors are not acceptable.
 2. Damp and Wet Locations:
 - a. Solderless watertight, pre-insulated twist-on spring tension wire connectors UL listed for damp and wet locations
 - b. UL/CSA Certified, 600 Volt rated, 60C temperature rated.
 - c. Connectors shall be Ideal "Weatherproof" and "Underground" or approved equals.
 - d. Push-on connectors are not acceptable.
- F. LARGE WIRE AND CABLE CONNECTORS #6 AWG AND LARGER
1. Dry Locations:
 - a. Solderless pressure-type bolted or compression connectors.
 - b. Permanent compression connectors shall be utilized as the first choice. Bolted connectors shall only be utilized with compression connectors are not made for the application.
 - c. Connectors shall be as manufactured by ILSCO, NSI Industries, or approved equal.
 2. Damp and Wet Locations:

- a. Solderless pressure-type bolted or compression connectors Watertight, UL486D listed for direct burial/below grade use and UL 50 listed for submersible applications.
- b. Insulated mechanical style connector or connector block. Connector shall be as manufactured by NSI Industries "Polaris Blue" or approved equal.

G. CONNECTORS / PIN ADAPTERS:

1. Connectors shall be factory-fabricated connectors of size, ampacity rating, material, type and class for applications and service indicated.
2. Connectors shall be of the following types:
 - a. Solderless, uninsulated high conductivity, corrosion resistant, compression connectors conforming to UL 467
 - b. Insulated, indenter-type compression butt connectors
 - c. Insulated, integral self-locking flexible shell, expandable spring connectors
 - d. Uninsulated, indenter-type compression pigtail connectors
 - e. Welded-type connectors

H. TERMINALS:

1. Terminals shall be factory-fabricated connectors of size, ampacity rating, material, type, and class for application and service indicated.
2. Terminals shall be of the following types:
 - a. Solderless, uninsulated, high conductivity, corrosion resistant, compression terminals conforming to UL 467 and IEEE 837
 - b. Insulated, compression terminals
 - c. Solderless, high-conductivity, corrosion resistant, hex screw type, bolted terminals
 - d. Welded type terminals.

2.08 CABLE SUPPORTS IN RISERS

- A. Clamping devices employing insulating wedges at code required locations or as indicated. O.Z. Type S or approved equal.

2.09 ELECTRICAL INSULATING TAPE

- A. Tape shall be specifically designed for use as an insulating tape.
- B. Vinyl Tapes PVC (Polyvinyl Chloride)
 1. Material: PVC backing, pressure-sensitive rubber-resin adhesive
 2. Voltage Rating: 600 Volt
 3. Temperature Rating: 0F to 220F.
 4. Performance: Flame Retardant, UV Resistant, Weatherproof
 5. Size: ¾" wide or 1-1/2" wide
 6. Listings: Conform to UL510, ASTM D1000 and ASTM D 3005
 7. Compatible with cable jacketings
 8. Interior Dry Locations:
 - a. 7 mils
 - b. ASTM D 3005 (Type I)
 - c. Scotch (3M) No. 33 or approved equal

9. Exterior / Damp / Wet Locations:
 - a. 8.5 mils
 - b. ASTM D 3005 (Type II)
 - c. Scotch (3M) No. 88 or approved equal
- C. Vinyl Mastic Pad / Vinyl Mastic Roll
 1. Scotch Vinyl Mastic Pad / Roll (3M) Pad 2200 and Roll 2210.
 2. Scotch Electrical Moisture Sealant Pad 06149 and Roll 06147
 3. 3M Scotch-Seal Mastic Tape 2229

2.10 SHRINKABLE TUBING

- A. General: Clear heavy wall PVC (Polyvinyl Chloride) heat shrinkable tubing. Properly sized for the application.
- B. General Performance:
 1. Continuous Operating Temperature: -55C to 110C for PVC.
 2. Shrink Temperature: Minimum of 120C.
 3. Shrink Ratio: Minimum 3:1 for heavy wall.
 4. Voltage Rating: Minimum 600V.
 5. Flame retardant (VW-1) rating.
 6. UV Resistant
- C. References:
 1. UL/CSA approved.
 - a. UL 486D, UL 224
 - b. CSA C22.2 No. 198.2: High-Voltage and Specialty Tubing.
 2. ANSI C119.1: Sealed Insulated Underground Connector System Standard
- D. Manufacturers:
 1. 3M
 2. Grayline
 3. Pexco (Insultab and VinylGuard)
 4. TE Connectivity (Raychem)
 5. Thomas & Betts (ABB)

2.11 PUTTY

- A. Insulating Putty
 1. Electrical-grade insulating putty used to fill voids and smooth irregular shapes in connections to provide a uniform base for further taping.
 2. Manufacturers:
 - a. 3M Scotchfil Electrical Insulation Putty
 - b. Engineer approved equal.
- B. Duct Seal
 1. Compound used to block moisture, drafts and dust from entering conduit and electrical boxes. Permanently soft, dough-like material that does not harden or form a skin. Non-toxic, non-corrosive and non-staining. Indoor use only.

2. Manufacturers:
 - a. Gardner Bender DS-530 Duct Seal
 - b. Ideal Industries
 - c. Engineer approved equal.

2.12 INSULATING SPRAY / SEALER

- A. Insulating Spray:
 1. Product Description: Electrical grade, fast drying sealers and insulators in pressurize can. These sealers protect surfaces against weather, moisture, corrosion, oil, alkalis and acids.
 2. Applications: Use insulation spray sealer to spray over insulation on wire and cable splices, as a general-purpose sealer.
 3. Product is available in Clear, Red and Black. Utilize Red unless noted otherwise.
 4. Sealer shall be liquid applied, fast-drying sealant; Scotch (3M) Scotchkote or approved equal.

2.13 ANTI-OXIDIZING COMPOUND

- A. Antioxidant, corrosion-inhibiting electrical joint compound designed for Al to Al, Al to Cu and conduit connections. Gray semi-solid grease with high temperature stability (dropping point approximately 230F, UL listed and RoHS compliant. Listed for 600 Volt applications.
 1. Utilize appropriate products for the applications based on manufacturer recommendations.
 2. Non-petroleum-based products are preferred.
- B. Manufacturers:
 1. Burndy Penetrox
 2. Penn Union CUAL Acid
 3. Approved Equal

2.14 IRREVERSIBLE TEMPERATURE INDICATING LABEL:

- A. Self-adhesive label that can be applied to cable, termination, breaker that provides one time indication of heat exceeding rating of sticker
- B. Manufacturers:
 1. Brady B7511 / B7512 part number TIL-1-60C/140F-DIA
 2. Engineer approved equal.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 1. Copper.
 2. Aluminum:

- a. Acceptable Uses:
 - 1) Sized No. 1/0 AWG and larger. (See Feeder Schedule.)
 - 2) Sized properly for ampacity specified. See Feeder Schedule. (i.e. Cu and Al ampacity is not equal for same size cable. 4/0 Cu is not equal ampacity to 4/0 Al.)
 - 3) Terminations / Connectors must be properly sized and rated for Al conductors.
 - 4) Raceways must be properly sized for properly sized Al feeders.
- b. Unacceptable Feeder Uses:
 - 1) Sized smaller than No. 1/0 AWG.
 - 2) HVAC equipment inclusive of Roof Top Units (RTUs).
 - 3) Elevators or Escalators.
 - 4) Photovoltaic Inverters and Combiner Panels.
 - 5) Refrigeration Equipment (Compressors).
 - 6) Air Compressors.
 - 7) Welding Equipment including outlets and disconnects.
 - 8) Anywhere specifically prohibited by equipment supplier not listed herein.
- 3. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
 - 1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. ASD Output Circuits Cable:
 - 1. Utilize ASD cable whenever cable length from Adjustable Speed Drive (ASD) (Also known as Variable Frequency Drive (VFD)) to motor served exceeds 50' of cable length.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- E. PV Circuits (DC up to 2000 Volts):
 - 1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance:
 - 1. Typical: Type XHHW-2, single conductors in raceway.
 - 2. Apartment Load centers: Multiconductor cable, Type SER.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace:
Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground:
Type XHHW-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

- F. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- G. Exposed Branch Circuits, Including in Crawlspace:
 - 1. Type THHN/THWN-2, single conductors in raceway.
 - 2. Metal-clad cable, Type MC where permitted.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
 - 1. Type THHN/THWN-2, single conductors in raceway
 - 2. Metal-clad cable, Type MC where permitted.
 - 3. Nonmetallic-sheathed cable, Type NM where permitted.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- J. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.
- L. ASD Output Circuits: Type XHHW-2 in metal conduit.
- M. PV Circuits, Type PV: For PV source circuits.
- N. Class 1 Control Circuits: Type THHN-THWN, in raceway
- O. Class 2 Control Circuits: Type THHN-THWN, in raceway

3.03 INSTALLATION, GENERAL

- A. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- B. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.
- C. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- D. Complete grounding per grounding conductor requirements in Section 26 05 26 Grounding.
- E. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- F. Vacuum and then swab all debris, moisture from raceway runs immediately prior to installing conductors.

- G. Use manufacturer-approved pulling compound or lubricant listed for application where necessary; compound used must not deteriorate conductor or insulation. Grease, soap or oil is not permitted.
- H. Do not pull cable in raceways when space and wiring temperature is below 33F.
- I. Cable shall only be installed in raceway that is UL listed for electrical installation, installed per specifications in compliance with applicable codes.
- J. Install all wires of the same circuit in the same conduit.
- K. Maximum number of current carrying conductors with separate neutral for each circuit in conduit shall be six.
- L. Exercise care when installing conductors so as not to damage conductor insulation. Utilize appropriate cable bending shoes, conduit end bell fittings, pulling wheels, etc. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- M. Feeders:
 - 1. Run feeders continuously without splices, except with the permission of the Engineer.
 - 2. Conductors for parallel feeders shall be identical in material type, stranding, insulation and length.
 - 3. Grouping of feeders in raceway system is not permitted unless specifically indicated in the Contract Documents.
 - 4. Lace or clip groups of feeder conductors together at switchboards, distribution panels and pull boxes.
 - 5. Where splices are necessary for termination of cables based on lug size the splices shall be permanent compression type with clear heat shrink.
 - 6. Splices shall only be in spaces that are accessible for inspection and arranged such that they remain visible and are not hidden behind other items.
 - 7. Splices where specifically indicated in top hats or pull boxes above switchboards to minimize outages and arc flash exposure shall be specifically called out on plans.
- N. Branch Circuit Wiring:
 - 1. Dedicated Neutral: Provide a dedicated neutral conductor for each circuit. Do not share neutral conductors between separate circuits, unless specifically indicated in Construction Documents.
 - 2. Final connections to motors, lighting fixtures and all locations where vibration or movement is present use Class B, stranded conductors. All other locations use solid conductors for #10 and #12.
- O. Control Wiring: Minimum size shall be #14 AWG.
- P. Signal Wiring: Minimum size shall be #18 AWG or as detailed in specifications or drawings.
- Q. Derating:

1. General:
 - a. Sizes of conductors (Branch Circuits and Feeders) shall be sized to meet recommendations of NEC and requirements of applicable Energy Codes.
2. Conduit Fill:
 - a. Grouping: Do not group more than nine conductors in one conduit.
 - b. Conductors include all phase conductors and the neutral conductors, switch legs and travelers.
 - c. Neutral conductor shall be considered a current carrying conductor for purpose of calculating derating factors.
3. Voltage Drop:
 - a. Calculate using 75C resistance values for conductor.
 - b. Adjust the size of conductors to maintain circuit ampacity by adjusting for the derating requirements of Section 310.15 of the Electrical Code.
 - 1) Branch circuit maximum does not exceed 3% between panel and farthest outlet.
 - 2) Overall circuit maximum does not exceed 5% from source to farthest outlet. (Feeder voltage drop limited to 2% from Switchboard to Panelboard.)
 - 3) The voltage drop from service transformer to service switchboard for purposes of voltage drop calculations is assumed to be negligible based on typical short length, ampacity and relatively low load factor.
 - 4) Load used for calculations:
 - a) Lighting branch circuits utilize load indicated on panel schedules.
 - b) Receptacle branch circuits (standard duplex / dedicated) utilize 80% rating of 20 Amp circuit. (16 Amps)
 - c) Receptacle branch circuits (non-standard) utilize load indicated on panel schedules.
 - d) Panelboard feeders utilize 80% of circuit breaker rating feeding the panelboard.
 - e) Motor / Equipment feeders utilize load indicated on panel schedules.
 - c. Minimum wire size from panel to the furthest device for 20 Amp circuits shall be:
 - 1) #12 AWG up to 100 feet.
 - 2) #10 AWG from 100' to 200'.
 - 3) #8 AWG from 200' to 300'.
 - 4) Per NEC with max 3% voltage drop for any circuit in excess of 300'.
- R. Do not exceed manufacturers minimum bending radius, maximum pulling tension or sidewall pressure values. Specifically, feeders shall comply with manufacturer minimum bend radius requirements in enclosures, cable trays, panelboards, switchboards, disconnects, etc. In no case shall the bend radius be less than four times the cable diameter. Utilize a dynamometer to measure pulling tension on all runs over 200 feet in length.
- S. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

- T. Train, lace and dress wiring inside equipment and panelboards with plastic tie wraps for a neat appearance.
- U. All spare wires in cabinets and panelboards shall be of adequate length for connections.

3.04 TYPE MC CABLE:

- A. **Not allowed on this project.**
- B. Permitted uses:
 - 1. Install concealed above finished ceiling.
 - 2. Installed indoors above the ground floor slab and concealed within walls.
 - 3. Unfinished spaces indoors above 6'-0" above finished floor.
 - 4. Lighting fixture connections.
 - 5. Concealed in stud walls for receptacle feed unless noted otherwise.
- C. Not permitted uses:
 - 1. Where prohibited by Article 330 of the latest Electrical Code adopted by AHJ.
 - 2. Below grade.
 - 3. Exterior locations. (Unless otherwise approved by Engineer using properly rated MC cable for application.)
 - 4. Exposed in finished spaces.
 - 5. Exposed in Mechanical and Electrical spaces below +6'-0" AFF.
 - 6. Feeders. (Switchboard, Panelboard, Generator, Service Entrance)
 - 7. Branch Circuits larger than 60 Amps.
 - 8. Home runs. (Home run shall be in conduit with conductors.)

3.05 TYPE NM CABLE:

- A. **Not allowed on this project.**
- B. Permitted uses:
 - 1. Residential applications.
 - 2. Where cable is fed from a Loadcenter.
 - 3. When cable is run within an apartment unit or townhouse.
- C. Not permitted uses:
 - 1. Exposed.
 - 2. Exposed above an Acoustic Tile Ceiling (ACT).
 - 3. Inside a plenum space
 - 4. Non-residential applications.
 - 5. Where cable is fed from a Panelboard or Distribution Center.

3.06 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Locate splices and terminations only in readily accessible properly sized boxes.
- C. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- D. Preparation:
 - 1. Connectors shall be properly sized for application, cable type and cable size.
 - 2. Strip conductor insulation using an approved method. Do not nick or ring the wire. Remove any major coating on the wire.
 - 3. Prepare Surfaces: Thoroughly clean wires before installing connectors so that joints will carry full capacity of conductors without perceptible temperature rise. Remove any surface oxides with a wire brush until bright and clean.
 - 4. Apply Compound: Use oxide inhibitor in each splice, termination, and tap for Aluminum conductors.
 - 5. Assemble Joint: Insert conductor all the way into the barrel of connector.
 - 6. Utilize proper die for approved tool that is not worn. Compress barrel from end of cable toward cable.
 - 7. Clean up: Thoroughly wipe all excess compound from the cable insulation.
 - 8. Utilize proper washers per connectors documented requirements.
- E. Torquing:
 - 1. Torque all mechanical connections per manufacturer's recommendations at time of installation. Record values, date/time, responsible electrician.
 - 2. Retorque all connections after initial torque no sooner than 24 hours later and no longer than 72 hours after installation. Retorque shall be by another electrician with another torque wrench. Record values, date/time, responsible electrician. Mark torque using Chinese marker on lugs.
 - 3. Submit torque report to engineer for record and include in closeout documents.
 - 4. Purpose of these additional steps is due to a substantial number of improperly terminated cables that were not properly torqued on numerous projects across a wide geographic area. Purpose of this requirement is to ensure quality connections, account for "relaxing" of cables in lugs and account for human error.
- F. Stranded Conductors #10 and smaller shall be terminated under screw terminals using insulated spade connectors such as "Sta-Con" or other approved connectors.

- G. Conductors #8 AWG and smaller shall be connected with compression connectors or wire nuts.
 - 1. Connectors shall be UL listed for application.
 - 2. Connectors for wet or damp locations shall be UL listed for application in inground and underground pull boxes, junction boxes, hand holes and manholes.
 - 3. Connectors for direct burial shall be UL listed for application.
 - 4. Install joints, connections, splices, etc. in a workmanlike manner and according to manufacturer's directions.
 - 5. Wrap minimum of two turns of electrical tape around all wire nuts overlapping nut and cable with full wrap of tape.
- H. Conductors #6 AWG and larger shall be connected with compression or hy-dent type connectors and clear shrink wrap.
- I. Splices:
 - 1. Terminations in dry locations for sizes #10 AWG and smaller shall be with compression terminals, insulated or uninsulated
 - 2. Terminations in dry locations for sizes #8 AWG through #3/0 AWG shall be permanent solderless uninsulated compression crimp type ring tongue terminals with clear heat shrink insulation. Bolted hex screw type ring tongue lugs are not acceptable.
 - 3. Terminations in dry locations for sizes #4/0 AWG and larger shall be permanent solderless, uninsulated compression crimp type ring tongue terminals with clear heat shrink insulation. Bolted hex screw type ring tongue lugs are not acceptable.
 - 4. Terminations in wet locations shall be as dry location terminations above, plus cover the entire termination area with two layers of clear heat shrink tubing with the requirements of this Section, shall be submitted to the Engineer for approval
 - 5. General Purpose Wires and Cables
 - a. Splices in dry locations for sizes #10 AWG and smaller shall use one of the following:
 - 1) Insulated, integral, self-locking flexible shell, expandable spring connectors shall be applied to the twisted conductors. Two, half-lapped layers of vinyl tape, extending not less than one inch from the connector, shall be applied.
 - 2) Compression type, insulated butt connectors shall be applied to the butted conductors by means of an appropriate crimping tool, providing controlled indentation. Two, half-lapped layers of vinyl tape, extending not less than one inch from the connector, shall be applied.
 - 3) Compression type, pigtail connectors shall be applied to the conductors by means of an appropriate crimping tool, providing controlled indentation. The connector shall be covered with a polyamide cap and two, half-lapped layers of vinyl tape, extending not less than one inch from the connector, shall be applied.
 - b. Splices in dry locations for sizes #8 AWG and larger shall use all of the following:
 - 1) Connectors shall be permanent solderless compression type.

- 2) Apply connector by means of an appropriate crimping tool, providing controlled indentation.
 - 3) Apply clear shrinkable tubing that extends a distance of not less than 1" from the connector.
 - 4) Bolted hex screw type ring tongue lugs are not acceptable.
 - c. Splices in wet locations for all sizes
 - 1) Same as dry location specified above, with two layers of shrinkable tubing extending 2' beyond the connection.
- J. Terminations:
1. Terminations in dry locations for sizes #10 AWG and smaller shall be with compression terminals, insulated or uninsulated
 2. Terminations in dry locations for sizes #8 AWG through #3/0 AWG shall be permanent solderless uninsulated compression crimp type ring tongue terminals with clear heat shrink insulation. Bolted hex screw type ring tongue lugs are not acceptable.
 3. Terminations in dry locations for sizes #4/0 AWG and larger shall be permanent solderless, uninsulated compression crimp type ring tongue terminals with clear heat shrink insulation. Bolted hex screw type ring tongue lugs are not acceptable.
 4. Terminations in wet locations shall be as dry location terminations above, plus cover the entire termination area with two layers of clear heat shrink tubing.
- K. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.07 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Color code wire as follows:
- | | <u>208/120 Volts</u> | <u>480/277 Volts</u> |
|----------------------|-----------------------------|----------------------|
| Phase A | Black | Brown |
| Phase B | Red | Orange |
| Phase C | Blue | Yellow |
| Grounded (Neutral) | White | Gray |
| Grounding | Green | Green |
| Isolated Ground | Green with Yellow Stripe | |
| Switch Leg Travelers | Pink or Purple | |
| Switch Leg Return | Same as associated circuit. | |
- C. Factory color code all cables.
- D. Circuit / Panel Identification
1. Provide identification of all panel and motor feeder cables and control wires in pull boxes and at terminations.
 2. Use flameproof cloth, vinyl plastic for labels wrapped around wire.
 3. Mark tags on power cables with panel and circuit name in black on a yellow background.

4. Mark tags on control wires with terminal numbers and circuit name in black on a yellow background.
 5. Use pre-printed markers with protective coatings wherever possible. Use only black India ink or permanent write-on markers.
 6. Manufacturer: Brady Slip on Markers.
- E. Properly phase and identify buses, feeders and branch circuit conductors throughout the entire electrical system as required under NFPA 70.
- F. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.
- G. Irreversible Temperature Indicating Label:
1. Install where called out on plans or specified herein:
 - a. On any mechanical splices such as Polaris slices.
 2. When specified install at each termination or splice on each phase conductor adjacent to the connection and visible when cover is opened for inspection.
 3. Place label as near to connection as possible without obscuring visibility of connection for visual inspection.

3.08 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

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

3.09 HEATSHRINK TUBING

- A. Preparation: Verify the tubing size is appropriate for substrate. The tube should be at least 20% larger than the object before shrinking and have at least 10% unresolved recovery remaining after installation for a tight fit.
- B. Installation:
1. Apply heat using a manufacturer-approved heat gun with a reflector nozzle.
 2. Heat from the center outward to the ends to avoid trapping air.

3.10 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.11 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and conductors #4 Cu and larger and all Al for compliance with requirements:
 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- B. Infrared Scanning
1. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each connection (splice and termination) in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 2. Follow-up Infrared Scanning:
 - a. Perform an additional follow-up infrared scan of each connection (splice and termination) no less than 6 months and no more than 11 months after date of Substantial Completion.
 - b. Time scan to correspond to a time when building load is at or near maximum demand for the facility.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.

3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Raceways and Boxes: Section 26 05 33

PART 2 - PRODUCTS

2.01 GENERAL

- A. Entire installation to be grounded and bonded in accordance with requirements of Article 250 of the National Electrical Code (NEC).
- B. Equipment grounding shall be provided for, but not limited to, the following items:
 - 1. Panelboard tubs and electrical structures.
 - 2. All motor frames that are not otherwise effectively insulated from ground.
 - 3. Enclosure for motor controllers and safety switches.
- C. Provide code size grounding conductor in all conduits and raceways.
- D. An equipment bonding jumper shall be used to connect the grounding terminal of a grounding type receptacle to a grounded box.
- E. All grounding type receptacles are to have grounding slot connected to green ground conductor.

2.02 EQUIPMENT GROUND

- A. Provide C.O. ground bus in tele/data equipment rooms with 3/0 MCM, "THW" grounded electrode conductor extended back to AC ground.

2.03 GROUND ROD

- A. Provide ¾ inch by 10 feet copper ground rod.

2.04 AC SYSTEM GROUND

- A. Ground system shall consists of 3 ground rods in triangle pattern or in a straight line 12'-0" apart. All ground rods shall be 3/4" diameter, 10'-0" sectional, Copper weld Blackburn, Penn Union or Weaver rods driven to a depth required to obtain ground resistance stated below.
- B. In addition to the triangle pattern ground rod system, ground to the street side of the water meter using OZ-Gedney Type 'BJ' Jumper, to foundation rebar, and to building steel as required by the NEC. After the ground system has been installed, but before it is fully covered, it shall be tested and shall be modified as required to obtain the ground resistance specified.

PART 3 - EXECUTION

3.01 GENERAL

- A. All grounding system connections shall be made using a thermos weld process similar to "Cadweld" and Thermo weld or a high pressure (non-reversible) compression type system similar to Burdy "Hyground".
- B. Test resistance to ground of ground system or grounding network at point where equipment, raceways and conductors are to be connected. Value of this resistance to ground shall not exceed 5 ohms and shall be measured from ground being tested to the system ground rod driven into the earth.
- C. Ground system tests shall be performed by qualified testing concern normally employed in this field using nationally acceptable test instruments. All test reports shall be certified and shall be submitted to the Engineer for review.
- D. Bond conduits at panels per NEC.
- E. No equipment rated at more than 150 volts to ground shall be grounded in a manner which will permit the building steel to provide the only return path for ground fault currents.
- F. Grounding wire run below grade shall be buried 30" deep (minimum).
- G. All contact surfaces shall be thoroughly clean and bright, before connection are made, to ensure making good electrical contact.
- H. Each feeder conduit shall have all joints made with conductive, waterproof joint compound as Sherwin Williams "Zink Clad", T & B "Kopr/Shield" or approved equal.

3.02 GROUNDING SYSTEMS TESTS

- A. Visual and Mechanical Inspection: Inspect ground system for compliance with plans and specifications.
- B. Electrical Tests

1. Perform 3-point fall-of-potential test per IEEE Standard No. 81, Section 9.04 on the main grounding electrode of system.
 2. Perform the 2-point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points.
 3. Alternate Method to 2 above: Perform ground continuity test between main ground system and equipment frame, system neutral and/or derived neutral point. This test shall be made by passing a minimum of ten amperes DC current between ground reference system and the ground point to be tested. Voltage drop shall be measured and resistance calculated by voltage drop method.
- C. Test Values: The main ground electrode system resistance to ground should be no greater than five ohms.

END OF SECTION

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SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19

1.02 PENETRATIONS

- A. Penetrations of fire rated walls, floors, roofs and ceiling will be sealed with rated fire stops by General Contractor.

1.03 WORK INCLUDED

- A. Furnished all labor, materials and equipment necessary to provide all sleeves and anchors as shown on the drawings.
- B. Any and all penetrations of below grade walls with conduit shall be protected by a sleeve with water sealing assemblies.

PART 2 - PRODUCTS

2.01 METALLIC TYPE CONDUITS

- A. Rigid Galvanized Steel (RGS): UL 6 and ASA C80.1 Full weight mild galvanized or sheradized steel pipe of standard pipe dimensions; with screwed fittings. Bushing shall be malleable iron. Bushings 1-1/4" and larger shall be insulated throat and grounding lug.
- B. Rigid-Aluminum-Heavy Wall Type (RA): Heavy Wall aluminum pipe of standard pipe dimension.
- C. Intermediate Metal Conduit (IMC): UL 242, Lighter weight galvanized or sheradized steel pipe of standard pipe dimension with full weight screwed fittings. Bushings shall be malleable iron. Bushings 1-1/4" and larger shall have insulated throat grounding lug.
- D. Electrical Metallic Tubing (EMT): UL 797 and ASA C80.3, Galvanized or sheradized thinwall steel conduit. Fittings 1-1/4" and larger shall have nylon insulated throat. Indentor or drive-on fittings are not acceptable.

- E. Flexible Metal Conduit (FMC): UL 1, Galvanized, single strip type with smooth wiring channel. Use in dry locations and for connections to motors, transformers, lighting fixtures and other equipment that may have movement or vibration. Fittings shall be steel.
- F. Liquid tight flexible metal conduit (LFMC): UL 360 galvanized, single strip with smooth wiring channel and neoprene jacket. Fittings shall be compression type. Use in all locations for final connections to motors, transformers, lighting fixtures or other items with movement or vibration.
- G. MC Cable (MC): UL 1569, pre-manufactured type solid aluminum sheath of interlocked metal jacket. "MC" cable shall contain type "THWN" copper conductors with overall "PVC" jacket.

2.02 POLYVINYL CHLORIDE TYPE (PVC)

- A. PVC pipe of standard pipe dimensions suitable for use with socket type solvent weld couplings, boxes and fittings.
- B. Conduit shall be PVC Schedule 40 or 80 (90°C) for application in underground, encased and exposed applications in accordance with NEC. Where exposed, Schedule 80 shall be used to 8 feet above floor or grade.
- C. PVC conduit and fittings shall be UL rated for electrical use. Material shall comply to NEMA Specifications TC-2, TC-3, Federal Specifications W-C-1094A, UL-651 and ANSI C33.91.
- D. Conduit shall be made from virgin polyvinyl chloride C300 to reduce smoke and HCL emissions in a fire situation. Conduit shall be rated for UV (ultraviolet) resistance for above ground installations outdoors or where exposed to ultraviolet radiation.
- E. Conduit, fittings and solvent weld cement shall be produced by same manufacturer to assure system integrity.
- F. Use metallic conduit for all 90-degree ells from below grade into building to protect conduit from damage.
- G. Manufacturers: Carlon PV-Duct Plus Systems or approved equal.

2.03 FIRE STOP SEALANTS

- A. Penetration Sealants
 - 1. Dow Corning "Firestop Foam" and "Firestop Sealant"
 - 2. Insta-Foam Products, Inc. "Insta-Foam Seal Silicone RTV Foam"
 - 3. 3M Brand "Fire Barrier" Caulk
 - 4. 3M Brand Moldable Putty "Pads" and Moldable Putty "Stix"

- B. Intumescent sealants for use in openings and sleeves involving plastic pipe, insulated pipe or flexible cable:
 - 1. Dow Corning "Firestop Intumescent Wrap Strip"
 - 2. Fox Coupling, Inc. "Cast-In-Place Firestop Coupling"
 - 3. 3M Brand "Fire Barrier" Caulk with FS-195 wrap strip and CS-195 composite sheet.
- C. Firestop Pillows
 - 1. Metacaulk® PILLOWS
 - 2. BIOSTOP™ Firestop PILLOWS
 - 3. 3M Firestop Pillows
- D. Wall Opening Protective Materials
 - 1. LECTRA-STOP™ Fire Rated Electrical Box Inserts, by BIO FIRESHIELD™
 - 2. BIOSTOP™ Fire Rated Putty Pads
 - 3. 3M Moldable Putty Pads
 - 4. Metacaulk® BOX GUARD™ Fire Rated Electrical Box Inserts, By RectorSeal Corporation
 - 5. Metacaulk® Putty Pads
 - 6. Metacaulk® Cover Guard™
 - 7. Bio Fireshield™ Firestopping Gasket
- E. Accessories: as specified by the tested assembly and:
 - 1. Forming/Damming Materials: Mineral fiberboard or other type recommended by manufacturer's tested system.
 - 2. Primer, Sealant and Solvent Cleaner: As recommended by manufacturer's tested system.
 - 3. Fasteners, universal restricting collars, etc. as recommended by the manufacturer's tested system.

2.04 METALLIC STEEL OUTLET BOXES

- A. General use interior boxes shall be galvanized die cast pressed steel units of proper depth and gauge required by the outlet location. Boxes shall be equipped with plaster ring or cover as necessary. These units shall be manufactured by Raco, Steel City or approved equal.
 - 1. Wall outlets: 4" square x 1-1/2" deep (minimum) with plaster ring as required.
 - 2. Ceiling outlet: 4" square or octagonal x 1-1/2" or 2-1/8" deep with stud or ears where required.

3. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide outlet boxes of the type and size suitable for the specific application.
- B. Exposed outlets: malleable iron or heavy cast aluminum with threaded hubs, Type FS, FD or GS as manufactured by Crouse Hinds, Appleton, Killark or approved equal. Die cast stamped steel boxes are not acceptable.
- C. Special system and equipment outlet boxes shall be as recommended by the manufacturers of this equipment. Construct junction or pull boxes not over 150 cubic inches in size as standard outlet boxes and those over 150 cubic inches the same as "cabinets" with screw covers of the same gauge metal.
- D. Drywall: walls the telephone/data rough-ins shall consist of a 4 11/16 "box by 3 1/2" deep (minimum) with plaster ring as required with 1.5" KO conduit stubbed up to the nearest accessible ceiling to the cable tray unless otherwise noted.
- E. Masonry walls: the telephone/data rough-ins shall consist of a 4 11/16 "box by 3 1/2" deep (minimum) with CMU single gang front (mud ring) that fits over the box, with 1.5 " KO conduit stubbed up to the nearest accessible ceiling to the cable tray unless otherwise noted.
- F. Back-to-back outlets in the same wall or "thru wall" type boxes are not permitted. Provide 12" (minimum) long nipple to offset for all outlets shown on opposite sides of a common wall to minimize sound transmission. Provide 24" (minimum) offset for boxes in fire rated walls to comply with code.
- G. Unless otherwise noted, locate outlets as follows. Heights listed are from finished floor to center of device. Mounting heights for other equipment are as shown on the electrical or architectural plans or as herein further indicated.
 1. Convenience and signal outlets: 18 inches above finished floor unless otherwise noted.
 2. Lighting switches: 4 feet, 0 inches
 3. Outlets: 18 inches above finished floor
 4. Where counter occur, mount all devices 44" AFF to top or 2 inches above back splash.

2.05 POLYVINYLCHLORIDE NON-METALLIC OUTLET BOXES

- A. Junction boxes in exposed overhead conduit runs shall be round type with 4-1/2" and 3/4" knockout socket openings. Similar to Carlon E970D and E970E.
- B. Outlet and switch boxes in walls shall be single gang type with one or two 1/2" or 3/4" knockout sockets openings. Similar to Carlon FSS of FSC series.

- C. Outlet boxes in ceiling slabs shall be 2-1/2" deep 4" octagonal stamped steel concrete type box. Each box to be liberally coated inside and outside with spray on PVC coating similar to Carlon.
- D. All junction and outlet boxes shall be of a NEMA Type 3R construction in wet outdoor areas and NEMA Type 12 in moist indoor areas.
- E. Junction boxes with hinged covers shall be fully gasketed and shall be available in the following sizes:
 - 1. 4" x 4" x 4" Similar to Carlon E987N
 - 2. 6" x 6" x 6" Similar to Carlon E987R
 - 3. 8" x 8" x 8" Similar to Carlon E989N
 - 4. 12" x 12" x 12" Similar to Carlon E989R

2.06 ANCHORS AND FASTENERS

- A. Anchors and fasteners shall be of a type designed and intended for use in the base material to which the material support is to be attached and shall be capable of supporting the intended load and withstanding any associated stresses and vibrations.
- B. In general, screws shall be used in wood, masonry anchors on concrete or brick, toggle bolts in hollow walls, and machine screws, bolts or welded studs on steel.
- C. Nails shall not be used except for temporary support or for light loads in wood frame construction.
- D. In outdoor locations or other corrosive atmospheres, the anchors and fasteners shall be non-corrosive or have suitable corrosion resisting coatings.

2.07 JUNCTION AND PULL BOXES

- A. Special junction boxes shall be sized as required for the conductors and number of splices they are to house. They shall be made from galvanized sheet metal and sized in accordance with the National Electric Code (NEC).
- B. Type: code gauge sheet steel, galvanized sized in accordance with NEC.
- C. Covers: Hinged covers with locks.

2.08 WALL SLEEVES

- A. Each sleeve shall consist of a sleeve body, oversized conduit and a pressure clamp, pressure ring and sealing grommet.
- B. The basic design of the sleeve shall be such that will allow the sleeve body and sleeve conduit to be cast into the concrete walls and the sleeve pressure clamp to be installed at a later date.
- C. The sleeve body and conduit shall be so designed to accept several different size

pressure clamp assemblies.

D. Sleeve Construction shall be as follows:

1. Body: the body shall be malleable with hot dip galvanized finish. Provide ground lug connection for #8 AWG copper conductor. Sleeve body shall have a sealing ring between the body and the conduit sleeve.
2. Conduit Sleeve: the conduit sleeve portion shall be oversize PVC sleeve.
3. Pressure Clamp and Pressure Ring with Sealing Grommet: the body shall be so designed to accept the following:
 - a. Pressure Clamp: shall be constructed of malleable iron with hot-dip galvanized finish with hex headscrews that anchor into the sleeve body.
 - b. The sealing grommet shall consist of an expandable type of long lasting elastic material that is sandwiched between two (2) malleable hotdip galvanized pressure plates. All sized for the exact O.D. thickness of conduit that will pass through the sleeve.

E. Manufacturer: similar to O-Z/Gedney type "FSK" #1020, 2030, 3040 or 4050 as indicated on drawings.

PART 3 - EXECUTION

3.01 CONDUIT USAGE

(All conduit types noted are acceptable for use listed.)

A. General

CONDUIT TYPES

1.	Underground electrical & telephone service entrance	RGS	IMC	PVC
2.	Electrical & telephone services other than underground	RGS	RA	
3.	Conduits in concrete slab	RGS	IMC	PVC
4.	Conduits below lowest floor slab	RGS	IMC	PVC
5.	Hazardous Area Class I, Div. I or II, Class II, Div. I of II (aluminum not acceptable in Moist alkaline environments)	RGS	IMC	RA
6.	Conduits in moist locations or exposed to weather (Parking Garage)	RGS	IMC	RA
7.	Feeders, power circuits (1-1/4" and larger)	RGS	IMC	RA
8.	Branch lighting and receptacle circuits (up to and Including 60 amp)		IMC	EMT
9.	Underground to remote locations. (Rigid or IMC must be liberally coated with asphaltum)	RGS	IMC	PVC

10.	Final connections to motor, transformers or other equipment requiring vibration isolation. (max. length of 36")	FMC	LFMC	MC
11.	From junction box to recessed lighting fixture	FMC	LFMC	MC
12.	Short connections where use of rigid is Impractical (must be approved by Engineer prior to installation)			
13.	For mechanical protection	RGS	RA	IMC
14.	Final connections to motors, transformers, under computer floors or other equipment In moist locations requiring vibration Isolation. Maximum length of 36" unless otherwise noted.	LFMC		
15.	All other locations unless otherwise noted	EMT		
16.	For ground electrode connectors	PVC		
17.	Fire alarm	RGS	IMC	EMT
18.	Security (access control and CC Cameras)	RGS	IMC	EMT
19.	Data, AV and other low voltage systems	RGS	IMC	EMT

NOTE:

- RGS: Rigid galvanized steel
- IMC: Intermediate metal
- EMT: Electrical metallic tubing
- PVC: Polyvinyl chloride
- FMC: Flexible metal conduit
- LFMC: Liquidtight flexible metal conduit
- RA: Rigid aluminum
- MC: "MC" cable

- B. Conduit fill shall be limited to not more than six (6) conductors or 3 phase A,B,C circuits, not including ground conductor.
- C. NO conduit shall be supported from the ceiling grid system assembly
- D. NO boxes shall be supported from the ceiling grid system assembly.
- E. All areas in Parking lots or similar applications subject to ambient temperature and ambient humidity shall be considered "Moist Locations."

3.02 PULL WIRES

- A. RGS, IMC, EMT: Use steel, nylon or polypropylene pull wires.
- B. PVC, RA, FMC, LFMC: Use nylon or polypropylene only.

3.03 CONDUIT INSTALLATION (GENERAL)

- A. The conduct system to be electrically continuous and shall be grounded in accordance with NEC. Separate grounding conductors to be used in all conduits.

- B. All conduit terminations to be equipped with locknuts and bushings. Conduits 1-1/4" and larger shall have insulating bushings, grounding lug and shall have locknuts inside and outside the enclosure.
- C. Conduits to be supported by pipe straps or trapeze hangers shall have their supports spaced not more than 8'-0" on center. Secure supports by means of toggle bolts, inserts or expansion bolts. MC cable shall be supported at distances no greater than 6 feet and with 12 inches of terminations at boxes and panels. PVC conduit shall be supported at distances not greater than the distances as required by NEC table 352.30.
- D. Conduits to be supported by wall brackets shall have their supports spaced not more than 4'-6" on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
- E. Conduits shall be supported directly from structural members not from ceiling suspensions system, ductwork, air handling units, pump bases, piping, etc. Additional supports shall be provided at junction and pull boxes.
- F. Conceal raceways in floors, walls, ceilings or furred spaces in finished areas unless otherwise noted on drawings.
- G. Support single horizontal conduits 1-1/4" and larger by means of rod and cast ring hangers. Support multiple horizontal runs of conduit in similar manner or use common trapeze hanger similar to Unistrut P2000 or P4000 as required for span and loading. Provide end caps on Unistrut type hangers in mechanical rooms. Conduits on Unistrut may be fastened by means of heavy galvanized steel straps if the Unistrut is above 7'-0" above finished floor.
- H. Surface mounted horizontal and vertical conduit supports on walls up to a height of 7'-0" above the floor shall be one or two hole sheet metal pipe straps. Pinch type hangers similar to Minerallac type may only be used at heights greater than 8'-0". The use of pinch type hangers similar to Minerallac type are expressly prohibited on ductwork, air handling units, and other mechanical equipment below 8'-0".
- I. Protect conduits during construction with temporary plugs or caps. All conduit shall be securely capped until wire or cable is installed therein.
- J. Minimum conduit size shall be 3/4" for electrical.
- K. No conduit shall be installed in elevated or supported concrete slabs except as noted on Structural Drawings and/or as approved by Structural Engineer.
- L. Provide three 1" conduits stubbed out into furred ceiling space above each flush mounted panelboard or cabinet.
- M. Running conduit horizontally in walls is not permitted. Convenience outlets, switches or other devices located on or in walls shall be individually fed overhead from ceiling unless otherwise noted or indicated on the drawings.

- N. Furnish expansion fittings where raceway crosses the building expansion joints. (O.Z. Type AX, EX, EXDS, TX, EXE or approved equal.)
- O. Provide pull wire in all conduits where other contractors or utilities are to install cables (i.e.: telephone, computer and other such conduit systems).
- P. Electrical drawings show the intended arrangement and electrical equipment and devices, they shall be followed as closely as actual building construction will allow. 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. Should an interference arise, the Contractor shall inform the Engineer before proceeding with the work. Should the Contractor fail to contact the Engineer and interferences develop, the Owner's Representative will decide which equipment, piping, etc. must be replaced, regardless of which was installed first. The relocating shall be performed at no expense to the Owner.
- Q. Conduit shall be continuous between power source, equipment, junction or pull boxes and fittings, and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from point of service to all outlets.
- R. There shall not be more than the equivalent of three 90° bends in any single run of conduit between outlet boxes or fittings. Bends shall be made so that the conduit will not be flattened or kinked and that the internal diameter of the conduit will not be reduced. The radius of the curve of the inner edge of any bend shall not be less than as indicated by the National Electrical Code.
- S. 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.
- T. When it is necessary to make field bends, they shall be made with tools designed for conduit bending. Heating of metallic conduit to facilitate bending is not permitted.
- U. Conduit shall be installed so as to incorporate a minimum of one pull box or conduit fitting per 100 foot run for easy installation of wire.
- V. 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 Owner or Engineer.
- W. Use compression type fittings on all EMT conduit.
- X. Pulling of wire or cable shall be immediately preceded by a thorough cleaning of the conduit to make it completely free of water or foreign matter.

- Y. Mount all conduits a minimum of seven inches above any accessible type ceiling or with spacing as required to permit relocation of recessed fixtures to any location.
- Z. Below or in floor conduit installation is to be anchored to prohibit floating within the concrete floor installation. Obtain approval from a flooring consultant on the proper cutting and patching required for existing floor electrical installations to insure proper floor finish results.
- AA. Feeder conduits run under on grade tenant floor slab areas are to be installed a minimum of 36" below finished slab elevation, be concrete encased with a minimum of 3" cover and have a yellow warning tape installed 6" above the concrete encasement. Dimensioned as-built drawings showing final locations are to be provided to the Engineer and Owner immediately after the installation is complete. Conduit to be concrete encased may be Schedule 40 PVC.
- BB. Exterior site lighting conduit will be Schedule 40 PVC with a minimum size of 2". Burial depth shall be a minimum of 24" below grade or below the frost line, whichever is greater.
- CC. All conduit installed outdoors/indoors or in concrete shall be temporarily capped or plugged immediately after installation. Seal all conduit penetrations where conduit passes from wet to dry areas.
- DD. MC cable shall be supported with appropriate style hangers and not tie wraps alone. Tie wraps shall be used for bundling cables and supplementary supports. Tie wraps shall be plenum rated. MC cable shall not be bundled together longer than 24" or conductors shall be de-rated.
- EE. Conduits crossing building expansion joints shall include expansion joints for the conduits.
- FF. PVC conduit shall not be used from 18" below grade or finished floor to 10'-0" above grade or finished floor.
- GG. Trenches within the building: Entire trench shall be backfilled with No. 14-2 sand in six inch layers to subgrade line for capillary water barrier.

3.04 SPECIAL CONDUIT LOCATION REQUIREMENTS

- A. Conduit run shall be kept at least six inches from insulated pipes, steam lines or any other hot pipes which 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.
- B. The location and sizing of conduit sleeves passing through floors, walls, etc. that are not shown on the drawings shall be the responsibility of the Contractor subject to the Owner and Engineer's approval.
- C. Install all raceways concealed except at surface cabinets, for motor and

equipment connection and in mechanical rooms.

- D. Provide flashing and counterflashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. which penetrate the roof.
- E. Route all raceways parallel or perpendicular to the building lines with right angle turns and symmetrical bends.
- F. Provide sleeves in forms for concrete walls, floor slabs and partitions for passage of raceways. Seal in an approved manner all raceway openings and sleeves through fire rated walls, floors and ceilings after raceway installation. Waterproof all sleeves raceways where required. Submit shop drawings showing locations of all sleeves through slabs, walls and masonry partitions.

3.05 CONDUIT INSTALLATION (RIGID AND IMC)

- A. Rigid and IMC conduit shall utilize threaded type fittings. Ends of conduit shall be threaded with five full threads and shall be reamed out to remove any rough edges and burrs. All conduit shall be thoroughly cleaned internally prior to installation of the conductors. Long threads known as "running threads" shall not be used. Field cuts on conduit shall be made with a hand or power saw or approved cutting machine and shall be made square.
- B. Conduit threads shall be coated with an approved conductive lubricant before the couplings are applied. Teflon tape shall not be used to lubricate any threaded conduit connections.

3.06 CONDUIT INSTALLATION (ALUMINUM)

- A. Use nylon pull ropes only with aluminum conduit.
- B. Lubricate screw threads with approved aluminum lubricant before assembling conduit fittings to pipe.
- C. Aluminum conduit shall not be used below grade, in contact with earth, or in contact with concrete.

3.07 CONDUIT SLEEVES

- A. Furnish, 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 construction. Sleeves through poured-in-place concrete floors shall be set prior to the pour and shall be of a design that will seal against passage of water between sleeves and concrete floor.
- B. Wall sleeves shall finish flush with walls. Floor sleeves shall extend 3" above finished floors unless otherwise specified.

- C. The void between the sleeve wall and conduit shall be neatly filled with an approved fire stop material.

3.08 FIRE ALARM CONDUIT

- A. Interior concealed dry spaces
 - 1. RGS, IMC, or EMT
 - 2. Where otherwise directed on drawings, or with Engineers approval, plenum rated, MC type cable specifically manufactured for use with Fire Alarm Systems shall be used in interior concealed dry spaces (MC-FPLP). Jacket shall have red coloring.
- B. Interior exposed, or in moist locations RGS or IMC shall be used.

3.09 UNDERGROUND RACEWAYS

- A. Low Voltage Feeder/Service Entrance
 - 1. The system shall consist of Schedule 40 PVC, IMC or RGS conduits. Concrete encased and quantity as indicated on drawings. Minimum conduit size is 4" unless otherwise noted on the drawings.
 - 2. Spacing between conduits shall be a minimum of 2" and the concrete envelope where required shall be 3" thick. Use end bell fittings where conduits terminate in manholes or building walls.
 - 3. Plastic conduit spacers shall be used to support conduits and to maintain proper spacing. Install polyethylene plugs on unused conduits.
 - 4. The top of duct banks shall be minimum of 2'-6" below grade and shall be sloped to drain away from buildings.
 - 5. Install a magnetic type marking tape 1' above top of duct bank. Bends in duct bank shall be 30" minimum radius.
 - 6. Where concrete encased duct bank connects to a building install #4 re-bars in corner and tie to building wall reinforcing steel. Use similar method at manholes. (minimum concrete above the conduit shall be 3 inches, and 4 inches on each side.)
 - 7. At completion of construction of duct bank pull a brush or pig through all conduits in presence of Owner's representative to verify accessibility of conduit system.
- B. Low Voltage Branch Circuits
 - 1. Minimum burial depth of 2'-6" for Schedule 40 PVC is required. Junction boxes and covers for branch circuits shall be constructed of cast iron or cast aluminum with neoprene gaskets and stainless steel screws.

C. Telecommunication System

1. The underground raceway system for the telecommunication system shall be constructed with similar methods to those outlined above in paragraph 'A' except use Schedule 40 PVC conduit only for telecommunications ducts.
2. Install "inner-duct" in one of the ducts as follows:
 - a. Manhole-to-building" (1) 3 channel inner-duct, 1-1/2" channel.
 - b. Inner-duct shall be U.L. listed for use with telecommunications/fiberoptic cabling systems.
 - c. Manufacturers: Carlon or approved equal.

3.10 INSTALLATION OF UNDERGROUND CONDUITS UNDER THE BUILDING SLAB

- A. No conduit shall be installed in the building slab unless otherwise noted.
- B. All under slab conduits shall be installed per NEC.
- C. All underground conduits must be neatly installed.
- D. All underground conduits shall have spaces between them and shall have separation of at least 12 inches between low voltage and high voltage.
- E. All underground conduits shall be installed above flowable fill under slab.
- F. All conduits shall be 12 inches below concrete slab, with flowable fill above the conduit to the slab water barrier.

3.11 OUTLET BOX INSTALLATION

- A. Set box square and true with finished building surfaces and trim.
- B. Secure boxes firmly to building structure.
- C. Verify location of outlets and switches in finished rooms with Architectural Drawings of interior details and finish. In centering outlets and locating boxes, allow for overhead pipes, ducts and mechanical equipment, variations in fireproofing and plastering, window and like, and correct any inaccuracy from failure to do so without expense to the Owner.
- D. Maintain symmetry of all outlets as closely as possible within Architectural Section contained. For example, the Contractor shall center light fixture over doorway or receptacle in section of masonry wall, if shown in that approximate position. If receptacle is shown in same location as counter or bench, determine countertop height and set receptacle to clear top and trim of counter and render outlet easily accessible.
- E. In the event of conflict between locations of electrical outlets as shown on the Electrical Drawings and on the Architectural Drawings, outlets shall be installed in accordance with the latter.

- F. Locate light switches on latch side of door and verify door hinge location in field prior to switch outlet installation.
- G. Protect devices on outlets in locations where outlets are subject to injury, by means of wire guards or other approved means of protection. (Example: Provide wire guards on all "exit" signs, emergency egress lighting and other surface mounted equipment in gymnasiums).
- H. The Owner reserves the right to relocate any device as much as 10'-0" (measured horizontally) from its indicated location at no additional cost, provided the contractor is notified prior to roughing that device in.

3.12 JUNCTION AND PULL BOX INSTALLATION

- A. Provide pull boxes wherever necessary to facilitate pulling of wire and as indicated.
- B. Locate junction and pull boxes as approved, generally not exposed in finished space unless otherwise indicated or approved by Engineer. Where necessary, reroute conduit or make other arrangements for concealment as required.
- C. Covers shall be accessible.
- D. Junction boxes for fixtures, recessed in hung ceiling, to be accessible through opening created by removal of the fixtures.

3.13 SLEEVE INSTALLATION

- A. Sleeves shall be mounted in concrete forms prior to concrete pour as recommended by sleeve manufacturer.
- B. Oversized PVC conduit sleeve shall be cut off to proper length prior to pour.
- C. Sleeve shall be capped at both ends as recommended by manufacturer to prevent entry of foreign material during concrete pour.

3.14 EPC-40-PVC CONDUIT INSTALLATION

- A. Conduit system to be continuous in accordance with NEC. Separate grounding conductors to be used in all conduit runs.
- B. All conduit terminations to be equipped with bushing type box adapters.
- C. Conduit to be supported by wall brackets or pipe straps on trapeze hangers spaced not more than 3'-0" on center. Secure supports by means of toggle bolts, inserts or expansion bolts. Pipe straps shall be so designed to allow expansion and contraction of pipe.

- D. Conduit above ceilings to be supported from structural system, not from ceiling suspension system. Additional supports shall also be provided at junction or pull box locations.
- E. Conceal raceways in floors, walls, ceilings or furred spaces in finished areas wherever possible.
- F. Protect conduits during construction with temporary plugs or caps.
- G. Minimum conduit size – 3/4".
- H. No conduit larger than 1" size to be installed in concrete slab.
- I. Provide code size green grounding conductor in all raceways. See NEC Table 250-95.
- J. Provide three 1" conduits stubbed out into furred ceiling space above each flush mounted panelboard or cabinet.
- K. PVC conduit turning up from below grade shall transition to RGS/IMC elbows at 18" below grade.

3.15 FIRE STOP INSTALLATION

- A. General
 - 1. Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designated as insulation, safing, or otherwise. Firestopping shall preserve integrity of fire rating of barrier.
 - 2. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
- B. Interior Walls and Partitions
 - 1. Where a wall or partition is continuous past a structural floor, such as a stairwells and vertical shafts, and a space would otherwise remain open between the wall face and perimeter edges of the adjoining structural floor, provide firestopping.
 - 2. Provide firestopping whether or not there are any clips, angles, plates or other members bridging or interconnecting the wall and floor systems, and whether or not such items are continuous.
 - 3. Where the top edge of a fire-rated wall or partition abuts and is at right angles to fluted-type metal decking, and the construction is such that would otherwise leave the flute spaces open, provide firestopping.

C. Penetrations

1. Penetrations include conduit, cable, wire, pipe, duct or other elements which pass through one or both outer surfaces of a fire rated floor, wall, or partition.
2. Except for floors on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof, provide firestopping to fill such spaces in accordance with ASTM E-1966 and UL2079 for dynamic movement.
3. Where penetrations occur at fire-rated walls or partitions of solid-type construction, provide fire-stopping to completely fill spaces around the penetration, in accordance with ASTM E-814.
4. Where penetrations occur at fire-rated walls or partitions of hollow-type construction, provide fire-stopping to completely fill spaces around the penetration, on each side of the wall or partition, in accordance with ASTM E-814.
5. These requirements for penetrations shall apply whether or not sleeves have been provided and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, fire stop annular spaces - if any - between sleeve and wall of opening.
6. Where openings occur for expansion, at intersections of dissimilar rated construction, or control joints provide a rated joint system in accordance with ASTM E-1966 or UL 2079.

D. Provide firestopping to fill miscellaneous voids and openings in fire-rated construction in a manner essentially the same as specified herein before.

E. General

1. Install of FireStops shall be performed by either a specialty contractor specializing in Firestop application (FM4991 Approved Contractor), or general or sub-contractors with experience in similar applications and projects with installers qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
2. Apply Firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
3. Coordinate with plumbing, mechanical, electrical and other trades to assure that all pipe, conduit, cable, and other items which penetrate fire rated construction have been permanently installed prior to installation of Firestops, schedule and sequence the work to assure that partitions and other construction, which would conceal penetrations, is not erected prior to the installation of Firestops.

- F. Dam Construction: Install dams when required to properly contain Firestopping materials within openings and as required to achieve required fire resistance rating. Combustible damming material must be removed after appropriate curing. Incombustible damming materials may be left as a permanent component of the Firestop system.
- G. Fire Quality Control
 - 1. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.
 - 2. Follow safety procedures recommended in the Material Safety Data Sheets.
 - 3. Finish surfaces of firestopping which is to remain exposed in the completed Work to a uniform and level condition.
 - 4. All areas of Work must be accessible until inspection by the application Code authorities.
 - 5. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification at no additional cost.

END OF SECTION

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SECTION 26 05 36 - CABLE TRAYS

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Wiring (600V or less): Section 26 05 19
- D. Division 27

1.02 SUBMITTAL

- A. Provide submittal data for cable tray systems and components in accordance with Specification Section 26 05 01.

1.03 SCOPE OF WORK

- A. Provide a cable tray system for communications and data cabling as indicated on the drawings as specified herein.

PART 2 - PRODUCTS

2.01 WIRE BASKET RUNWAY SECTIONS AND COMPONENTS

- A. General: Provide wire basket of types and sizes indicated with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

2.02 TYPE OF WIRE BASKET RUNWAY SYSTEM

- A. All straight section longitudinal wires shall be straight (with no bends).
- B. Wire basket runway shall be made of high strength steel wires and formed into a standard 2 inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along runway sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
- C. Wire basket sizes shall have a 4-inch usable loading depth by widths indicated on the drawings.
- D. All fittings shall be field formed as needed.
- E. Wire basket runway supports shall be center support hangers or trapeze hangers

as required to support basket runway below raised access floor.

- F. Trapeze hangers or center support hangers shall be supported either 1/4 inch or 3/8-inch diameter rods.
- G. Special accessories shall be furnished as required to protect, support and install a wire basket runway system.

2.03 WIRE BASKET MANUFACTURER

- A. The cable tray and fittings shall be manufactured by
 - 1. Cooper B Line
 - 2. E.Z. Tray
 - 3. Mono-Systems Inc.
 - 4. MP Husky
 - 5. PW Industries, Inc.
 - 6. Flextray by GS Metals
 - 7. Cablofil

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Splice Connectors: Sections of tray shall be joined using a two bolt rectangular splice connector which telescopes into the spline of the tray. Splice connectors shall allow for thermal expansion/contraction of the tray system.

3.02 INSTALLATION FOR WIRE BASKET

- A. Install wire basket runways as indicated; in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
- B. Provide sufficient space encompassing wire basket runways to permit access for installing and maintaining cables.

END OF SECTION

SECTION 26 05 40 - TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Raceways and Boxes: Section 26 05 33
- D. Electricity Metering: Section 26 27 13

1.02 REFERENCES

The latest issues of the following documents form a part of this specification to the extent hereinafter specified.

- A. American Society of Testing Materials (ASTM)
 - 1. D698 Standard Proctor Maximum Dry Density
 - 2. D1556-64 Density of Soil in Place by the Sand Cone Method
 - 3. D2167-66 Density of Soil in Place by the Rubber Balloon Method
- B. Indiana State Highway Commission Standard Specifications (ISHSS), Section 903, Aggregates

1.03 DELIVERY, STORAGE AND HANDLING

- A. Imported materials shall be stockpiled on site where directed if not ready for installation. Maintain segregation of differing materials.
- B. Do not deliver materials until ready for incorporation into the permanent work. Storage space is not available.

1.04 PROJECT/SITE CONDITIONS

- A. Subgrade and embankment protection
 - 1. During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along the subgrade shall be maintained in such manner as to drain effectively at all times.
 - 2. Operate pumping equipment as required to keep the excavation free of water and subgrades dry, firm and undisturbed until approval of the permanent work has been received from the Architect.

3. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped if required and recompact prior to the placing of surfacing.
 4. The storage or stockpiling of materials on a finished subgrade will not be permitted.
 5. Erosion control shall be performed by this Contractor until the installation of permanent vegetation, structures and erosion control devices.
- B. Protection of topsoil areas: after placement of topsoil, all such areas shall be protected from heavy machinery. All topsoil compacted by heavy machinery shall be removed and replaced at no additional cost to the Owner.
- C. Shore and brace excavations as necessary to prevent cave-ins.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Select Aggregate: No. 14-2 sand in accordance with ISHSS 903.01(g).

PART 3 - EXECUTION

3.01 INSPECTION

Before commencement of work, verify the following with the documents associated with all site work.

- A. Verify installation of fences.
- B. Protective fencing for trees and plants has been installed as specified.
- C. Demolition of miscellaneous structures.
- D. Clearing and grubbing.
- E. Stripping and disposal of sod and stripping and stockpiling of topsoil.

3.02 PREPARATION

- A. Layout the various lines on the ground using stakes, flags or painting.
- B. Do not proceed with excavation until layout is approved.
- C. Set line and grade stakes as required or specified in the various sections covering the installation of conduits.

3.03 TRENCHING

- A. General: All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations and any water accumulating therein shall be removed by pumping or by other approved methods. Sheet piling and shoring shall be placed as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if the conduit can be safely and properly installed and backfill can be compacted in such tunnel sections.
- B. Trench Excavation: Trenches shall be of the necessary width for proper laying of conduit. The banks of trenches shall be as neatly vertical as practicable. Care shall be taken not to over-excavate. The bottom of the trenches shall be accurately graded to provide a uniform surface for the type of bedding specified. Stones shall be removed as necessary to avoid point bearing. Except as hereinafter specified for wet or otherwise unstable material, overdepths shall be backfilled as and with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the conduit is encountered in the bottom of the trench, such material shall be overexcavated to a depth to allow for construction of a stable conduit bedding.
- C. Special requirements for specific utilities.
 - 1. Electrical Conduits: unless otherwise indicated, trenches shall be excavated to a depth that will provide not less than 3 feet of cover over the top of the conduit from finished grade.
 - 2. Excavation for Appurtenances: Excavation for manholes, junction boxes and similar structures shall be sufficient to leave at least 12" clear space between the outer surface of structure and the bank or timber that may be used to hold and protect the banks. Any overdepth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with sand, gravel or concrete as directed at no additional cost to the Owner.

3.04 BACKFILLING

- A. General: After bedding, the trenches shall not be backfilled until all required tests are performed. Except as otherwise specified for special conditions of overdepths, trenches shall be backfilled to the ground surface with selected material as hereinafter specified. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified or the condition shall be restored to its original condition as near as practicable and as hereinafter specified.

- B. Backfilling lower portion of trench: No. 14 sand shall be deposited in 6-inch maximum thickness layers and compacted with suitable tampers to the specified density and graded as hereinafter specified until there is a cover of not less than one foot over other utility lines unless detailed otherwise. If any portion of the cover in the lower portion of the trench is in the depth of special compaction and materials requirements under pavement, the special requirements shall control. Special care shall be taken not to damage the coating or wrapping of conduit.
- C. Backfilling remainder of trench: Except for special materials for pavements, the remainder of the trench shall be backfilled with excavated material that is free of stones larger than three inches or one-half the layered thickness, whichever is smaller, in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified hereinafter and each layer shall be compacted to the minimum specified hereinafter as applicable to the particular area.
- D. Backfilled under Roadways, Parking Areas and Walks: Six inch layers, at least 95% of maximum density at moisture contents ranging from 1% below to 4% above optimum up to the elevations at which the requirements for pavement subgrade materials and compaction control.
- E. Trenches within the building: Entire trench shall be backfilled with No. 14-2 sand in six inch layers to subgrade line for capillary water barrier.
- F. Under sodded or seeded areas: Twelve inch layers, at least 88% of maximum density at moisture contents ranging from 1% below to 4% above optimum up to the elevation at which topsoil requirements control.
- G. Topsoil placement: Placement and depth as indicated on the drawings or described herein. Contractor shall overfill by 20% to allow for settlement.

3.05 TESTS

- A. Tests for and Control of Density: Tests for determination of maximum density and optimum moisture shall be the responsibility of the Electrical Contractor and shall be performed by the Testing Agency in accordance with the requirements of ASTM D698 Standard Proctor maximum dry density. Samples shall be representative of the materials to be placed. An optimum moisture-density curve shall be obtained for each principal type of material or combination of materials encountered or utilized. Results of these tests shall be the basis of control for compaction. The above testing shall include Atterberg limits, grain size determinations and specific gravity.
- B. Test for Density Control: The Testing Agency will control the density of the backfill by test made in accordance with ASTM Standard D1556. A density test shall be made for each foot of fill for each 200 lineal feet or less of trench. The Contractor shall make as many additional tests as he requires to obtain the specified density at all points.

3.06 PAVEMENT REMOVAL AND REPLACEMENT

- A. Where construction requires cutting and replacing of flexible pavement, cutting

shall be so accomplished that the remaining exposed edges shall conform vertically and horizontally to a straight line. Width of the section of pavement removed shall be of necessary width for proper laying of pipe or duct. After the pavement is removed to its full depth, the surface course shall be cut back one foot on both sides of the trench with a concrete saw to provide a true joint in the surface courses. Pavement removed shall be replaced to the same section, materials and compaction as the original pavement. Waste materials shall be disposed of by the Contractor offsite at his own expense and responsibility.

- B. Where construction requires removal and replacement of rigid pavement, the cutting shall be accomplished by a concrete saw, minimum depth of vertical cut shall be one inch. The remaining depth of section may be broken out in any approved manner. Width of section removed shall be such that no area of pavement removed or replaced and no adjacent slab or portion of slab which remains in the pavement abutting the replacement slab shall have length or width between joints of less than 10 feet. Pavement removed shall be replaced to the same section using Class E concrete. Concrete rubble resulting from the above operations shall be disposed of offsite at the Contractor's expense and responsibility.

END OF SECTION

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SECTION 26 05 53 - IDENTIFICATION OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01

1.02 SUBMITTALS

- A. In accordance with Specifications Section 26 05 01, General Provisions, submit manufacturer's data on labels. Include a listing of labels ordered with name of equipment or control device.

1.03 IDENTIFICATION

- A. Labeling
 - 1. Label all electrical equipment or controls provided or connected by Electrical Contractor by means of engraved laminated plastic plates screwed or riveted to the devices. Height of letters not to be less than 1/4" unless otherwise specified or directed.
 - 2. Items to be labeled shall include, but not be limited, to the following:
 - a. All motor starters, contactors, safety switches, relays, etc.
 - b. All remote pushbutton stations
 - c. Remote control and specialty switches for lights, etc.
 - d. All motors which cannot be readily identified by their starter label when observer is standing at the motor.
 - e. All main switches or circuit breakers
 - f. All panelboards shall be labeled on outside of door with both source and destination. All final destinations shall be labeled with the source. Example: Panel "A" 120/208V-3PH-4W fed from panel "MDP" via "HC-1".
 - g. Panelboard circuit identification cards shall be typewritten.
 - h. Relay cabinets
 - i. Automatic transfer equipment
 - j. Receptacles
 - k. Cover plates
 - l. Junction boxes
 - 3. Printed card labels may be used on items of equipment furnished with plastic windows. Labeling of card shall be neatly printed using lettering device such as a Leroy Instrument.
 - 4. Embossed, adhesive tape labels are not permitted.

5. Panelboards:
 - a. New Directories: filled in complete (Typewritten) listing each circuit and respective equipment served and rooms where outlets, lights, etc., are located.
 - b. In addition, all concealed junction and/or pull boxes shall be painted to match the color code of the conduit system to which they are connected and shall be labeled legibly by hand in permanent ink to indicate the panel and circuit numbers which are contained within the junction and/or pull box.
6. Raceway: **all** raceways both exposed and concealed above accessible ceilings shall be labeled to identify contents. Weatherproof adhesive type labels shall be applied a minimum of every 10'-0" or as required to provide at least one (1) label within each space or room.
7. Wiring and cabling: Systems wiring and cabling not run in conduit shall be tie wrapped and labeled a minimum of every 10'-0" or as required to provide at least one label within every space. Labels for various cable systems shall be grouped together in each location to provide ease of system identification.
8. Examples of system abbreviations/labels shall be as follows: (Note: this list may not be all inclusive.)

<u>Raceway</u>	<u>Label</u>
Power Circuits	"Danger" (voltage contained; normal power black letters; emergency power red letters)
Fire Alarm System	"FA"
Tele/Data System	"TD"
Temperature Control	"TEMP CTL."
Paging System	"PAG"
Telecommunications System	"TELE"
Television System	"TV"

**PART 2 - EXECUTION
NOT USED**

**PART 3 - EXECUTION
NOT USED**

END OF SECTION

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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.

1.02 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1.03 WORK INCLUDED BUT SPECIFIED ELSEWHERE

- A. Commissioning of Building Systems: Section 01 91 01

1.04 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

1.05 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
1. CGI CYME.
 2. SKM Systems Analysis, Inc.
 3. Easy Power

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Impedance of utility service entrance.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.03 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Distribution panelboard.
 - 2. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 2. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.04 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 241 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P- 32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

3.05 ARC FLASH BOUNDARY ANALYSIS

- A. Determine the arc flash boundary for medium voltage switchgear, unit substations, distribution switchboards and panelboards to determine the energy exposure in accordance with NFPA 70E.2004.
- B. Provide and install labels to indicate level of hazard in accordance with NFPA 70E-2004. Install labels on each piece of equipment.

3.06 CORRECTIVE MEASURES

- A. Electrical Contractor shall correct all identified problem areas prior to project acceptance. Review all problem areas and proposed corrective actions with the Engineer prior to corrective actions being implemented.

END OF SECTION

SECTION 26 08 01 - PERFORMANCE TESTING

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Grounding and Bonding Electrical Systems: Section 26 05 26
- D. Panelboards: Section 26 24 16
- E. Wiring Devices: Section 26 27 26
- F. Low Voltage Circuit Protective Devices: Section 26 28 00
- G. Low Voltage Controllers: Section 26 29 00
- H. Diesel Engine Driven Generator Sets: Section 26 32 13.13
- I. Automatic Transfer Switches: Section 26 36 23
- J. Fire Alarm and Detection System: Section 28 31 00

1.02 SCOPE OF WORK

- A. Complete testing of all systems as herein specified in the presence of the Architect/Engineer and/or Owner's agent.
- B. Electrical Contractor shall be responsible for documenting all performance test results for submittal to the Engineer, Owner. Insert final report in the maintenance manuals.
 - 1. All testing procedures and forms shall be submitted during the submittal process. The forms will detail the Contractor's testing plan with actual equipment, feeders, system details, to be tested. The forms shall be completely filled out prior to testing. This submission is the Contractor's detailed plan as to which piece of equipment on this project is being tested. The test forms shall be specific to this project. Generic test forms will not be accepted.

- C. Scheduling of tests shall be as required for timely completion of construction but with as much consideration as possible for the Owner, Engineer and Construction Manager. A minimum of 72 hours notice shall be given before any scheduled tests.
- D. Testing whenever possible shall be undertaken only on completed systems. Partial system testing shall be acceptable only with prior approval of the Engineer and the Owner. Test results of partial tests shall be submitted at the time of test and also be included in the final system test reports.
- E. Testing of systems as listed herein shall be in accordance with industry standards, practices and recommendations.

**PART 2 - PRODUCTS
NOT USED**

PART 3 - EXECUTION

3.01 TESTING PROCEDURES

- A. Electrical Wiring (600V and less feeder cables only)
 - 1. Visual and Mechanical Inspection
 - a. Inspect cables for physical damage and proper connection in accordance with single line diagram.
 - b. Test cable mechanical connections to manufacturer's recommended values with a calibrated torque wrench.
 - c. Check cable color coding with applicable Engineer's specifications and National Electric Code Standards.
 - 2. Electrical Tests
 - a. Perform insulation resistance test on each feeder conductor with respect to ground and adjacent conductor. Applied potential to be 1000 volts dc for 1 minute.
 - b. Perform continuity test to ensure proper cable connection.
 - 3. Test Values: minimum insulation resistance values shall be not less than two megohms.
 - 4. List all feeder cables to be tested and submit the forms prior to actual testing. The forms must be approved by the Engineer.
- B. Panelboards (Circuit Breakers)
 - 1. Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
 - 2. Operate circuit breaker to ensure smooth operation.
 - 3. Inspect case for cracks or other defects.
 - 4. Check tightness of connections with calibrated torque wrench. Refer to manufacturer's instruction.

5. Record phase to phase, phase to neutral voltages and panelboards full load current.
 6. List all panel boards, switchgear, fused switches and circuit breakers to be tested. Submit the forms prior to actual testing. The forms must be approved by the Engineer.
- C. Wiring Devices: Test receptacles with Woodhead #1750 or Hubbell #5200 Tester for proper connection of ground wire and correct polarity. . List all receptacles to be tested within a circuit grouping. All receptacles shall be tested, but circuit grouping reports only are required.
- D. Motor Starters:
1. Inspect for physical damage, proper anchorage and grounding.
 2. Compare equipment nameplate data with design plans or starter schedule.
 3. Motor Running Protection
 - a. Compare overload heater rating with motor full load current rating to verify proper sizing. Record heater rating.
 - b. If power factor correction capacitors are connected on the load side of the overload heaters, include the capacitive reactance in determining proper overload heater size.
 - c. If motor running protection is provided by fuses, verify proper rating considering motor characteristics and power factor correction capacitors if applicable.
 - d. Check tightness of bolted connections.
 4. Record phase to phase voltages and running load amperage for each starter.
 5. Check all motors for correct rotation. The Electrical Contractor shall be available during operation of the balancing and adjusting mechanical systems and shall make such changes in wiring, heater sizes and other adjustments as are required to permit proper balancing of the systems.
 6. List all motor and motor starters to be tested and submit forms prior to actual testing. The forms must be approved by the Engineer.
- E. Safety Switches
1. Inspect for physical and mechanical condition.
 2. Compare equipment nameplate information with latest single line diagram and report discrepancies.
 3. Check for proper anchorage and required area clearances.
 4. Inspect all doors, panels and sections for paint, dents, scratches and fit.
 5. Verify that fuse sizes and types correspond to drawings. Record this information.
 6. Perform mechanical operation tests.
 7. Check each fuse holder for adequate mechanical support of each fuse.
 8. Inspect all bus or cable connections for tightness by calibrated torque wrench method. Refer to manufacturer's instructions.

9. Test all electrical and mechanical interlock systems for proper operation and sequencing.
 10. List all safety switches to be tested and submit forms prior to actual testing. The forms must be approved by the Engineer.
- F. Gaseous Engine Alternator Set: Refer to Specification Section 26 32 13.13, Diesel Engine Driven Generator Sets.
- G. Automatic Transfer Switches: Refer to Specification Section 26 36 23.
- H. Grounding Systems: Refer to Specification Sections 26 05 26. Submit test results as specified in this section.
- I. Fire Detection and Alarm System. Refer to Section 28 31 00.
1. Test each device and verify proper operation and calibration.
 2. Verify sequence of operation for each device in the system.
 3. Provide written verification of test.

END OF SECTION

SECTION 26 24 15 - SWITCHBOARDS (MOLDED CASE BREAKERS)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SCOPE

- A. The contractor shall provide and install switchboards as herein specified and shown on related electrical drawings

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Grounding and Bonding for Electrical Systems: Section 26 05 26
- D. Raceways and Boxes: Section 26 05 33
- E. Performance Testing: Section 26 08 01
- F. Panelboards: Section 26 24 16
- G. Electricity Metering: Section 26 27 13
- H. Low Voltage Circuit Protective Devices: Section 26 28 00
- I. Low Voltage Controllers: Section 26 29 00

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's printed product data.
- B. Drawings: Submit shop drawings for approval. Include components, materials, finishes, detailed plan and elevation views, required conduit rough-in openings, anchors and accessories.

1.05 RELATED STANDARDS

- A. ANSI/NFPA 70 – National Electrical Code (NEC)
- B. NEMA PB2 – Deadfront Distribution Switchboards
- C. UL 891 – Deadfront Switchboards

1.06 QUALITY ASSURANCE

- A. Manufacturer: For equipment required for the work of this section, provide product which is the responsibility of one manufacturer.
- B. Performance Requirements: Provide switchboards manufactured in accordance with Article 408 of the latest National Electrical Code and applicable portions of the NEMA PB2, UL 891 and NFPA 70, the National Electrical Code.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cutler Hammer
- B. General Electric
- C. Square D-Schneider Electric
- D. Siemens

2.02 SWITCHBOARDS - GENERAL

- A. Construction: Switchboard shall be of the modular type construction, constructed in accordance with the latest NEMA PB-2 and UL 891 standards, with the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw-on code gauge steel plates. Switchboards shall include all protective devices and equipment as listed on drawings with necessary interconnections, instrumentation and control wiring. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Service entrance switchboards shall be suitable only for use as service equipment and be labeled in accordance with UL requirements. System voltage, amperage and interrupting capacity shall be as indicated on the drawings. Enclosure construction shall be NEMA 1 indoor.
- B. Bus Requirements: The bus shall be of sufficient size to limit the temperature rise to 65 degree C, based on UL tests 1000A / sq-in for copper and may be tapered per UL standards and shall be fully rated the entire length of the switchboard. The bus shall be braced and supported to withstand mechanical forces exerted during a short circuit from a power source having the available short circuit current as indicated on the drawings. Provide a full capacity neutral where a neutral is indicated on the drawings. The through bus on the end section shall be extended and pre-drilled to allow the addition of future sections. Ground bus and grounding conductor lug shall be furnished. Ground bus shall extend the entire

length of the switchboard and shall be firmly secured to each vertical section.
Bus Material shall be silver-plated copper fully rated.

- C. Main Protective Device: molded case circuit breaker
 - 1. Breaker shall be a molded case circuit breaker or equivalent. Trip functions shall include adjustments for long time pickup and delay, short time pickup and delay, instantaneous, ground fault pickup and delay, zone selective interlocking for short time and ground fault, and shall have an integral test function to test the trip unit electronics. Fault indication shall be provided on the trip unit for overload, short time, short circuit and ground fault trip conditions. All breakers must carry a UL489 listing, be rated for 100% continuous duty, approved for reverse connection and shall be stationary mounted, suitable for electrical operation.
 - 2. Trip Unit Functions
 - a. The trip unit shall provide the ability to field-select either instantaneous, or short time pick-up and delay, or both instantaneous and short time protective functions.
 - b. The trip unit shall provide integral metering functions including an integral keypad and back-lit graphical display capable of displaying real time voltage and current waveforms, Volts, Amps, PF, Frequency, Watts, VA, Crest Factor, Amp Demand, Watt Demand, Voltage and Current Unbalance, Mechanical, & Interruption Fault Level Counters, time-stamped Event Logs & Trip Logs.
- D. Distribution Sections: molded case circuit breakers. All sections shall be aligned front and rear
- E. Distribution Section Branch Protective Devices: All molded case circuit breakers, used as a protective device in a branch circuit shall meet the requirements of the appropriate paragraph below. Frame sizes and trip ratings to be as shown on the drawings. All breakers to have an interrupting capacity as indicated on the drawings. Breakers shall be electronic LSI adjustable.
- F. Metering Equipment: Provide a multi-function, high accuracy digital power metering instrumentation module equipped with LCD display. The power metering module shall provide simultaneous measurements for current, voltage, and power parameters.
- G. Finish: The complete switchboard shall be phosphatized and finished with ANSI 61 light gray polyester powder paint.
- H. Markings
 - 1. Each switchboard section shall have a label permanently affixed to it, listing the following information: Name of manufacturer, system voltage, ampacity, type, manufacturer's shop order number and date.
 - 2. Each section of switchboard shall bear a UL listing mark, where qualified, and a short circuit rating label.

3. Front, side, rear and top of each switchboard section will have a DANGER label in accordance with NEMA Standard PB-2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Examine substrates and conditions in which units will be installed. Check for clearance that will be required before, during and after equipment installation. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Strictly comply with manufacturer's instructions and recommendations and NEMA PB 2.1. Coordinate installation with adjacent work to ensure proper sequence of construction, clearances and support.
- B. Install units plumb, level and rigid without distortion to the switchboard cubicle(s).

3.03 INSPECTION AND TEST PROCEDURES FOR SWITCHBOARD ASSEMBLIES

- A. These tests to be conducted by a National Electrical Testing Association Certified Testing Company.
 1. Visual and Mechanical Inspection
 - a. Inspect for physical, electrical and mechanical condition.
 - b. Compare equipment nameplate information with latest single line diagram and report discrepancies.
 - c. Verify that circuit breaker sizes and types correspond to drawings.
 - d. Verify that current and potential transformer ratios correspond to drawings.
 - e. Inspect all bus connections for high resistance. Use low resistance ohmmeter or check tightness of bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instructions or National Electrical Testing Association Standards for proper torque levels.
 - f. Test all electrical and mechanical interlock systems for proper operation and sequencing.
 - g. Clean entire switchboard using manufacturer's approved methods and materials.
 - h. Exercise all active components.
 - i. Inspect all indicating devices for proper operation.
 2. Electrical Tests
 - a. Perform ratio and polarity tests on all current and voltage transformers.
 - b. Perform ground resistance test in accordance with Specification Section 26 05 26, Grounding and Bonding.

- c. Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Conduct tests to verify satisfactory performance of each control feature.
- d. Perform secondary voltage excitation test on all control power circuits and potential circuits as detailed in Sections 7.1.2.12 and 7.1.2.13. Voltage levels will be checked at each point on terminal boards and at each terminal on devices.
- e. Perform current injection tests on the entire current circuit in each section of switchgear.
 - (1) Incoming and outgoing current will be tested at each device.
 - (2) All current transformers will have the following tests performed in accordance with ANSI/IEEE C57.13.1.
 - (i) Determine the burden of the current transformer secondary circuit and saturation level of the current transformer.
 - (ii) Test current transformer circuits supplying overcurrent relays to determine proper operation at the relay tap value. Verify that the maximum current deliverable by the CT is not below the maximum value required by the coordination study.
- f. Calibrate all meters at midscale. Calibrate watt hour meters to one-half percent (.05%). Verify multipliers.

3.04 ADJUSTING AND CLEANING

- A. Clean exposed surfaces using manufacturer recommended materials and methods.
- B. Touch-up damaged coatings and finishes using non-abrasive materials and methods recommended by manufacturer. Eliminate all visible evidence of repair.

3.05 WARRANTY

Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

END OF SECTION

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Raceways and Boxes: Section 26 05 33
- E. Performance Testing: Section 26 08 01

1.02 WORK INCLUDED

- A. Furnish and install material, labor and accessories required for the following pieces of equipment as shown on the drawings and specified herein - Panelboards

1.03 SUBMITTALS

- A. Submit shop drawings for distribution equipment in accordance with Specifications Section 26 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cutler Hammer
- B. General Electric
- C. Square D-Schneider Electric

2.02 PANELBOARDS

- A. Provide panels consisting of an assembly of branch circuit switching and protective devices mounted inside a dead front enclosure. Provide the number, size and arrangement of these branch circuit devices as shown on the drawings. Poles shown on Panel Schedules without circuit description shall be provisions for future protective devices.

B. Panelboard Interior

1. Rigid removable assembly of copper bus bars and interchangeable bolted branch circuit devices.
2. Bus bars drilled to permit branch circuit devices of all sizes and number of poles to be interchangeable and installed in any spare space of sufficient size, without disturbing adjacent units, removing main bus or branch circuit connectors and without machining, drilling and tapping.
3. Arrange bus in sequence or distributed phasing so that multi-pole circuit breakers can replace any group of single pole circuit breakers of the same size.
4. Unless noted otherwise on panel schedules provide spare breakers consistent with size and type of specified breakers so that panel is full. (i.e. Where schedule is blank and does not indicate load description, space or spare.)

C. Enclosure

1. Code gauge 20" wide (minimum) steel box galvanized after fabrication with turned up peripheral front edge, bolted joints and multiple knockouts on top and bottom.
2. Provide ground bus on inside of tub.
3. Minimum gutter sizes as follows:

<u>Panel Sides</u>	<u>Top and Bottom</u> <u>No Main Lugs</u>	<u>Main Lugs</u>
20 poles or less	4" or 5"	6"
More than 20 poles	6" or 6"	8"
Feed thru cables	8" (one side only)	

4. Flush mounted in finished areas and where indicated. Surface mount elsewhere.

D. Front

1. Provide door in door construction.
2. Heavy code gauge steel reinforced with welded corners on rear as required to maintain panel face flat.
3. Provide lock in stainless steel or brushed chrome finished in door over branch circuit devices (or approved equal). All panels keyed alike. Supply four (4) keys to Owner.
4. Bold front closed with trim clamps.
5. Same size fronts on panels mounted adjacent to other panels or telephone cabinets. Largest required size governs height of all.
6. Factory finished in medium gray baked enamel or two coats of air drying lacquer over a rust inhibitor.
7. Provide door within a door.

E. Terminals

1. Bolted type, suitable for copper conductors.
2. Locate main lugs properly at top or bottom depending on where main feeder enters.

F. Electrical Ratings

1. 120/208 volts, three phase, four wires, full neutral, Type NQ (as manufactured by Square D) or equal unless otherwise noted.

2.03 FIRE ALARM BREAKERS

- A. Provide Fire Alarm Circuit breaker to meet NFPA 71, 2013 10.6.5.2.
- B. Fire alarm circuit breakers shall be "RED".
- C. Fire alarm breakers must have lockout tags on them.
- D. B.O.D.: Space Age Electronics: ELOCK-FA series lockout kit.

PART 3 - EXECUTION

3.01 PANELBOARD INSTALLATION

- A. Support panel cabinets independently to building structure with no weight bearing on conduits.
- B. Securely anchor surface mounted panelboards to masonry walls with heavy duty machine bolt anchors.
- C. Install recessed panelboards to allow cover to be drawn tight against wall to provide neat appearance.
- D. Install panelboards so top breaker is no higher than 6'-0" above the floor.
- E. Protect panelboards and cabinets during construction to prevent damage and entry of dirt, paint, etc.
- F. Adjacent panel cabinets shall be mounted in horizontal alignment at top.
- G. Wiring inside the equipment, panels and boxes shall be installed in a neat and workmanlike manner.
- H. Provide concrete pad under the electrical panels.
- I. Neatly install underground conduit up to bottom feed.
- J. Provide panel skirt from the concrete pad to the bottom of the panel.(finish shall be the same as the panels)

3.02 BALANCING ELECTRICAL LOAD

- A. Care shall be exercised in connecting various electrical loads to panelboards in order to arrive at reasonable balance between loads on each phase at each panelboard. It will be the responsibility of the Electrical Contractor to make tests and adjust loads at each panelboard to result in a reasonably balanced load condition, satisfactory to the Owner.

END OF SECTION

SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Grounding and Bonding: Section 26 05 26
- E. Raceways and Boxes: Section 26 05 33

1.02 ENTIRE SERVICE ENTRANCE

- A. The service entrance shall comply with NEC and utility company's requirements.

1.03 COORDINATION WITH UTILITY COMPANY

- A. Contractor shall coordinate with the utility company and verify the limits of responsibility with respect to metering, terminations and the like.
- B. Under no circumstances shall the Contractor be reimbursed for changes in the service installation brought about due to the failure of the Contractor to verify all the details with the utility company.
- C. Obtain from local utility company an estimate of the billable expenses that the utility company expects to incur on this project and include this price in your bid. The successful bidder shall pay these charges.

1.04 SOURCE

- A. The electrical service entrance source shall be as shown on the drawings.

1.05 SECONDARY CHARACTERISTICS

- A. Three phase, four wire, 120/208 volts, wye connected, 60 Hertz, alternating current.

PART 2 - PRODUCTS

2.01 PRIMARY ENTRANCE CABLE

- A. The primary entrance cable shall be furnished and installed by the utility company.

2.02 PRIMARY SERVICE ENTRANCE CONDUIT

- A. The primary service conduit shall be furnished and installed by the Electrical Contractor of the size and type as indicated on the drawings and as specified under Specifications Section 26 05 33 Raceways and Boxes.

2.03 SECONDARY SERVICE FEEDERS

- A. Conductor by the Electrical Contractor
- B. Service Conduit from utility transformer to building electrical services by the Electrical Contractor

2.04 TERMINATIONS

- A. Terminations at transformers shall be by the utility company.

2.05 TRENCHING AND BACKFILLING

- A. Primary by the Electrical Contractor
- B. Secondary by the Electrical Contractor
- C. All trenching and backfilling shall comply with Specifications Section 26 05 40, Trenching, Backfilling and Compacting for Electrical Systems.

2.06 METERING

- A. Per utility company standards. EC should anticipate bushing CT's in utility transformer enclosure with 2" conduit by the EC extended to adjacent meter location.
- B. Meters: furnished by the utility company. Meter base by utility company installed by Electrical Contractor. Final connections to base by utility company. Meter set by utility company.

PART 3 - EXECUTION

3.01 GENERAL

- A. It shall be the responsibility of the Electrical Contractor to coordinate all service entrance items required for this project with the local utility company.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Raceways and Boxes for Systems: Section 26 05 33
- E. Performance Testing of Systems: Section 26 08 01
- F. Floor Boxes: Section 26 27 27

1.02 SUBMITTALS

- A. Submit shop drawings or data sheets on all devices and plates used in accordance with Specification Section 26 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 SWITCHES

- A. Specification grade switches shall be single pole, two pole, three-way, four way, momentary, lighted or pilot lighted as required to control lights or other device and shall be toggle or key operated, heavy duty, specification grade, 20 amp, 120/277 volt, quiet type and shall meet the requirements of Federal Specifications WS-896-d and NEMA-WD-1. Assembly shall be by screw to mounting bridge. Screw into plastic base or riveting is not acceptable.
 - 1. Manufacturers: (with unlighted handle) Hubbell #CS1221; Bryant #4901; Cooper #2221; Pass & Seymour #20AC1; G.E. #5931; Leviton 1221-2
- B. Where space is limited or when reusing existing switch boxes, "Despard" (twin horizontal switches in single gang arrangement) quiet type, rated 20 amps, may be used.
- C. Weatherproof switches shall be Bryant #4981, Hubbell #HBL1281 Series "Presswitch" with a #HBL1750 grey "Hypalon" coverplate; or Cooper #2991 Switch with a 2881G coverplate. Where a toggle switch is required, provide Hubbell Plate #1795.

- D. All switches shall have binding post terminals or pre-wired pigtails.
- E. Color of switches shall be selected by the architect.

2.02 RECEPTACLES

- A. All receptacles shall be grounding type and shall be Duplex 120 volt, 120/208 volt, single phase, 208/240 volt, 277 volt, single phase or 120/208 volt and 277/480 volt, three phases as scheduled below or as indicated on the drawings.
- B. Specification grade duplex receptacles shall be 20 ampere, 125 volts, with impact resistant face, wrap around steel mounted strap, and shall meet the requirements of Federal Specification WC-596-e, NEMA WD-1 and UL-498.
- C. Ground Fault (GFCI) Receptacles
 - 1. Receptacles shall be duplex style with impact resistant face with built-in ground interrupter set to trip out at a 5-milliamp maximum ground fault. Receptacles shall be rated 20 amperes, standard or feed-through as required.
 - 2. Manufacturers: Hubbell #GFRTR20x; General Electric #TGTR1120F; Bryant #GFR Series; Pass & Seymour #2091, Leviton 8899; Cooper XGF20
- D. Weatherproof Duplex Receptacles (wet or damp label locations)
 - 1. Weatherproof duplex receptacles shall be 20 ampere, GFCI type with an expandable weatherproof while in use cover. Hubbel Taymac ML500G or approved equal. (Color selection by Architect.)
 - 2. Outdoor cover plates shall be Hubbell RW15100GY or HBLSS83R or HBLSS84X or approved equal.
- E. Safety Devices:
 - 1. Duplex units shall be 20 ampere, specification grade, back side wired.
 - 2. Devices to be designed to prevent accidental shock due to the insertion of a foreign object.
 - 3. Hubbell HBL8300SG or equal by Pass & Seymour, Bryant or Cooper Wiring Devices.
- I. All receptacles shall have binding post terminals.
- J. USB-AC Charger Receptacles
 - 1. Special Use Receptacles: USB Combination Charger
 - a. Rating and Type
 - (1) USB charging 5 amp, 5 VDC dual ports
 - (i) Stainless steel grade 304 USB ports rated for 10,000 cord insertions and removals.
 - (ii) Complies with battery charging specification USB

- BC 1.2
- (iii) Compatible with USB 1.1/2.0/3.0 devices, including Apple products
- (iv) Complies with Part 16 of the FCC rules.
- (2) 15 amp and 20-amp 125 volt tamper resistant duplex decorator style
 - (i) 2 pole 3 wire grounding straight blade
 - (ii) Listed to UL498 and 1310
- b. Hubbell 20 amp, 125 volt Series Cat #USB20ACx Available Colors: Black, Gray, Ivory, Light Almond, White: W. LED USB power light to indicate charging available or approved equal.

K. Schedule of Receptacles, Plugs and Connectors

1. 125 volt, 20 amp, 2 pole, 3 wire grounding

NEMA CONFIGURATION

MANUFACTURER

Cooper Wiring Devices
 Bryant
 General Electric
 Hubbell
 Pass & Seymour
 Leviton

5-20R RECEPT

5362
 5362
 5362
 HBL5362
 5362A
 5362A

2. 250 volt, 20 amp, 2 pole, 3 wire grounding

NEMA

CONFIGURATION

MANUFACTURER

Cooper Wiring Devices
 Bryant
 General Electric

 Hubbell
 Pass & Seymour
 Leviton

6-20R

RECEPT.

5462
 5462-I

 HBL5462-
 I
 5862-I
 5462

6-20P

PLUG

5466N
 5466-N
 GED0621
 HBL5466-
 C
 5466-X
 5466

6-20R

CONN.

5469-N
 5469-N
 GED0623
 HBL5469-
 C
 5469-X
 5469

3. 250 volt, 30 amp, 2 pole, 3 wire grounding

NEMA

CONFIGURATION

MANUFACTURER

Cooper Wiring Devices
 Bryant
 General Electric
 Hubbell
 Pass & Seymour
 Leviton

6-30R

RECEPT.

1234
 9630-FR
 4139-3
 HBL9330
 5930
 5372

6-30P

PLUG

5701N
 9630-RP
 GED0631
 9331
 5931
 9630P

6-30R

CONN.

6700N

 GED0633

4. 125 volt, 20 ampere, 2 pole, 3 wire grounding (locking type)

<u>MANUFACTURER</u>	<u>RECEPT.</u>	<u>PLUG</u>	<u>CONN.</u>
Bryant	70520FR	70520NP	70520NC
Pass & Seymour	L5-20R	L5-20P	L5-20C
Hubbell	HBL2310	HBL2311	HBL2313
Leviton	2310	2311	2313
Cooper Wiring Devices	CWL520R	CWL520P	CWL520C

5. Color of Wiring Devices / Plates

- a. Device and cover plate color and material finish must be approved by Architect as part of the submittal process. (Failure to obtain explicit Architectural approval of device color and cover plate finish/color as part of the submittal process may result in the contractor changing out devices at their cost.)
- b. All emergency power receptacles shall be RED in color.
- c. Default in finished interior spaces: White Nylon with white devices.
- d. Default in exterior spaces: Black weatherproof-while-in-use with black devices.
- e. Default in unfinished spaces: Galvanized with grey devices.
- f. Provide proper plates on all wiring devices.
- g. Provide blank plates on all unused boxes.
- h. Stainless steel shall be #302 or #304 brushed stainless steel. Brushed finish shall extend to edge of plate including beveled surfaces.

- L. Color of receptacles shall be selected by the architect.

2.03 COVER PLATES

- A. Cover plates shall be stainless steel in the apparatus bay, machinal and electrical room.
- B. Stainless steel shall be #302 or #304 brushed stainless steel. Brushed finish shall extend to edge of plate including beveled surfaces.
- C. Cover plates in all other areas shall be selected by the architect.

2.04 PHOTOCCELL

- A. Photocell shall be adjustment type rated 1800 watts at 120 volts.
- B. Housing shall be cast aluminum weatherproof with 1/2" nipple for conduit connection.

- C. Manufacturers: Tork #2101; Paragon #CW201; Intermatic K4121; or approved equal.

2.05 ASTRONOMIC TIME CLOCKS

- A. General
1. A 40 ampere (tungsten) synchronous motor driven time switch with Astronomic dial.
 2. Turns "ON" only at sunset; can be set 20 or 40 minutes before or after normal sunset to adapt to local area.
 3. Turns "OFF" at sunrise or can be set from 8:30 pm to 2:30 am in half hour increments; no setting for seasonal changes as trippers follow the seasons.
 4. Day-omitting feature: switch shall operate every day unless set to omit selected days.
 5. Separate manual "ON/OFF" levers enable operation without disturbing automatic settings.
 6. Different dials provided for every 140 miles or 2 degrees of north latitude; specify city of use; maximum 47 degree north.
 7. Reserve power to keep dial on time for 16 hours in case of power failure (optional).
- B. Time switch contacts shall be capable of switching 40 amperes per pole continuously at 277 volts and shall be DPST, 3PDT or SPDT, as required.
- C. Enclosure shall be NEMA 1 surface type. Enclosure shall be finished in baked epoxy enamel with combination 1/2", 3/4" knockouts on bottom, both sides and top and back. Provision shall be made for positive padlocking and/or sealing.
- D. Terminals shall be of the pressure type capable of receiving #8 AWG wire.
- E. Manufacturers
1. Tork #7200ZL; Paragon #4004-71SZ (DPST) Intermatic T174
 2. Tork #7120ZL; Paragon #4006-71SZ (SPDT) Intermatic T175
 3. Tork #7300ZL; Paragon #47217-27SZ (3PST) Intermatic T1471BCR
 4. Or approved equal

2.06 CONTACTORS

- A. Use: in separate NEMA 1 enclosures to operate number of circuits simultaneously.
- B. Type
1. Single coil, magnetically operated, mechanically locked type without hooks on latches.
 2. Mounting: on dampening device or in insulated cabinet.
 3. Contacts: silver with auxiliary arcing contacts.

4. Lockout relays: to prevent simultaneous operation from two remote locations.
5. Solid state control module for 2-wire control.
6. Manufacturers: ASCO, Bulletin #918
7. Provide hand-off-automatic selector switch on contactor for manual override of contactor.

2.07 PILOT LIGHT (OTHER THAN FOR MOTORS CIRCUITS)

- A. Red rectangular jewel with integral 125 volt neon lamp. Suitable for mounting in single gang box.
- B. Manufacturers: General Electric #GE04218-0; or approved equal.

2.08 WALL DIMMER CONTROLS

- A. All devices shall be U.L. listed specifically for the required loads (i.e., incandescent, fluorescent, magnetic low voltage transformer, electronic low voltage transformer). Manufacturer shall provide file card upon request. Universal dimmers shall not be acceptable.
- B. All dimmers shall incorporate an airgap switch which shall be accessibility without removing the faceplate. The airgap switch shall be capable of meeting all applicable requirements of U.L. 20 for airgap switches in incandescent dimmers.
- C. All dimmers shall provide power failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default levels is not acceptable.
- D. Dimmers shall meet the ANSI/IEEE Std. C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.
- E. Dimmers shall meet the U.L. 20 limited short circuit test requirement for snap switches.
- F. Dimmer control shall be linear slide type. Dimmer shall provide a smooth and continuous Square Law Dimming curve.
- G. Dimmer shall include voltage compensation circuitry that adjusts the firing angle of the dimmer in such a manner as to compensate light output for variations in the AC line voltage. Dimmers in which the firing angle is merely held constant with varying AC line voltage shall not be acceptable.
- H. Dimmer control slider shall be captive to the dimmer wall faceplate.
- I. All switches grouped with dimmers shall also be slide type to match.
- J. Manufacturer: Lutron "Nova T Star" dimmers and switches or approved equal.

2.09 MULTI-GANG WALL BOXES

- A. The recessed wall boxes shall be modular with face plates, wall flanges and barriers for branch circuit wiring. All product numbers listed herein are Hubbell multi-connect system numbers.
- B. Barriers required to separate power from low voltage chambers shall be provided.
- C. Recessed wall mounted boxes shall be manufactured to accommodate two, four and six-gang applications as shown on drawings or herein specified. Barriers are to be furnished separately to isolate power from low voltage circuits. A separate ground terminal will be provided for each gang. Recessed wall boxes shall be made of galvanized 16 gauge cold rolled steel construction to adapt for installations in wood or metal-framed walls. Box will be furnished with two adjustable stud mounting brackets to support a 1/2", 3/4", 1" or 1-1/4" wallboard. Boxes will also include an adjustable PVC device mounting platform to assure a flush appearance. Combination knockouts will support 1/2", 3/4" and 1" conduit feeds.

<u>Hubbell Number</u>	<u>Gang</u>	<u>Knockouts</u>	<u>Barriers</u>
HBLWSCS1	1	1/2", 3/4"	HBLSCSBW
HBLWSCS2	2	1/2", 3/4"	HBLSCSBW
HBLWSCS4	4	1/2", 3/4", 1"	HBLSCSBW
HBLWSCS6	6	1/2", 3/4", 1"	HBLSCSBW

- D. Face plates shall be modular and shall be made of high strength PVC (UL94V-0 rated) and furnished with a textured pebble finish. Means of fastening include snap-in or screw type installations. Duplex, Style Line®, toggle and various data openings are provided to support flush data requirements. A blank face plate is also available to support future applications. Color shall be ivory.
- E. Wall flanges shall be mounted to recessed boxes listed above and be made of high strength PVC. All flanges will be furnished with a textured pebble finish. Hubbell Type HBLTRIM2W (2 gang), HBLTRIM4W (4 gang) and HBLTRIM6W (6 gang) are available to support the box of matching gangs. Color shall be ivory.
- F. Unless noted otherwise on the drawings all multi-gang wall boxes on this project shall have four (4) gangs, with one (1) duplex at each end with voice/data and audio/visual devices in the center two (2) gangs. See details on drawings.

2.10 (DUAL TECHNOLOGY) OCCUPANCY SENSORS

- A. The device listed herein shall be an occupancy / vacancy sensor, (ceiling type switch or wall mounted switch with manual override), capable of detecting infrared emissions from human presence and ultrasonic motion detection, and responding by switching incandescent, low-voltage and fluorescent lighting loads on. If this unit does not detect infrared emissions or movement after a preset period of time, it will respond by switching its assigned load off. The unit shall switch at the zero crossing point of the AC power curve to ensure maximum relay contact life, and compatibility with electronic ballasts.

- B. Unit shall provide automatic adjustable walk-through feature to prevent lights from remaining on for extended periods after momentary occupancy in the area being monitored.
- C. The Ceiling Switch Occupancy Sensor shall feature self-adjusting delayed-OFF time and ambient light override capabilities.
- D. Unit shall also provide 360° field of view of 180° field of view for wall mounted switches and shall have sensitivity adjustments.
- E. Coverage area shall be approximately 2000 sq.ft.
- F. Locations of occupancy sensors shown on drawings are representative and the quantity of sensors may not be adequate for specific manufacturers. In areas indicated for automatic control, coverage data issued by manufacturer shall be used to determine locations for proper coverage and sensors required shall be provided by the contractor.
- G. Manufacturer: Leviton #OSC20-MOW or #OSSMT Series or approved equal

2.11 (PASSIVE INFRARED) OCCUPANCY SENSORS

- A. The device listed herein shall be a ceiling type switch occupancy sensor, capable of detecting infrared emissions from human presence and responding by switching incandescent, low-voltage and fluorescent lighting loads on. If this unit does not detect infrared emissions or movement after a preset period of time, it will respond by switching its assigned load off. The unit shall switch at the zero crossing point of the AC power curve to ensure maximum relay contact life, and compatibility with electronic ballasts.
- B. Unit shall provide automatic adjustable walk-through feature to prevent lights from remaining on for extended periods after momentary occupancy in the area being monitored.
- C. Unit shall also provide 180° field of view and shall have sensitivity adjustments.
- D. Coverage area shall be approximately 2000 sq.ft.
- E. Manufacturer: Leviton #ODS15-IDW or approved equal

PART 3 - EXECUTION

3.01 SWITCHES AND RECEPTACLES

- A. Install switches and receptacles of adequate rating and capacity for loads served.
- B. Install single (multi-gang) wall plates for outlet boxes with more than one device.
- C. Receptacle Orientation: Vertically mounted receptacles shall be installed with ground pin slot up; horizontally with neutral blade slot up.

- D. Provide receptacles with USB as shown on the drawings.

3.02 120 VOLT RECEPTACLE CIRCUITS

- A. Perform operational testing.
- B. Test receptacles with Woodhead #1750 or Hubbell #5200 Tester for proper connection of ground wire, correct polarity and faults in wire.

3.03 LABELS

- A. Cover plate of each receptacle shall be labeled identifying panelboard and branch circuit device serving the receptacle using clear tape. Label with 3/16" black letters.
- B. Special purpose receptacles such as x-ray or other such equipment shall be labeled with engraved or embossed label identifying load served as well as the circuit and panelboard identification described above.

END OF SECTION

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SECTION 26 27 27 - FLOOR BOXES

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Electrical General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Raceways and Boxes for Electrical Systems: Section 26 05 33

1.02 SCOPE

- A. The floor box provides the interface between power and communication cabling in a concrete floor, where both power and communication device outlets are required. The box provides recessed device outlets that will not obstruct the floor area.

1.03 CLASSIFICATION AND USE

- A. The floor box is approved for use on above-grade concrete floors and can be used on-grade with a vapor barrier where permitted by local code. The floor box shall have been examined and tested by Underwriters Laboratories Inc. to their Standard UL514A and bear the listing mark. It shall also bear the Canadian UL mark. The floor box shall conform to the standards set in the National Electrical Code. This floor box shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Floor Box Construction - boxes shall consist of a concrete-tight stamped steel construction with 14 gauge sides and bottom and 10 gauge steel top. The floor box shall be painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete and be approved for use on grade and above-grade floors.
 - 1. Dimensions: the box exterior dimensions are to be 14-3/4" (356mm) long x 12-5/8" (321mm) wide. The height may be either 4-1/8" (105mm) or 6-1/8" (156mm).

2. Capacity: the wiring volume for the floor box shall comply with the following table:

No. of Compartments	No. of Gangs/ Volume of Compartment 1	No. of Gangs/ Volume of Compartment 2	No. of Gangs/ Volume of Compartment 3	No. of Gangs/ Volume of Compartment 4
4	3 gangs 84 CU.in (1377ml)	1 gang 35 CU.IN (574 ml)	1 gang 35 CU.IN (574 ml)	6 gangs 156 CU.IN (2589 ml)

3. Knockouts: The floor box shall provide the following number of conduit knockouts: four combination 1" and 1-1/4" concentric trade size, four combination 3/4" and 1" concentric trade size, and ten combination 1-1/4" and 2" concentric trade size.
4. Adjustment: external pre-pour adjustment shall be provided by at least 2" leveling screws.

B. Cover:

1. Cover shall be cast aluminum. Lid to be offered with solid, flush surface for tile, wood or terrazzo and an insert option for carpet inlay.
2. Egress to be provided by two 15/16" x 6-3/8" (23.8mm x 161.9mm) access doors. Access door is to fold under lid during cable exit for unobtrusive appearance and mechanical protection.

2.02 COMMUNICATION DEVICES AND ACCESSORIES

- A. The floor box manufacturer will provide a complete line of communication outlets and modular inserts for UTP, STP (150 OHM), Fiber Optic, Coaxial, audio and video devices with faceplates and bezels to facilitate mounting. The box shall provide a series of device mounting plates that will accommodate Ortronics workstation connectivity outlets and modular inserts, the Pass and Seymour Network Wiring System, and other open system devices. Box to accept industry standard size one, two, and three-gang device plates and sectional device plates.

2.03 MANUFACTURERS

- A. Wiremold RFB11 or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The floor box shall contain four leveling legs to provide full pre-concrete pour adjustment. Additionally, the box shall ship with a disposable cover to prevent the entry of debris during the construction phase. Alternate disposable covers to provide terrazzo pour stops is to be available from the manufacturer.

END OF SECTION

SECTION 26 27 28 - FIRE RATED POKE-THROUGHS

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Raceways and Boxes: Section 26 05 33

1.02 WORK INCLUDED

- A. The poke-thru described in this scope feeds power and communications services to open space areas from the floor/ceiling space below. The poke-thru device provides both flush power service, as well as flush or recessed communication service for UPT, STP (150 ohm), fiber optic, coaxial, or video connectors.

1.03 CLASSIFICATIONS AND USE

- A. This poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL 514A and/or UL514C and Canadian Standard C22.2, No. 18-92 and bear the U.S. and Canadian UL Listing Mark. This poke-thru device shall also have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. This device shall also conform to the standards set in the National Electrical Code, Section 300-21. These devices meet all UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens. This poke-thru device shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors. Suitable for use in air handling spaces in accordance with Sec. 300-22 (c) of the National Electrical Code.

1.04 SUBMITTALS

- A. Submit shop drawings or data sheets on fire rated poke-throughs used in accordance with Specification Section 26 05 01, General Provisions.

1.05 MATERIALS

- A. The activation shall meet Underwriters Laboratories, Inc. Standard UL514A, and bear the listing mark.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The poke-thru device shall be compatible to accept a complete line of Ortronics® workstation connectivity outlets and modular inserts, or the Pass & Seymour Network Wiring System.
- B. The insert body shall have the necessary channels to provide complete separation of power and communication services. There shall be one 3/4" channel for power and two 1/2" channels for communication cabling. The channels shall be arranged such that communication cables can be conduit protected and connected to the insert body using a die-cast zinc conduit connector with two 1/2" threaded openings to accept both rigid and flexible conduit connections.
- C. The body will consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire rating of the unit and the floor slab. The insert shall have a spring steel-retaining ring that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 3/4" conduit stub that is connected to the insert body and a 24.5 cu. in. stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru device to the system ground.
- D. Activations:
 - 1. The poke-thru cover shall be manufactured from textured Polycarbonate or PVC and will come in black, gray, ivory, and brass. The slide holder assembly shall be flush with the floor and provide "Dead-front" protection that allows the receptacle covers to snap back into place when receptacle is not in use. A gasket is attached to the slide cover assembly to maintain scrub water tightness. The device shall also have accommodations for up to four communication connectors and will close over the connectors when not in use. Communication connectors shall be flush or recessed within the device.
 - 2. The trim flange shall be manufactured out of die-cast aluminum alloy and forged brass. The die-cast aluminum flanges shall be textured, powder-coated or plated in a two-stage painting process. The aluminum trim flanges are available in gray, black, ivory, brushed aluminum, and brushed brass. A gasket is attached to the underside of the trim flange to maintain scrub water tightness by preventing water, dirt, and dust from entering the power and communication compartments.
 - 3. The device shall be UL Classified for fire resistance for use with 1, 1-1/2, or 2-hour rated, unprotected reinforced concrete floors and 1, 1-1/2 or 2-hour rated floors employing unprotected steel floor units and concrete toppings.

- E. Manufacturers, Recessed Poke Thru: Wiremold or approved equal

<u>Wiremold</u>	<u>Cat.</u>	<u>Core</u>	<u>Drill</u>	<u>Service Description</u>
<u>No.</u>		<u>Size</u>		
Evolution 6AT		6"		1-20 amp duplex and two locations for voice, including Cat 6 or data inserts.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Use is defined by the UL Fire Resistance Directory as a minimum spacing of "2' on center and not more than one device per each 65 sq. ft. of floor area in each span."
- B. Unit shall permit all wiring to be completed at floor level. Installation shall be completed by pushing unit down into cored-hole. Prior to and during installation, refer to system layout and/or approval drawings. Installer shall comply with detailed manufacturer's instruction sheet included with each poke-thru unit.
- C. The unit shall contain a retainer for securing the device in the slab, as well as the necessary intumescent material to seal the cored-hole under fire conditions. Power and communication isolation shall be continued through the device with power termination in an accessible junction box. Power and communication isolation will be completed by utilizing a nonmetallic divider between the receptacle and communication connectors.

END OF SECTION

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SECTION 26 27 73 - DOORBELL/BUZZER SYSTEM

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. Section 26 05 01 – General Provisions.

1.02 SUMMARY:

- A. This Section includes the following:
 - 1. Provide a complete operational doorbell system.

1.03 SCOPE OF WORK:

- A. Provide all labor and materials and equipment required for a complete and operational doorbell system for public access area as indicated on the Contract Documents.

1.04 SYSTEM DESCRIPTION:

- A. The system shall be comprised of a wall mounted vibrating bell, buzzer, and exterior momentary pushbutton.

1.05 SUBMITTALS:

- A. Submit shop drawings and product data under Division 01 and Section 26 05 01.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Deliver, store and handle materials in accordance with Division 01 and Section 26 05 01.

1.07 SEQUENCING AND SCHEDULING:

- A. Sequence and schedule work in accordance with Division 01 and Section 26 05 01.

1.08 WARRANTY:

- A. Warranty in accordance with requirements of Division 01 and Section 26 05 01.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Edwards Signaling and Security Systems.

- B. Federal Signal.
- C. Simplex Grinnell.

2.02 VIBRATING BUZZER:

- A. Diameter of 4 inches with output of 70 dB at 10 feet.
- B. 120-volt AC operation.
- C. Adjustable volume control.
- D. Continuous ringing sound with the striker continuously striking the gong in rapid-fire action as long as current is applied.
- E. Rated for indoor use.
- F. Buzzer shall be Edwards Signaling and Security Systems #340A-N5 or approved equal.

2.03 WEATHERPROOF PUSHBUTTON:

- A. Flush mount, weatherproof push button with satin chrome finish stainless steel, and stainless-steel wall plate with rubber gasket. Switch shall be rated for 6 amps AC at 125 volts. Switch shall be Edwards Signaling and Security Systems #852 or approved equal.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. For floor boxes mounted in insulated slabs ensure there is insulation below floor boxes.

3.02 INSTALLATION:

- A. Provide all equipment, wiring, conduit and outlet boxes required for the installation of a complete and operating system in accordance with the Contract Documents.

B. Buzzers:

1. Indoors: Flush Mount Grille and Wall Box: Where indicated in the Contract Documents, provide buzzers flush mount grille and wall box for a full recessed installation.

- C. Weatherproof Push Button: Unless otherwise indicated, provide flush mounted weatherproof outlet box for push buttons. Where push buttons are located on existing construction, outlet boxes may be surface mounted type only where indicated or approved by the Architect.

END OF SECTION

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SECTION 26 28 00 - LOW VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General Provisions: Section 26 05 01
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Raceways and Boxes: Section 26 05 33
- E. Performance Testing: Section 26 08 01
- F. Panelboards: Section 26 24 16
- G. Low Voltage Controllers: Section 26 29 00

1.02 WORK INCLUDED

- A. Furnish and install material, labor and accessories required for the following pieces of equipment as shown on the drawings and specified herein.
 - 1. Circuit Breakers
 - 2. Fuses (Low Voltage)

1.03 SUBMITTALS

- A. Submit shop drawings for distribution equipment in accordance with Specifications Section 26 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 CIRCUIT BREAKERS

- A. Contractor shall provide the following unless otherwise specified or shown on the drawings. See "Panel Schedules" for minimum panelboard I.C. ratings. All breakers in these panels shall meet the minimum panelboard ratings. Series integrated equipment rating is not acceptable.

<u>Type of Service</u>	<u>Frame Size (Amperes)</u>	<u>I.C. Rating (Amperes)</u>
120/208 volt, single phase lighting & power	15-60	10000
120/208 volt, three phase power	15-60	10000
120/208 volt, three phase power	70-200	22000
120/208 volt, three phase power	225-400	42000
120/208 volt, three phase power	450-1200	50000

- B. Provide circuit breakers where indicated of proper sizes for loads served.
- C. Do not install two poles in single module.
- D. Install multiple pole breakers with single trip mechanism. Do not install external mechanical ties between single pole breakers.
- E. Manufacturers: General Electric; Square "D"; Cutler-Hammer

2.02 FUSES

- A. 601 amps and above: UL Class L current limiting type, 200,000 amp interrupting capacity, 4 second time delay at 500% rating. Buss Hi-Cap KRP-C; Ferraz-Shawmut Amptrap A4BY, Reliance LCL or Littelfuse KLP-C.
- B. 600 AMPS and Below
 - 1. Protecting branch circuit panelboards and miscellaneous non-inductive loads: fuses to be current limiting type, single element with no time delay, 200,000 amp interrupting capacity. UL Class RK1. Buss Limitron KTN, KTS; Ferraz-Shawmut Amptrap A2K, A6K, Reliance NCL-R, SCL-R or Littelfuse KLN-R, KLS-R.
 - 2. Motor circuits and transformers: dual element type 200,000 amp interrupting capacity. UL Class RK5. Buss Fusetron FRN-R, FRS-R, Ferraz-Shawmut Tri-Onic TR, TRS; Reliance ECN-R, ECS-R; or Littelfuse FLN-R, FLS-R.

PART 3 - EXECUTION

3.01 FUSES

- A. Provide the Owner with 10% additional spare fuses (or a minimum of three whichever is greater) for each size fuse used in the installation.
- B. Fuses to be stored in special cabinet located adjacent to each substation, MCC or fusible panelboard containing fuses.
- C. Submit shop drawings of cabinet for approval.

END OF SECTION

SECTION 26 29 00 - LOW VOLTAGE CONTROLLERS

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Raceways and Boxes: Section 26 05 33
- D. Performance Testing: Section 26 08 01
- E. Panelboards: Section 26 24 16

1.02 WORK INCLUDED

- A. Furnish and install material, labor and accessories required for the following pieces of equipment as shown on the drawings and specified herein.
 - 1. Motor Starters
 - 2. Safety Switches

1.03 SUBMITTALS

- A. Submit shop drawings for distribution equipment in accordance with Specifications Section 26 05 01, General Provisions.

PART 2 - PRODUCTS

2.01 MOTOR STARTERS

- A. Type
 - 1. Full voltage across-the-line starters with motor running protection in accordance with Motorized Equipment Schedule shown on the drawings and as indicated below.
 - 2. Starters to be equipped with auxiliary control devices as indicated on Motorized Equipment Schedule.
 - 3. Starters operated at a phase-to-phase voltage of 200 volts or more shall be equipped with individual transformers to provide 120-volt supply for control devices such as pushbutton, relays, float switches, etc.
- B. Use
 - 1. Manual: single phase up to 1/2 HP; with pilot light similar to Allen Bradley Bulletin 600 series.

2. Manual: single phase 3/4 HP and greater; similar to Allen Bradley Bulletin 609 series.
 3. Magnetic: single or three phase; similar to Allen Bradley 509 series.
 4. Combination magnetic starter with fused switch (circuit breaker switch). Similar to Allen Bradley Bulletin 512 series (513 series).
 - a. All combination magnetic starters shall have hand off automatic switches with pilot light unless otherwise noted.
 - b. All combination magnetic starters to be equipped with control circuit transformers unless otherwise noted.
- C. Pushbutton Stations: heavy duty type in NEMA 1 enclosure; similar to Allen Bradley Bulletin 800H series.
- D. Control Circuits
1. Control circuit voltage shall be not to exceed 120 volts and shall be obtained through the use of control circuit transformers.
 2. Transformers shall be of sufficient size to service control device connected thereto.
 3. Control circuit shall be made in the following manner:
 - a. One side of secondary of transformer shall be grounded.
 - b. One side of all operating coils of control devices shall be connected to grounded side of control circuit.
 - c. All contacts of relays, limit switches, etc., shall be connected in series on line side of the control circuits.
 4. A minimum of two (2) spare interlocks shall be furnished per starter or contactor. These interlocks shall be field reversible from normally open to normally closed.
 5. All terminal points, including interlock contacts, shall be brought out to terminal blocks.
- E. Manufacturers: Allen Bradley; Square D; General Electric; Cutler Hammer

2.02 SAFETY SWITCHES

- A. UL approved, heavy duty, 2 and 3 pole, quick-make, quick-break fused or non-fusible type, as indicated on the drawings. Fuse clips shall be suitable for the fuses specified under this section.
- B. Totally enclosed with external operating handle. Enclosure to be NEMA type as indicated on the drawings.
- C. Manufacturers: General Electric; Square D; Cutler Hammer

PART 3 - EXECUTION

3.01 MOTOR STARTER INSTALLATION

- A. Motor starters furnished under other sections are to be mounted by the Electrical Contractor.
- B. Mount on walls or on approved type floor stands.
- C. Starter interlocked with other starters or control to be provided with labels on inside of cover stating nature of the interlock system. (Example: interlocked with 120V circuit from exhaust fan.)
- D. Rotation
 - 1. Connect motors for correct rotation before they are connected to driven load.
 - 2. Repair or replace (at the Owner's option) motors and equipment damaged because of incorrect motor rotation.
- E. Conduit: use flexible liquid tight conduit for all connections.
- F. Install overload relay heater elements and ascertain that size of heater elements correspond to motor full load current and that motors will start and operate immediately.
- G. Mount pushbutton 4'-0" above finished floor.
- H. Mount individual starters 6'-0" from finished floor to top of starter.
- I. Control Circuits
 - 1. Perform continuity tests.
 - 2. Check control and interlocking wiring for the proper operation.

3.02 MOTOR TESTS AND DATA

- A. Check all motors for correct rotation. The Electrical Contractor shall be available during operation of the balancing and adjusting mechanical systems and shall make such changes in wiring, heater sizes and other adjustments as are required to permit proper balancing of the systems.
- B. Refer to additional testing requirements in Section 26 08 01 Performance Testing and Electrical Systems.

3.03 SAFETY SWITCH INSTALLATION

- A. Mount safety switch on walls or on approved type floor stands with top +6'-0" A.F.F.
- B. Floor stands to be constructed of mild steel angle iron or channel type such as Unistrut or Kindorf. Bolts shall not project more than necessary for structural purposes.
- C. Install HP rated, non-fused, motor disconnect switch at each motor location.

END OF SECTION

SECTION 26 29 15 - MOTOR STARTERS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes the following:
 - 1. Motor starters and all power and control wiring complete for all electric motor driven equipment.
 - 2. All necessary pushbuttons, selector switches and similar control devices not specifically furnished by others. Provide these devices of the same manufacturer as the starters.

1.02 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 22 – Plumbing
- C. Division 23 – Heating Ventilating and Air Conditioning.
- D. Section 26 05 01 – General Provisions
- E. Section 26 05 02 – Assignments of Miscellaneous Work.
- F. Section 26 05 33 – Raceways and Boxes.
- G. Section 26 05 53 – Identification of Electrical Systems.
- H. Section 26 27 26 – Wiring Devices.
- I. Section 26 28 00 - Low Voltage Circuit Protective Devices
- J. Division 27 - Communications
- K. Division 28 - Electronic Safety and Security.

1.03 REFERENCES:

- A. Review the Drawings and all sections of the Specifications for equipment furnished by other Contractors and the Owner throughout the entire project.
- B. See references noted in Specification Section 26 05 00, Paragraph 1.03.
- C. NEMA 250-2008 – Enclosures for Electrical Contracting
- D. NECA 1 – 2006 – Good workmanship in electrical Contracting.
- E. UL - Underwriters Laboratories, Inc.

1.04 SYSTEM DESCRIPTION:

- A. Manual motor starters.
- B. Automatic motor starters.

1.05 SUBMITTALS:

- A. Submit shop drawings and product data under Division 01 and Section 26 05 01.
- B. For each starter, submit all electrical characteristics, including voltage, NEMA size, control wiring diagram, and motor starter label (e.g., MSA-1)

1.06 QUALITY ASSURANCE:

- A. Provide motor protection switches of the appropriate NEMA size. For units not using NEMA rating, use equivalent NEMA size

1.07 DELIVERY, STORAGE AND HANDLING:

- A. Deliver, store and handle materials in accordance with Division 01 and Section 26 05 01.

1.08 SEQUENCING AND SCHEDULING:

- A. Sequence and schedule work in accordance with Division 01 and Section 26 05 01.

1.09 WARRANTY:

- A. Warranty in accordance with requirements of Division 01 and Section 26 05 01.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Allen-Bradley.
- B. Cutler-Hammer, Inc.
- C. General Electric Co.
- D. Siemens Energy & Automation, Inc.
- E. Square D Company.

2.02 MATERIALS:

- A. Manual Motor Starters:
 - 1. In new walls and finished areas, provide flush mounted toggle switch with thermal overload protection, pilot light and stainless steel coverplate, similar to Square D Model 2510 FS1P or approved equal.
 - 2. In non-fishable existing walls and mechanical spaces, provide surface mounted toggle switch with thermal overload protection, pilot light and general-purpose enclosure, similar to Square D Model 2510 FG1P or approved equal.
 - 3. Provide NEMA Type 1 starter unless otherwise noted.
- B. Magnetic and Combination Motor Starters:
 - 1. Provide surface mounted starters in NEMA Type 1 enclosures unless otherwise noted.

2. For combination type starters, provide non-fusible disconnect switch type with provisions for locking the operating lever in either the "ON" or "OFF" position.
 3. Provide an electronic overload device for each phase of the motor. Overloads to be adjusted to motor horsepower.
 4. Provide with fused control circuit with the fuse properly sized by the starter manufacturer to protect the electronic overload. Refer to Section 16478 for spare control circuit fuse requirements.
 5. Provide two extra normally open auxiliary contacts and two extra normally closed auxiliary contacts in addition to those necessary for the particular control circuit involved.
- C. Magnetic and Combination Motor Starter Phase Failure Relay.
1. Provide each multi-phase motor starter with a phase failure relay. This relay shall shut down the controller upon:
 - a. Phase failure.
 - b. Undervoltage.
 - c. Phase reversal.
 - d. Phase unbalance of 10 percent or greater.
- D. Magnetic and Combination Motor Starter Accessories:
1. Provide all pilot lights, pushbuttons, selector switches and similar control devices indicated on the Contract Documents. These devices shall be of the same manufacturer as the motor starters.
 2. Energy Management System (EMS)/Building Automation System (BAS) Wiring Terminals:
 - a. With each starter, provide wiring terminals as part of the starter for the connection of a control contact of an energy management system (EMS)/building automation system (BAS).
 - b. These terminals shall be part of the "automatic" control portion of the HOA selector switch control of the starter coil circuit.
 - c. Provide a jumper wire between these terminals to allow operation of the starter without EMS/BAS controls.
 - d. Provide clear, specific labeling of these terminals identifying their intended usage.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Verify the location and size of each motor, and properly connect all motors required on the project.

3.02 PREPARATION:

- A. Do not install magnetic and combination motor starters directly to concrete walls, masonry walls or exterior walls. Provide structural channels such as Unistrut to install starters at least 3/4 inch away from concrete or masonry walls.

- B. Where starters are to be installed in open area without wall for support, provide structural steel channel (Unistrut or equal) to support motor starters.

3.03 INSTALLATION:

- A. Installation shall be in accordance with NECA practices.
- B. Install manual motor starters flush at 48 inches above the floor.
- C. Install magnetic and combination motor starters near the motors served at a height of 72 inches above the floor to the top of the starter. Provide structural channel supports as required.
- D. Labeling: Provide equipment and circuit identification labeling as specified in Section 26 05 53.
- E. Manual Motor Starters for Automatic Exhaust Fans: Provide a manual motor starter with thermal overloads and pilot light for each automatic exhaust fan controlled by a contactor. Install these starters beneath or adjacent to the associated contactor, unless otherwise noted.

3.04 CONSTRUCTION:

- A. Provide heater elements sized based upon the nameplate full load current of motor provided for all manual motor starters.

3.05 ADJUSTING:

- A. Set overload devices to protect motors provided.

END OF SECTION

SECTION 26 32 13.13 - DIESEL ENGINE DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19

1.03 UNIT DESCRIPTION

- A. Standby power units shall be a diesel engine driven alternator unit complete with all necessary accessories.
- B. Unit shall have diesel dispenser.
- C. Diesel and auto transfer equipment shall comply with all requirements of current edition of NFPA 110.
- D. Acceptable Package Fabricators
 - 1. McAllister Machinery (Caterpillar Engine)
 - 2. Cummins Midstates, Inc. (Cummins Engine)
 - 3. Clark (Detroit Diesel)
 - 4. Kohler (Buckeye Power)
 - 5. Generac

1.04 SUBMITTALS

- A. Submit complete shop drawings and data sheets on generator, alternator, diesel engine set, starting system, exhaust system instruments and transfer equipment as indicated in Specification Section 26 05 01, General Provisions.

1.05 OPERATIONS AND MAINTENANCE DATA

- A. Provide operations and maintenance data in accordance with Specification Section 01770 Project Close Out.

PART 2 - PRODUCTS

2.01 ENGINE

- A. Four cycle turbo-charged engine designed to efficiently produce rated capacity.

Engine to be mounted on vibration isolators within enclosure.

- B. Fuel shall be #2 fuel oil. Provide engine mounted a U.L. subbase tank closed top dike design with low level and leak detection contacts wired to control panel alarms sized for forty-eight (48) hours fuel at rated full load.
- C. Cooling system: heavy duty radiator with blower fan and fan guard. Engine driven water pump. Engine jacket water heater with thermostatic control; on "V" block engines use two (2) heaters or single heater with circulating pump. Minimum of 2250 watts total.
- D. Governor: electronic isochronous.
- E. Lubricating System: engine driven lube oil pump; full flow oil filter with replaceable elements; oil pressure gauge.
- F. Engine Starters: heavy duty 12 or 24 volt DC electric motors.
- G. Starting System: industrial type lead acid batteries 12 or 24 volt DC, 90 seconds total cranking time at 30°F ambient; end voltage to be 70% (minimum) of capacity; automatic battery charger; fused protection; battery rack and battery cables.
- H. Battery charger sized to completely recharge batteries within 12 hours. Charger also to have remote summary alarm contacts. Charger shall have automatic float/equalize and a minimum of 10 AMPS. Charger shall have digital 1% accuracy volt meter and ammeter. In addition, charger shall have alarms with indicating lights and remote contacts for the following: low DC current, High DC shutdown, and AC available (light only). The charger shall use "set point memory" to retain set points without power or battery. Each alarm set point shall be field adjustable.
- I. Exhaust System: heavy duty critical type exhaust silencer with condensate trap and flexible exhaust connection. Silencer shall be insulated with 1" thick flexible blankets as manufactured by Insultech Corporation or approved equal. Turn silencer and insulation blankets over to Mechanical Contractor for installation
- J. Air Cleaners: heavy duty dry type with replaceable elements.
- K. Engine Instruments and Controls: water temperature gauge, lube oil pressure gauge, hour meter, safety shutdown controls for high water temperature, low oil pressure, starting battery failure, overspeed and overcrank with restart lockout. Use NFPA 110 Level 1 indicators and shutdown.
- L. Remote annunciator status panel shall comply with NFPA 110. Locate as indicated on drawings.

2.02 ENCLOSURE (SOUND ATTENUATED)

- A. The weather protected enclosure shall be a **reach-in** type of formed steel construction use of any combustible materials is not permitted. The design and construction shall be a minimum thickness of 14 gauge for all component parts. The roof of the enclosure shall meet or exceed the minimum gauge requirements specified, but in addition, shall be strengthened in such a manner as to support the largest commercially available exhaust silencer recommended by the engine manufacturer for this application.
- B. All hardware including door latches/hinges and fasteners shall be of stainless steel. The doors shall be key locking.
- C. At the point where the exhaust pipe flexible tubing penetrates the roof of the enclosure, a suitable "rain skirt" and collar shall be provided by the manufacturer. It shall be designed to prevent the entrance of rain and allow for expansion and vibration of the exhaust piping without chafing or stress to the exhaust system. This detail must appear on the drawings submitted for approval.
- D. Upon final assembly of the weather protected enclosure, it shall be prime painted with a minimum of two (2) coats of rust-inhibiting primer. The final finish painting shall be a minimum of two (2) coats of enamel with color to be selected by Architect.
- E. The entire enclosure except for the louvered openings shall have insulation material mechanically attached to the interior surfaces of the unit and #18 gauge perforated, galvanized liner provided. Sound level of the completed package operating at rated output, shall not exceed 79 db (A) at 23'.
- F. The generator set and enclosure shall be mounted and shipped to the job site on a common structural steel sub-base. Provisions for crane unloading of the complete package shall be designed into the base of the unit.
- G. The entire unit consisting of generator set, base, enclosure, and all other specified items including liquids (i.e. lube oil and cooling water) shall be supplied by the manufacturer. Fuel shall be provided/installed by the installing contractor, to include initial fill and top off after testing. The base of the unit shall be engineered, designed, and manufactured as a heavy duty, welded steel construction with four (4) point lifting provisions as used on heavy duty construction installations. Details and manufacturer's certification of the base construction shall be included with the drawings submitted for approval.
- H. The floor of the enclosure shall be designed and constructed in such a manner as to prevent the entrance of rodents. This may be accomplished with solid metal or expanded metal grating, but in any event, must be capable of supporting any ancillary equipment specified which may be secured to it (such as batteries, day tanks, etc.) plus the anticipated weight of maintenance personnel and their tools. Under no circumstances shall the floor area or any of its parts be considered for cooling air intake or discharge requirements of the generator set or its associated equipment, nor shall its properties as a "heat-sink" or heat dissipating medium be utilized in any manner whatsoever in this application.

- I. All necessary fittings, hoses, shut-off valves, etc., shall be provided by the manufacturer of the weather protected enclosure to facilitate lube oil and water drain at the exterior of the enclosure. In addition, engines equipped with crankcase breather tubes shall have this tube terminate at the exterior of the enclosure.
- J. Cooling air exhaust and intake louvers shall be provided of aluminum or galvanized steel construction. The louvers shall open automatically upon diesel generator start and close upon diesel generator shutdown (spring open, motor close). Exhaust louvers may be gravity type. Turn hoods shall be provided at the air intake and exhaust ends, directing exhaust air vertically and sound insulated as required to achieve the sound requirement.
- K. Provision shall be made for conduit entry through the enclosure floor and into the generator circuit breaker connection box.
- L. A manual fire-safe shutoff valve and a filter/separator shall be provided on the fuel supply line.
- M. Silencer shall be mounted inside the enclosure as described under "Exhaust System" above and exhausted into the turn hood.
- N. Housing shall be 191 inch long, 75 inches wide and 103 inches high.

2.03 ALTERNATOR

- A. Alternate shall be brushless, synchronous, single bearing or two bearing close-coupled, with Permanent Magnet Exciter capable of providing a nominal 300% of the name plate rated three phase short circuit power for ten seconds at the alternator terminals.
- B. The alternator shall use form wound coils with vacuum impregnated epoxy insulation. Random wound coils or epoxy dip and bake insulation is not acceptable.
- C. The alternator shall use space heaters (120 VAC) to protect against condensation moisture.
- D. The temperature rise of the alternator shall not exceed 105°C when operated at rated load under continuous duty conditions with the cooling air inlet temperature of 40°C. The insulation of the stator and rotor shall have a minimum temperature rating of Class 155°C (Class H) per IEEE Std.1.

2.04 REMOTE ANNUNCIATOR

- A. Provide Power Zone Pro Sync Controller with 7-inch touch screen display panel. Locate panel as shown on the drawings or as directed by the owner,
- B. The contractor shall provide the wiring in conduit from this panel to the generator, coordinate all requirements with the generator manufacturer.

2.05 BREAKERS

- A. Provide 400-amp breakers as shown, see E601 for more information.

2.06 DIESEL FUEL DISPENSER

- A. Provide #2 diesel fuel dispenser w/ USB data communications.
- B. Pump: Rotary vane pump.
- C. Flow Rate: 22 GPM.
- D. Voltage : 120 volt single phase, branch feeder shall be ¾ " conduit with Seal-Offs to meet code..
- E. Display: two line LCD display, illuminated.
- F. Max Suction 8 -12 feet.
- G. Hose Qty.: 1 hose, ¾ diameter 13 ft.
- H. Dimension: 16 " X 11 " by 60 inches high.
- I. Enclosure: Robust power coated enclosure
- J. Unit shall be mounted and connected to the emergency generator tank per manufacturers recommendation.
- K. B.O.D.: Tecalemit HDM eco 80 w/USB data communication , HD managers 8 software, or approved equal by owner.

2.07 SUB FUEL TANK

- A. Provide 2000 Gallon sub fuel tank system per the manufacturer's recommendations.
- B. Contractor shall provide the fuel as required by the owner request.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRIC GENERATING PLANT

- A. Mount unit on the top of the fuel tank. (Note: engine set and alternator to be on vibration isolators, not unit frame and structure.)
- B. Provide operation instruction period for Owner.
- C. Unit to be fully lubricated and ready for operation.
- D. Generator, sub tank and enclosure shall be mounted on a concrete pad, see drawings for more information. Provide extra 6 inches beside the length and width of the generator.

3.02 TESTING

- A. Prior to acceptance of the installation, the equipment shall be subjected to an on-site test at full load with resistive load banks for a minimum of 4-1/2 hours as follows:
1. 1/2 hour @ 50% load
 2. 1 hour @ 75% load
 3. 3 hours @ Full load
- B. All consumables necessary for this test operating shall be furnished by the bidder. Any defects which become evident during this test shall be corrected by the bidder at his own expense. Tank shall be left full after acceptance with #2 fuel oil.

3.03 PARTS AND SERVICE

- A. The engine-alternator set bidder shall be the authorized dealer of the engine-alternator set manufacturer and shall be factory trained and authorized to provide service and parts for both the engine and alternator at any time during the day or night.

3.04 MAINTENANCE

- A. The bidder shall furnish three (3) copies of operating and maintenance instructions and illustrated parts books covering the engine-alternator and auxiliary equipment which will require operating instructions and periodic maintenance.

END OF SECTION

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Raceways and Boxes: Section 26 05 33
- D. Performance Testing: Section 26 08 01
- E. Diesel Engine Driven Generator Sets: Section 26 32 13.13

1.02 GENERAL REQUIREMENTS

- A. Equipment shall be new, factory assembled and tested.
- B. The transfer switch shall conform to the current requirements of:
 - 1. UL 1008 - Standard for Automatic Transfer Switches
 - 2. NFPA 70 - National Electrical Code, including use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702.
 - 3. NFPA 110 - Standard for Emergency and Standby Power Systems
 - 4. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
 - 5. IEEE Standby 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
 - 6. NEMA Standard ICS-2-447-AC Automatic Transfer Switches
 - 7. IEC - Standard for Automatic Transfer Switches
- C. The transfer switch shall be UL listed in accordance with UL 1008 as follows:
 - 1. Rated in amperes for total system transfer including control of motors, electric discharge lamps, electric-heating and tungsten-filament lamp loads as referred to in Paragraph 38.13 of UL 1008.
 - 2. Switches rated 400 amperes and below shall be suitable for 100% tungsten-filament lamp load. Switches rated above 400 amperes shall be suitable for 30% tungsten-filament load.
 - 3. Overload and endurance at 480 volts AC per Tables 25.1, 25.2, 27.1 and 27.2 of UL 1008 when enclosed according to Paragraph 1.6.
 - 4. Temperature rise test after the overload and endurance tests to confirm the ability of the transfer switches to carry their rated current within the allowable temperature limits.
 - 5. No welding of contacts. Transfer switch must be electrically operable to alternate source after the withstand current tests.

6. Dielectric tests at 1960 volts, rms, minimum after the withstand current test.

1.03 SUBMITTALS

- A. Submit shop drawings on all automatic transfer switches as indicated in Specification Section 26 05 01, General Provisions.
- B. Provide complete wiring details showing all components of the emergency system.

1.04 OPERATIONS AND MAINTENANCE DATA

- A. Provide operations and maintenance data in accordance with Specification Section 01770 Project Close Out.

PART 2 - PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH

- A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized to minimize power consumption and heat generation. The operating transfer time shall be one-sixth ($1/6$) of a second or less. The switch shall be positively locked and unaffected by voltage variations or momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life. The switch shall be mechanically interlocked to ensure only one of two possible positions-normal or emergency.
- B. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand current capability and be protected by separate arcing contacts.
- C. Inspection of all contacts (movable and stationary), linkage and moving parts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout the entire travel to properly inspect and service the contacts when required.
- D. When neutral conductors are indicated on the schedule ATS to be provided with switched overlapping neutral contacts.
- E. The transfer switch shall be rated to withstand the 35000 amperes rms symmetrical short-circuit current at the terminals.

2.02 BYPASS-ISOLATION SWITCH

- A. Provide a bypass isolation switch for each transfer switch specified herein and as indicated on the drawings.
- B. A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven. Arrangements utilizing electrically driven contacts are prohibited.
- C. Power interconnections shall be silver-plated copper bus bar. The only field-installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control intertwining shall be provided with disconnect plugs.
- D. Separate bypass and isolation handles shall be utilized to provide a clear distinction between the two functions. The bypass handle shall provide three operating modes: "Bypass to Normal", "Automatic" and "Bypass to Emergency". Bypass to the load-carrying source shall be affected without any interruption of power to the load (make-before-break contacts). Load break-type bypass for ATS test and isolation shall not be acceptable. The operating speed of the bypass contacts shall be the same as that of an associated automatic transfer switch and shall be independent of the speed at which the manual bypass handle is operated. In the "Automatic" mode, bypass contacts shall be all open so they will not be subjected to fault currents.
- E. The isolation handle shall provide three operating modes: "Closed", "Test" and "Open". The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switch(es), without any interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.
- F. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch allowing transfer and re-transfer for the load between the two available sources without the feedback of load-regenerated voltage to the transfer switch. This transfer/retransfer operation shall comply with Paragraph 42.7 of UL 1008.

2.03 MICROPROCESSOR CONTROL MODULES

- A. The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent digital communications capability. The control module shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control module to be disconnected from the transfer switch for routine maintenance.

- B. The control module shall be completely enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on plug-in printed circuit boards for maximum reliability. Interfacing relays shall be industrial control grade plug-in type with dust covers. All relays shall be identical to minimize the number of unique parts.
- C. The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472-1974 (ANSI C37.90a-1974) and the impulse withstand voltage test in accordance with the proposed NEMA Standard ICS 1-109.
- D. In phase Monitor: An in-phase monitor shall be built-in to the microprocessor control module and shall control transfer so that motor load inrush currents, do not exceed normal starting currents to avoid nuisance tripping of circuit breakers and possible mechanical damage to motor couplings. The in-phase monitor shall operate without external control of electrical loads and without any external control of the power sources. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency difference. In phase transfer shall be accomplished if both sources are within 2 Hz of nominal frequency and 70% or more of nominal voltage.
- E. Provide block load transfer function to add/shed load as directed by the load management controller.
- F. System LCD controller/display. Shall include the following features:
 - 1. System status screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example:
 - a. Normal Failed
 - b. Load on Normal
 - c. TD Normal to Emergency (X min X seconds)
 - 2. Self-Diagnostics: The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being complete.

3. Data Logging: The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in non-volatile memory:
 - a. Event Logging:
 - b. Data and time and reason for transfer normal to emergency
 - c. Data and time and reason for transfer emergency to normal
 - d. Data and time and reason for engine start.
 - e. Data and time engine stopped.
 - f. Data and time emergency source available.
 - g. Data and time emergency source not available.
4. Statistical Data:
 - a. Total number of transfers.
 - b. Total number of transfers due to source failure.
 - c. Total number of days controller is energized.
 - d. Total number of hours both normal and emergency sources are available.

2.04 ENCLOSURE

- A. The automatic transfer switch, microprocessor control module and bypass isolation switch where required shall be housed in a single NEMA 1 enclosure.

2.05 MANUFACTURERS

- A. ASCO/Schneider 7000 Series ATS-
 1. Any alternative shall be submitted for approval to the consulting engineer at least 10 days prior to bid. Any alternatives to this bid shall only be considered if a complete written description of the proposed system along with any variances with the specification, are received ten (10) days prior to bid due date. Any variances not specifically enumerated prior to bidding shall be considered non-responsive. Costs incurred to modify the building and/or interfacing equipment which are affected as a result of an alternate, shall be the responsibility of the contractor

2.06 OPERATION & FEATURES

- A. The voltage of each phase of the normal source shall be monitored, with pickup adjustable from 85 to 100% and dropout adjustable from 75 to 98% of pickup setting, both in increments of 1%, and shall be fully field adjustable without the use of any tools, meters or power supplies. Repetitive accuracy of settings shall be $\pm 2\%$ or better over an operating temperature range of -20°C to 70°C . Factory set to pick up at 90% and drop out at 85%.

- B. Single-phase voltage sensing of the emergency source shall be provided, with a pickup adjustable from 85 to 100% (and dropout fixed at 84 to 86% of pickup), and frequency sensing with pickup adjustable from 90 to 100% (and dropout fixed at 87 to 89% of pickup). Both pickup settings shall be fully field-adjustable in 1% increments without the use of any tools, meters or power supplies. Repetitive accuracy off setting shall be $\pm 2\%$ or better over an operating temperature range of -20°C to 70°C . Factory set to pick up at 90% voltage and 95% frequency.
- C. The control module shall include four-time delays that are fully field-adjustable in increments of at least 13 steps over the entire range as follows:
 - 1. Time delay to override momentary normal source outages to delay all transfer switch and engine-starting signals. Adjustable from 0 to 6 seconds. Factory set a 1 second.
 - 2. Transfer to emergency time delay. Adjustable from 0 to 5 minutes. Factory set at 0 minutes.
 - 3. Re-transfer to normal time delay. Time delay is automatically bypassed if emergency source fails, and normal source is acceptable. Adjustable from 0 to 30 minutes. Factory set at 30 minutes. Provide a toggle switch to manually bypass time delay on retransfer.
 - 4. Unloaded running time delay for emergency engine generator cooldown. Adjustable from 0 to 60 minutes. Factory set at 5 minutes.
- D. A set of DPDT contracts rated 10 amps, 32 VDC shall be provided for a low voltage engine start signal when the normal source fails. The start signal shall prevent dry cranking of the generator by requiring the generator to reach proper output, and to run for the duration of the cooldown setting regardless of whether the normal source restores before the load is transferred. Also provide a "commit/no commit to transfer" selector switch to select whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
- E. A momentary-type test switch shall be provided to simulate a normal source failure. Also, terminals for a remote contact which opens to signal the ATS to transfer to emergency and terminals for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal shall be provided.
- F. A visual position indicator shall be provided to indicate bypass-isolation switch position. Pilots' lights shall indicate availability of power sources and automatic transfer switch position. A prominent and detailed instruction plate shall be furnished.
- G. One set of auxiliary contacts shall be rated 10 amps, 480 VACS, consisting of one contact closed when the ATS is connected to normal and one contact closed when the ATS is connected to emergency. Output terminals to signal the actual availability of the normal and emergency sources, as determined by the voltage sensing pickup and dropout settings for each source, shall be provided.

- H. Include the following closed transition functions and characteristics for automatic transfer switches:
1. Fully automatic make before break
 2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100ms.
 3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
 - a. Initiation occurs without active control of generator.
 - b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
 4. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
 5. Terminal provisions for a remote contact which opens to signal, the transfer switch to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.
- I. Include the following digital power monitoring:
1. The power monitor shall be flush mount to the transfer switch enclosure.
 2. The power monitor shall be equipped with a continuous duty, LCD backlit display to provide local access to the following metered quantities:
 3. Current, per phase RMS and neutral (if applicable).
 4. Current unbalance percentage.
 5. Voltage, phase-to-phase and phase-to-neutral.
 6. Voltage unbalance percentage.
 7. Real power, per phase and 3-phase total
 8. Apparent power, per phase and 3-phase total.
 9. Reactive power, per phase and 3-phase total.
 10. Power factor, 3-phase total and per phase.
 11. Frequency.
 12. Accumulated energy (MWH, MVAH and MVARH).
 13. Power monitor shall include 24 months of peak Demand kW historical data and shall display the peak kW per month for 24 months prior. Meets NEC 220.80.
 14. Displaying each of the power monitor quantities shall be accomplished through the use of menu scroll buttons.
 - a. Reset of the following electrical parameters shall be allowed from the front of the power monitor.
 - b. All reset and setup functions shall provide a means for protection

- against unauthorized/accidental changes.
 - c. The power monitor shall be connected to power management system through RS485 serial port and/or TCP/IP Ethernet port without translator.
 - d. Power monitor shall include the following:
15. Accurate to 1 percent measured, 2 percent computed values and display resolution to .1 percent. Voltage and current for all phases are sampled simultaneously to assure high accuracy in conditions of low power factor or large harmonics waveform distortions.
 16. Capable of operating at frequencies of 45 to 66 Hz and over a control power input voltage range of 20 to 32 VDC.
 17. Interfaced with a communications module to permit information to be sent to remote location for display, analysis and logging
 18. Accept inputs from industry standard instrument transformers (120 VAC secondary PT's and 5A secondary CTS). Direct phase voltage connections, 600 VAC and under, shall be possible without the use of PT's.
 19. Monitor shall be applied in 3-phase, three and four wire circuits. A fourth CT input shall be available to measure neutral or ground current.
 20. All setup parameters required by the power monitors shall be stored in non-volatile memory and retained in the event of a control power interruption.
 21. The following metered readings shall be communicated by the power monitor, via serial communication:
 - a. Current, per phase RMS and neutral (if applicable).
 - b. Current unbalance percentage.
 - c. Voltage, phase-to-phase and phase-to-neutral.
 - d. Voltage unbalance percentage.
 - e. Real power (kW), per phase and 3-phase total.
 - f. Apparent power (kVA), per phase and 3-phase total.
 - g. Reactive power (kVAR), per phase and 3-phase total.
 - h. Power factor, 3-phase total and per phase.
 - i. Frequency.
 - j. Accumulated energy (MWH, MVAH and MVARH).
 - k. Accumulated real energy kWh.
 - l. Accumulated reactive energy KVAH.
 - m. Accumulated apparent energy KVARH.
 22. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel. Include SNMP, Modbus RS485 & TCP/IP communications, SMTP email notifications, & integral web page for remote monitoring. Communication interface shall have four Ethernet Ports to allow for daisy chain of multiple devices

PART 3 - EXECUTION

3.01 INSTALLATION OF ATS'S

- A. All production units shall be installed per the manufacturer's recommendation.
- B. Coordinate the ATS'S installation with all trades.
- C. NO clearances on the sides or back is required for these ATS'S.
- D. Connect the cables as required per the manufacturer's recommendations.
- E. The new ATS's shall be energized by a factory authorized person in the present of the owner, the electrical contractor and the engineer.

3.02 TESTS & CERTIFICATIONS

- A. All production units shall be subjected to the following factory tests:
 - 1. The complete transfer switch shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
 - 2. The switch shall be subjected to a dielectric strength test per NEMA Standard ICS 1-109.21.
- B. The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards and withstanding current ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of submittals shall be included in the certification.

3.03 PARTS AND SERVICE

- A. The automatic transfer switch bidder shall be the authorized dealer of the equipment and shall be factory trained and authorized to provide service and parts for same at any time during the day or night. A description of the service and parts support capability shall be included with submittal information.

3.04 MAINTENANCE

- A. The bidder shall furnish three (3) copies of operating and maintenance instructions and illustrated parts books covering the control changes and the automatic transfer switch and any auxiliary equipment which will require operating instructions and periodic maintenance.
- B. Provide one copy of the operation and maintenance instructions in electronic format, coordinate with owner on the format type.

3.05 TRAINING

- A. Provide two (2) training sessions for Owner's personnel. Each session shall be approximately 4 hours and shall cover basic system components, operations (automatic and manual) testing and maintenance.
- B. Training sessions shall be professionally videotaped by equipment supplier with a taped copy turned over to the Owner.
- C. Training shall be scheduled prior to occupancy at the Owner's convenience.

END OF SECTION

SECTION 26 43 13 - SURGE PROTECTION DEVICES (SPD) FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Raceways and Boxes: Section 26 05 33
- D. Panelboards: Section 26 24 16
- E. Low Voltage Controllers: Section 26 29 00
- F. Low Voltage Circuit Protective Devices: Section 26 28 00

1.02 SUBMITTALS

- A. Submit shop drawings or data sheet on SPD equipment used in accordance with Specification Section 26 05 01, General Provisions.

1.03 SUMMARY

- A. These specifications describe the electrical and mechanical requirements for a high energy surge protection devices (abbreviated as SPD in this specification and on all drawings).
- B. The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Types 1, 2, 3, or 4 environments, as indicated on drawings.
- C. The system shall meet these requirements as tested by ANSI/IEEE C62.11, C62.45. The system shall be connected in parallel with the protected system; no series connected elements shall be used which limit load current or KVA capability.

1.04 STANDARDS

- A. The specified system shall be designed, manufactured, tested and installed in compliance with:
 - 1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
 - 2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
 - 3. National Electrical Manufacturer Association (NEMA Publication LS-1)
 - 4. National Fire Protection Association (NFPA 20, 70, 75 and 78)

5. Underwriters Laboratories (UL 1283 and UL 1449, 3rd Edition)
 6. National Electrical Code (NEC).
- B. The system shall be UL listed as passing the applicable location category current waveforms specified in UL1449 (3rd Edition).
- C. The listings shall be displayed on the unit with a permanently attached factory label. The ratings of the system must be supported by 'published' test data from an independent laboratory which verifies the repetitive surge current impulse ratings. Also, to support the UL 1449 testing, a report needs to indicate the VPR rating and actual fault current withstand rating.

1.05 SYSTEM DESCRIPTION

- A. System Operating Voltage and applicable modes: The nominal system operating voltage shall be 120/208V, three phase wye, 4 wire plus ground, L-N, L-G and N-G.
- B. The SPD maximum continuous operating voltage shall be greater than 115% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage (swell) conditions.
- C. The operating frequency range of the system shall be at least 57 to 63 Hertz.
- D. Provide capacitors as required to not provide additional noise to system in accordance with UL 1283.
- E. Overcurrent Protection (Fusing): All protection modes of type shall be internally fused with the fuses in capability to allow the suppressor's maximum rated transient current to pass through the SPD without fuse operation. If the rated in characteristics of the fusing is exceeded, the fusing shall be capable of opening and clearing both high and low impedance fault conditions. This overcurrent protection circuit shall be monitored and provide indication of suppression failure/operability.
- F. The SPD shall provide protection for modes as outlined in "system operating voltage and applicable modes" above. Note: L= Line, N= Neutral, G= Ground.
- G. The SPD multiple surge current minimum rating for any one individual mode (L-L, L-N, L-G or N-G) based on the standard 8 x 20 microsecond impulse shall be no less than:
1. Location Type 3 Panelboards – 100-80KA
 2. Location Type 2 Main Distribution – 200-160KA
 3. Location Type 1 Service Entrance – 300-240 KA
- H. The system performance ratings shall be based on the appropriate UL, 1449 3rd Edition listing ratings for the applicable IEEE C62.41 impulse waveforms.

1.06 DEFINITION

- A. The category of the surge protection device (SPD) shall be determined by its location according to the following descriptions:
 - 1. Type 3 - This shall be any branch circuit panelboard located more than 30 circuit feet from the service equipment.
 - 2. Type 2 -Main distribution panel
 - 3. Type 1 - This shall be any device installed on load or line side of the main service over current protection (OCP).

1.07 PROJECT SCOPE

- A. This project contains the following equipment categories.
 - 1. Type 3
 - 2. Type 2
 - 3. Type 1

PART 2 - PRODUCTS

2.01 SURGE SUPPRESSION COMPONENTS

- A. The system shall be constructed using multiple surge current diversion modules utilizing matched metal oxide varistors (MOV). Each module shall be capable of withstanding over 1,000 pulses of the applicable IEEE62.41 Category surge current without failure or degradation of performance when tested per C62.11, C62.45, suggested wait times. The modules shall be designed and constructed in a manner which ensures MOV surge current sharing.
- B. Terminals shall be provided for all of the necessary power and ground connections. The terminals shall accommodate wire sizes of up to #6 AWG for Type 3, #2 AWG for Type 2 and #1/0 AWG for Type 1.
- C. All surge current diversion module intra-unit connections shall be by way of low impedance connections. All module mounting hardware and power wiring shall be captive or remain in place when a module is removed or replaced. The system shall be designed for simple change out of any or all SPD components modules by a qualified electrician.
- D. The specified system shall be provided in a heavy duty NEMA 1 enclosure. The cover of the enclosure shall be hinged and require a tool for access to internal components. Indication of surge current module status shall be visible without opening the door.

2.02 ACCESSORIES

- A. Unit Status Indicators: Status indicators with printed labels shall be provided on the hinged front cover to continually indicate each modules status. Indicator shall reliably indicate that one or more surge current diversion modules or fuses have failed and that service is needed to restore full operation. All protection modules and modes (including N-G) shall be monitored.
- B. Electrically isolated Form C (one N.O. and one N.C.) summary alarm contact rated for at least 120 VAC and 1 ampere shall be provided for remote annunciation of unit status. The summary alarm contact shall change state if any one or more of the surge current diversion modules has failed.
- C. Audible Alarm: The specified system shall be equipped with an audible alarm which shall be activated when any one or more of the surge current diversion modules has failed. In conjunction with the audible alarm, an alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm function. Both switches and the audible alarm shall be located on the unit's hinged front cover.
- D. Transient Counter: A transient voltage surge counter to totalize all transient voltage surges which caused operation of the SPD system. The readout shall be at least a five digit LCD located on the unit's hinged front cover. The counter shall be equipped with a battery back-up to retain memory when power is not present. A pushbutton switch on the display's faceplate shall be provided for manual counter reset.

2.03 MANUFACTURERS

- A. Current Technology
- B. L.E.A. International
- C. Liebert
- D. Square D
- E. Eaton

PART 3 - EXECUTION

3.01 SURGE PROTECTION DEVICE INSTALLATION

- A. Mount surge protection device adjacent to panelboards, switchboard and switchgear as indicated on the drawings.
- B. Mount device to maintain minimum wire length between device and protected source. MAXIMUM LENGTH:

1. Panelboards: 12" with minimal wire bends.
- C. Run wiring in non-metallic conduit as straight as possible. If a conduit bend is required use long radius bends.
- D. Install overcurrent protection and disconnecting means for surge devices in accordance with National, State and Local Codes.

END OF SECTION

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SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary, apply to this Section.
- B. See LUMINAIRE SCHEDULE in electrical drawing set for all luminaires specified by Circle Design Group Lighting.
- C. Luminaires/Ceiling Systems - See related sections for ceiling systems. Contractor to coordinate luminaire trims, accessories and components to ensure lighting and ceiling systems compatibility. See section 1.4 SUBMITTALS for Contractor submittal information/confirmation.

1.02 SUMMARY

- A. Scope: The extent of interior lighting required is indicated on the drawings and schedules and by the requirements of this Section and all related Electrical Specification Sections.
- B. Furnish and install material, labor, and accessories required for the following pieces of equipment as shown on the drawings and specified herein.
- C. Types of luminaires specified in this Section are for indoor use and include the following:
 - 1. LED
 - 2. Exit Signs
 - 3. Emergency Lighting Units
 - 4. Interior lighting fixtures, supports, and accessories
- D. Related Sections: Refer to other Electrical Specification sections for the following:
 - 1. Drawings - Luminaire Schedule
 - 2. Section 26 05 01 – General Provisions.
 - 3. Section 26 05 33 – Raceways and Boxes
 - 4. Section 26 27 26 Wiring Devices
- E. References
 - 1. Review the Drawings and all sections of the Specifications for equipment furnished by other Contractors and the Owner throughout the entire project.
 - 2. See references noted in Specification Section 26 05 01, Paragraph 1.03.
 - 3. ANSI/NECA 1-2006 – Good Workmanship in Electrical Contracting.
 - 4. Illuminating Engineering Society of North America Lighting Handbook and Recommended Practices.
 - 5. FCC 47 CFR Part 15, Federal Code of Regulation (CFR) testing standard

- for electronic equipment.
- 6. IESNA LM-79, Electrical and Photometric Measurements of Solid-state Lighting Products.
- 7. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Lighting Products.
- 8. UL1598, Standard for Safety of Luminaires.
- 9. UL 8750, Safety Standard for LED Lighting
- 10. NEMA SSL 3 – 2010, High-Power White LED Binning for General Illumination.

F. Definitions

- 1. CRI: Color-rendering index.
- 2. CU: Coefficient of utilization.
- 3. LER: Luminaire efficacy rating.
- 4. Luminaire: Complete lighting fixture, including ballast housing if provided.
- 5. RCR: Room cavity ratio.

G. Products installed but not provided under this section.

- 1. Decorative lighting fixtures not specified by Engineer/Lighting Designer.

1.03 SUBSTITUTIONS

- A. No substitutions will be accepted after bids are received: The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous performance requirements of this project.
- B. One Manufacturer or "Pre-Bid Approved Equal": When only one manufacturer is listed within the description of the luminaire, the engineering, performance or aesthetics *MAY NOT* allow substitution of other manufacturers. "CDG Lighting Pre-Bid Approved Equal" permits pre-bid submittal of a product for CDG Lighting consideration under submittal guidelines established by this specification section.
- C. Three Manufacturers: When three manufacturers are listed on the Luminaire Schedule, the design, engineering, or architectural aesthetics will allow the CONTRACTOR to choose one of the three manufacturers listed. The first manufacturer listed by name and catalog number is the basis of design. The second and third manufacturer's name will be noted along with the wording "EQUAL PRODUCT" instead of a catalog number. The second and third listed manufacturer's "EQUAL PRODUCT" shall be provided which meets or exceeds the manufacturer's product noted with catalog number in materials, finish, components and accessories. CDG Lighting will have final opinion of "EQUAL PRODUCT" interpretation. Contractor/Distributor/Representative must formally submit questions in writing. All submittals must be in CDG Lighting possession not later than ten (10) business before the bid opening. CDG Lighting will issue a formal written response thru official channels.

- D. Luminaire Substitutions/Substitution Packages: CONTRACTOR may elect to submit to CDG Lighting a luminaire substitution package for review. All submittals must be in CDG possession not later than ten (10) business days before the bid opening. All luminaire substitutions must meet the following requirements or will be rejected outright by CDG Lighting.
- E. Substitution submittals requirements: A luminaire substitution (substitution package) shall consist of the following information or will be rejected outright by CDG Lighting:
1. Original luminaire cut sheet noting exact options / features of the proposed product in detail/dimensional accuracy.
 2. Color image of luminaire, in the configuration of the proposed product.
 3. Dimensioned drawing of luminaire to an identified scale per sheet print size.
 4. Electric data of the proposed luminaire with specified lamping, transformer, driver, or power supply.
 5. IES format photometric files for the proposed luminaire with specified lamp.
 6. Photometric reports must list the actual candela values for the luminaires' distribution in at least three planes. Copies of candela curves, footcandle and lumen tables and iso-footcandle contours must also include IES format electronic photometric files identified by CDG Luminaire type.
 7. Calculations - Substitutions for luminaire types impacting "calculation / light level sensitive" project rooms / areas must be submitted with a complete point by point calculation grid of the area utilizing the substituted luminaire and adjacent luminaires contributing to the light levels. The point by point submittal must include a statistical chart showing all fixed and variable calculation factors including, but not limited to: initial / maintained lamp lumens, all LLFs (Light Loss Factors), lamp/luminaire mounting heights, calculation plane height(s), surface reflectance's, complete Luminaire model numbers and calculation point spacing. Calculations will be rejected outright by CDG without this information. CDG reserves the right to obtain an electronic copy of the calculation files and the substitute luminaire IES files. CDG may run a comparison calculation model using AGI.
- F. All substitution submittals shall be provided to CDG Lighting in electronic format:
1. Electronically posted files shall be delivered thru Owner / Architect / Contractor established communication channels. No files shall be directly delivered to CDG Lighting by vendors or their agents.
- G. Lighting Designer Fee Compensation:
1. CONTRACTOR will be responsible for all costs (architecture time, CDG Lighting time, engineering time, manufacturer's costs, distributor costs, etc.) incurred to replace installed lighting equipment not approved by CDG Lighting.

2. CONTRACTOR shall pay professional fees at current standard hourly rates and reimburse expenses directly to all design professionals for time spent reviewing substitutions proposed by the Contractor after the bid has been awarded. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
3. Additional fees will be required for all submittals / substitution reviews exceeding (2) shop drawing submittals per luminaire.

1.04 SUBMITTALS

- A. General: Furnish submittals in accordance with the requirements of the related section.
- B. Coordination: All luminaire drawings shall be coordinated with the drawings and details of the Architectural, Structural, Electrical, Mechanical, and other related trades to assure a perfect and efficient installation.
- C. No Variations: No variations from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance by the architect. All variations must be clearly marked on the drawings submitted for approval.
- D. Shop Drawings: Submit legible, dimensioned drawings of specified lighting assemblies including:
 1. Luminaire Shop Drawings - Luminaire shop drawings shall clearly indicate:
 - a. Specified luminaire accessories, finishes, components on each sheet including but not limited to physical description of the light fixture, emergency components, energy efficiency data, and life/output. If only the catalog number is provided without graphically identifying the exact luminaire accessories, finishes, components on each sheet, the luminaire type will be REJECTED AS NOTED.
 - b. Modified or custom luminaires require a factory produced shop drawing. Standard luminaire cut sheet annotated/noted as "modified" will not be permitted (even for lamping modification) the luminaire type will be REJECTED AS NOTED.
 - c. No hand-written notes are permitted on lighting shop drawing submittals or the luminaire type will be REJECTED AS NOTED.
 - d. Catalog cuts lacking sufficient detail to indicate compliance with contract documents will be REJECTED AS NOTED.
 - e. Luminaires / ceiling systems - See other specification sections for ceiling systems.
 - (1) Contractor responsible to coordinate luminaire and ceiling systems compatibility of hardware, trims and materials.

- (2) Ceiling / Luminaire Trim Contractor coordination must be noted as verified on each shop drawing by Contractor for luminaire in final approved/purchased ceiling type, which may be a ceiling system different than originally specified.
 - (3) One luminaire type may be installed in multiple ceiling types requiring the following submittals.
 - (i) A separate cut sheet must be provided for each luminaire and unique ceiling system noting coordination.
 - (ii) A spreadsheet/matrix of luminaire types and ceiling types coordinating above details.
 2. Booklet format - Shop drawings shall be submitted in booklet form organized with a separate sheet for each luminaire type, ballast or driver type, lamp type, and Contractor's luminaires/Ceiling Systems compatibility confirmation assembled in order of luminaire "type" designation.
 3. Submittal format - Submittals shall be provided to CDG in electronic format:
 - a. Electronically posted files shall be delivered thru Owner/Architect/Contractor established communication channels. No files shall be directly delivered to the CDG or EE Team by vendors or their agents.

E. Remote Driver Location Submittal Drawings: Provide shop drawings clearly noting the location remote power supplies for CDG Representative Review. These submittal drawings are required at time of Luminaire Shop Drawing submittal review to CDG.

F. For pendant mounted extruded lighting fixtures submit layout shop drawings, organized by room number, indicating lengths, mounting points and power connections.

G. If required by the architect, provide sample fixture with the shop drawings for final approval.

H. Show details of non-standard or custom lighting fixtures. Indicate dimensions, weighs, methods of field assembly, components, features, and accessories.

 1. Wiring diagrams – Power and control wiring.

I. Record Shop Drawings Required: Record luminaire, power supply, and lamp shop drawings shall be delivered to the CDG at time of Substantial Completion. All "Approved as Noted" comments shall be corrected / picked up in this record set. All shop drawing review comments shall be included in this set. Record luminaire shop drawings shall be provided in a three-ring binder and electronically or by remote storage device.

J. Luminaire ordering schedules and shop drawing schedules: All lighting equipment shall be ordered in a timely manner. The Contractor shall provide a spreadsheet to CDG Lighting with the following detailed information organized by luminaire type:

1. Originally quoted delivery dates (6-8 weeks, etc.) from time of Bidding.
 2. Shop drawings delivery dates to CDG Lighting.
 3. Dates when equipment orders are placed/finalized per approved shop drawings.
 4. Final product delivery schedules.
 5. Long lead items - At time of original quote/bid, Contractor is required to identify any long lead lighting items and identify in the master project construction schedule for trade coordination.
- K. Battery and charger data shall be submitted for emergency lighting units.
- L. Electrical ratings and photometric data with certified results of independent laboratory tests for luminaires and specified lamps.
- M. Field test reports indicating, and interpreting test results specified in Part 3 of this section.
- N. Maintenance manual: Refer to Section 26 05 01 for general requirements. At the completion of the project, the luminaire manufacturer shall furnish to the owner a recommended lighting maintenance manual. Each maintenance manual shall include:
1. Tools Required.
 2. Types of cleaners to be used.
 3. Replacement parts identification lists.
 4. Final as built shop drawings.
- O. Shop drawings and samples requested shall be submitted for approval before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the Contractor bearing full responsibility and cost.
- P. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of CDG. All variations must be clearly marked as such on the drawings submitted for approval.

1.05 QUALITY ASSURANCE

- A. Standards: Materials, equipment, and appurtenances as well as workmanship provided under this section shall conform to the highest commercial standard as specified and as indicated on drawings.
- B. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- C. Listing and Labeling: Provide Luminaires, emergency lighting units, and accessory components specified in this section that are listed and labeled for their indicated use and installation conditions on project.

1. Special Listing and Labeling: Provide Luminaires for use in damp and wet locations that are specifically listed and labeled for such use.
 2. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
- D. Mock-Ups
1. Provide light fixtures for the mock-up of rooms/areas noted under provisions of Division 01. Rooms to be designated by Architect, Engineer and Owner.

1.06 PROJECT CONDITIONS

- A. The Contractor is responsible for confirming compatibility and interface of other materials with the luminaire and ceiling system and shall provide proper luminaire extender rings, plaster frames, flange kits, etc. for ceiling system in which it will be installed. Report discrepancies to the Architect and defer ordering until clarified.
- B. Coordinate with the ceiling contractor in locating recessed and surface mounted luminaires.
- C. Coordinate with divisions 21, 22, and 23 to avoid conflicts between luminaires, supports, fittings, and mechanical equipment.
- D. Coordinate layout and installation of luminaires and suspension systems with other construction that penetrates the ceiling or is supported by them including HVAC equipment, fire suppression systems, and partition assemblies.
- E. Deliver, store and handle materials in accordance with Division 01.

1.07 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty for Batteries: Submit a written warranty executed by the manufacturer agreeing to replace rechargeable system batteries that fail in materials or workmanship within the specified warranty period. The Special Warranty Period on rechargeable system batteries shall be not less than 5 years after date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for last 4 years.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnished to the Owner.
2. Battery and Charger: One for each type of emergency lighting unit installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products specified in the Luminaire Schedule on the drawings or follow the substitution requirements for CDG Lighting consideration.

2.02 LUMINAIRES AND LUMINAIRE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position. Face plates or frames of recessed luminaires that serve as ceiling trim and swing to allow access to the interior of the luminaire shall be gasketed.
- D. Reflecting Surfaces: Minimum reflectance as follows:
1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or water white, annealed crystal glass:
- a. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - b. Lens Thickness: 0.125-inch (3 mm) minimum; except where greater thickness is indicated.
- F. Provide lampholders for the proper performance of lamps in luminaire, UL listed, of a type designed and acceptable for the purpose and bearing the manufacturers' name or trademark, type, number, and rating on each item.
- G. Housings shall be constructed so all electrical components are easily accessible and replaceable without removing them from their mountings.
- H. Light Leaks between ceiling trims of recessed lighting equipment and the ceilings will not be tolerated. If Luminaire is used in partials transparent ceiling, light leaks above the ceiling line will not be tolerated.

2.03 SUPPORTS

- A. Luminaire Support Components: Comply with Electrical Specification section "Basic Electrical Materials and Methods." All Luminaire Support Components shall be individually supported from the structure above and shall not be supported directly from a suspended ceiling system. Contractor shall coordinate exact mounting hardware necessary for installation based on the specified ceiling systems and shall verify on shop drawing submittals.
- B. Suspend or support independently of the ceiling construction all recessed luminaires which are not the lay-in grid type and all surface type luminaires in or on the ceiling from the structural members above.
- C. For recessed lay-in (grid) fixtures, provide safety cables or safety chains attached at each corner of fixtures supported from the structural members above to support all recessed lay-in fixtures.
- D. Safety cables shall be as follows:
 - 1. For concrete deck structure, cables shall be Gripple Stud Hanger #2, Erico/Caddy #SLD2L(X) with forged anchor, B-Line "KwikWire" equivalent, or approved equal.
 - 2. For steel structure, cables shall be Gripple Loop Hanger #2, Erico/Caddy #SLD2L(X), B-Line "KwikWire" equivalent, or approved equal:
- E. Safety chains shall be unwelded steel sash/safety chain, steel jack chain, or steel double loop chain. Working load limit of each individual chain shall be a minimum of five times (5X) the load weight of the fixtures being supported.
- F. Provide plaster frames or rings for all lighting fixtures recessed in plaster ceilings.
- G. Provide flange kits for all lighting fixtures in gypsum board ceilings.

2.04 LIGHTING FIXTURE SUPPORT COMPONENTS:

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, <12 gage> stainless steel, 12 gage.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.05 LED LUMINAIRES

- A. Complete System: The contractor shall furnish the completed LED-based lighting system. A 'Complete System' shall refer to an LED Luminaire and any power conditioning and/or interface equipment functioning together as a working unit.
- B. Thermal Management: The LED Luminaire manufacturer shall provide appropriate thermal management technology to ensure that temperatures do not exceed the limits established by the LED chip manufacturer. LED driver performance and compatibility with other light Luminaire components to be tested and verified by the light Luminaire manufacturer.
- C. LED Luminaires: LED Luminaires shall provide a continuous light output. Luminaire output and dimensions shall be in accordance with the contract drawings and specifications. LED Luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED Luminaires to operate in ambient temperature of -20 degrees Celsius and +50 degrees Celsius. White LEDs to have a minimum life of 50,000 hours and color LEDs to a minimum of 1000,000 hours. Color changing Luminaires shall be capable of 8-bit control of differently colored LEDs to produce the specified range of colors. All LED Luminaire types shall be provided with complete photometric data including lumen output, lumen depreciation, life, and distribution.
- D. Performance Assessment: The performance of LED Luminaires shall be evaluated and reported according to IESDNA standards LM-79 'Electrical and Photometric Measurements of Solid-State Lighting Products' and LM-80 'Measuring Lumen Maintenance of LED Light Sources'. The results of such evaluation shall be reported by the LED Luminaire manufacturer.
- E. Performance Requirements:
1. Driver shall operate from 60 Hz input source of 120V thru 277V with sustained variations of +/- 10% with no damage to the driver.
 2. Driver output shall be regulated to +/- 5% across published load range.
 3. Power Factor: Greater than 90%.
 4. Total Harmonic Distortion: Less than 20%
 5. Sound Rating: Class A.
 6. Minimum operating temperature: -40 deg F.
 7. Driver shall tolerate sustained open circuit and short circuit output conditions.
 8. Dimmable drivers shall be controlled by Class 2 low voltage 0-10V DC controller.
- F. Regulatory Requirements:
1. Driver shall be UL listed, Class 2 Outdoor.
 2. Comply with ANSI C62.41 Category A for transient protection.

3. Comply with ANSI C82.11
4. Comply with Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18 non-consumer Class A for EMI/RFI (conducted and radiated).

2.06 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Mount on standard 4-inch outlet boxes, unless otherwise noted.
- C. Internally Lighted Signs:
 1. Retain one of two "Lamps for AC Operation" subparagraphs below. See "Energy Considerations" Article in the Evaluations for discussion.
 - a. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 - b. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 2. Revise "Battery" Subparagraph below to specify different battery. See "Emergency Lighting" Article in the Evaluations for discussion on battery types. Verify that battery selection is available as UL-listed unit and coordinate with "Warranty" Article.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.07 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 1. Supplement subparagraphs below with data in the Interior Lighting Fixture Schedule or with details on Drawings.

2. Revise "Battery" Subparagraph below to specify different battery. See "Emergency Lighting" Article in the Evaluations for discussion on battery types. Verify that battery selection is available as UL-listed unit and coordinate with "Warranty" Article.
 - a. Battery: Sealed, maintenance-free, lead-acid type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
3. Wire guard in first subparagraph below is optional feature. Coordinate with Drawings.
 - a. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or Luminaires.
4. Retain "Integral Time-Delay Relay" Subparagraph below for time-delay option if units are indicated for areas normally lighted by HID fixtures that will not relight for a period after power is restored due to lengthy arc restrike delays.
 - a. Integral Time-Delay Relay: Holds unit on for fixed interval (per local code/minutes) when power is restored after an outage.
5. Retain "Integral Self-Test" Subparagraph below to eliminate necessity to manually perform periodic test required by codes for emergency equipment. Verify requirements of authorities having jurisdiction.
 - a. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.08 LAMPS

- A. All lamps in a source group must be provided/installed from the same manufacturer. A different manufacturer may be provided for each source group. Approved manufacturers are:
 1. General Electric
 2. North American Philips
 3. Osram/Sylvania
 4. Venture
 5. Refer to individual lamp type for acceptable manufacturers for each lamp.

- B. LED "lamps" and drivers are not all required to be provided by the same LED lamp supplier. It is understood each lighting manufacture will source LEDs from different sub-vendors/suppliers.
- C. Comply with ANSI C78 series that is applicable to each type of lamp.
- D. LED Lamps: Luminaire manufacturer shall be required to provide adequate heat sinking and thermal management.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Lumileds, Osram Sylvania, Cree, Nichia, or as noted in the Luminaire schedule.
 - 2. White Light LEDS – Color temperature as specified. Minimum rated lamp life 50,000 hours.
 - 3. Colored LEDS - RGB LED systems to be controlled as noted. Minimum rated lamp life 70,000 hours.

2.09 FINISHES

- A. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

PART 3 - EXECUTION

3.01 PREPARATION

- A. In areas where new recessed and surface mounted lighting fixtures are replacing existing lighting fixtures installed in or on plaster or gypsum board ceilings, the Contractor is responsible for cutting and contracting with the approved trades to patch, repair, and paint ceilings as required to accommodate the new installations.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install a minimum of two at diagonal corners (or four if shown by detail on the Contract Drawings) ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - 2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

3.02 INSTALLATION

- A. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and/or approved Shop Drawings.
 - 1. Support Luminaires according to requirements of Electrical Specification section "Basic Electrical Materials and Methods" and local seismic code requirements.
- B. Mounting: Mounting heights specified or indicated are to bottom of Luminaire for suspended and ceiling-mounted Luminaires and to center of Luminaire for wall-mounted Luminaires unless otherwise noted.
 - 1. Where mounting heights are not noted on the Construction Drawings, obtain the exact mounting height for lighting Luminaires from CDG in writing, prior to electrical "rough-in" installation.
 - 2. Coordinate rough-in with the type, style, and pattern of the ceiling wall material being installed.
 - 3. All light Luminaires installed without CDG approved mounting height shall be relocated at the Contractor's expense.
- C. All recessed downlights must be installed so that the bottom of the throat is even with the finished ceiling plane.
 - 1. The overlapping flange shall be fit flush to the ceiling plane/throat.
 - 2. No light leak shall be visible.
 - 3. All miscellaneous hardware and ceiling modifications necessary to accomplish the above shall be provided.
 - 4. Do not install luminaires or parts such as finishing plates and trims for recessed luminaires until all plastering and painting that may mar luminaire finish has been completed.
- D. Recessed and Semi-recessed Luminaires Supported to Structure: Luminaires must not be supported from the suspended ceiling support system if the Luminaire weight is more than the specified ceiling manufacturer's weight limits or in excess of 50 pounds or in violation of governing building codes, earthquake codes and ordinances.
- E. Grid-Type Luminaires
 - 1. Fixtures shall be supported by the ceiling framing members and securely fasten fixtures to framing members utilizing earthquake clips.
 - 2. Safety Cables and Safety Chains
 - a. At all recessed lay-in fixtures provide safety cables or safety chains attached to each corner of fixtures and attached to building structural members above
 - b. Attach or loop safety cables or safety chains utilizing approved clamps or by wrapping around structure. In the case of safety cables, all methods utilized shall be approved by the safety cable manufacturer.

- c. The safety cables or safety chains shall be installed nearly vertical in orientation or slightly splayed apart so that if the ceiling were to drop or collapse, the fixtures would swing or move no more than six inches. Provide structural channel or steel support above the ceiling as necessary to meet this requirement.
 - (1) Install safety cables such that they are approximately 1/2 inch short of being taut.
 - (2) Install safety chains such that they are one chain link short of being taut.
 - d. One safety cable or safety chain may serve two adjacent corners of a fixture by attachment to one fixture corner, loop around structure, and attachment to adjacent fixture corner.
 - 3. Coordinate with other trades so luminaires are properly aligned with diffusers, grilles, speakers, etc. If necessary, relocate luminaires as directed so there will be no conflict with the other trades' equipment.
 - 4. Install earthquake clips for all lay-in grid type luminaires, securely fastened to ceiling grid members, a minimum of one clip at or near each luminaire corner.
 - a. "Bend-out" style earthquake clips integral to the upper housing are only acceptable if permitted in writing by local building codes. This shall be done in addition to the light Luminaires being supported to structure with by a minimum of 2 rods or wires.
- F. Luminaires of Sizes Less than Ceiling Grid: Center in acoustical panel or as noted on architectural ceiling plan and detail drawings.
 - 1. Do not support Luminaires by ceiling acoustical panels or the ceiling suspension system.
 - 2. Support Luminaires by a minimum of 2 rods or wires from the structure to at least two 3/4-inch (20-mm) metal channels spanning the ceiling suspension system supports.
 - 3. The two channels shall be securely attached to the ceiling suspension system supports at all (4) four channel to grid intersection points with tie-down wire.
- G. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- H. Lighting Fixtures:
 - 1. Alzak Finishes: Handle Alzak reflectors and parabolic louvers with clean gloves to avoid finger marks.

2. Lighting fixtures are indicated in their approximate locations and may be relocated as requested by the Architect without additional charge to the Owner.
3. Install recessed fixtures to permit removal from below to gain access to outlet or prewired fixture box.
4. Wiring Connections:
 - a. Recessed Fixtures: Connect each fixture separately to associated junction box with flexible conduit and fixture wire. Wiring lighting fixtures in a "daisy-chain" manner (looping from lighting fixture to lighting fixture) is not permitted.
 - b. Pendant Mounted Fixtures:
 - (1) Unless specified indicated otherwise, connect fixtures with flexible conduit and fixture wire.
 - (2) Flexible conduit or cord shall be the minimum length required to connect the fixtures, and shall be routed straight, plumb, and neatly tied or otherwise attached to the fixtures and fixture support hardware. Excess lengths, loops or sags in flexible conduit and cords is not acceptable.
- I. Painting: Unless factory finished, paint all exposed flexible conduit and fixture support hardware in finished and semi-finished areas of the building. This includes rooms without ceilings but with painted roof or steel structure.
- J. Drivers:
 1. Provide ballasts of compatible design to lamps specified.
 2. Remote Drivers:
 - a. Mount drivers that are not an integral part of the fixture (remotely mounted) vertically with 12 inch vertical spacing and 6 inch horizontal spacing between adjacent drivers on 3/4 inch structural channel securely mounted to the building structure unless greater spacing is requirement by driver manufacturer's installation instructions or directions. Provide adequate space behind drivers for ventilation.
 - b. Increase the size of conductors between remotely mounted drivers and the associated lighting fixtures based upon the conductor lengths as recommended by the driver manufacturer.
 - c. Label each remote driver to identify exactly which lighting fixture is serves.

3.03 CONNECTIONS

- A. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.04 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replaced damaged luminaires and components.
 - 1. Give advance notice of dates and times for field tests.
- B. Provide instruments to make and record test results.
- C. Tests: Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include the following information in tests of emergency lighting equipment:
 - 1. Duration of supply.
 - 2. Low battery voltage shutdown.
 - 3. Normal transfer to battery source and retransfer to normal.
 - 4. Low supply voltage transfer.
- D. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
- E. Replace luminaires that show evidence of corrosion during Project warranty period.
- F. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.05 LAMPING & LAMP REPLACEMENT

- A. Install proper number, type, and size lamp in luminaire as indicated on drawings.
- B. Relamp all luminaires in service during construction with new lamps prior to turning over the premises to the owner or give equivalent of new lamping to the Owner.

3.06 ATTIC STOCK

- A. General: Provide attic stock at time of substantial completion to meet the following:
 - 1. Complete fixtures in box for storage. Provide one (1) when the fixture total count exceeds 100 fixtures on the project. Provide an additional one (1) for each 100 fixtures provided. (Example: 95 fixtures = no attic stock; 341 fixtures = 3 attic stock.)
 - 2. LED Boards: None.
 - 3. LED Drivers: Supply one (1) driver of each type utilized on the project at a minimum. Provide an additional driver when the driver count of that type exceeds 100 drivers for each 100 drivers provided. (Note that count is per driver type; not fixture type.)
 - 4. LED Inverter Drivers: None.

5. LED Lamps: Where LED lamps are field replaceable by Owner (A-Lamps, PAR Lamps, MR16 Lamps, etc.) provide a quantity of three (3) of each type minimum. Provide an additional three (3) per 100 utilized for each 100 provided.
6. LED Exit Signs: Provide two (2) complete exit signs for each type utilized on the project. These signs are to be utilized for any additional AHJ requested exit signs identified during substantial completion inspections. Excess exit signs are to be turned over to the Owner for attic stock.

3.07 REINSTALLATION

- A. Contractor shall carefully remove and store the existing lighting fixtures noted to be relocated.
- B. Contractor shall install the relocated lighting fixtures in the locations indicated and connect them to the circuits and controls indicated on the drawings.
- C. Contractor shall inspect and provide all necessary labor and material to ensure that each of the existing fixtures to be relocated is in first class working condition.

3.08 CLEAN LUMINAIRES

- A. Clean: During construction, installation, clean luminaires of dirt and debris to ensure proper performance and operational temperatures.
- B. At time of Substantial Completion, all luminaires must be clean of dirt and debris.
- C. Protection: Protect installed luminaires from damage during the construction period.

3.09 ADJUST LUMINAIRES

- A. Adjust: Aim, adjust, focus, and lock, all adjustable lighting units under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews required. All aiming and adjusting shall be carried out after the entire installation is complete. Furnish all ladders, scaffolds, etc. required at the direction of the lighting consultant. As aiming and adjusting is completed, locking mechanisms such as setscrews, bolts, and nuts shall be tightened securely.
- B. Targeting shall take place after sunset at a time designated by CDG.
- C. All labor and material costs made necessary by this requirement shall be included as part of the base bid.

END OF SECTION

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary, apply to this Section.
 - 1. See Drawings for LUMINAIRE SCHEDULE for all luminaires specified by Circle Design Group Lighting.

1.02 SUMMARY

- A. Scope: The extent of exterior lighting required is indicated on the drawings and schedules and by the requirements of this Section, and all related Electrical Specification Sections.
 - 1. Furnish and install material, labor, and accessories required for the site lighting as described herein and shown on the drawings.
- B. Types of luminaires specified in this Section are for outdoor use and include the following:
 - 1. LED
 - 2. Pole light fixture.
 - 3. Poles.
 - 4. Flag pole lighting
- C. Related Sections: Refer to other Electrical Specification sections for the following:
 - 1. See drawings for Luminaire schedule.
 - 2. Section 26 05 01 – GENERAL PROVISIONS
 - 3. Section 26 05 26 – GROUNDING & BONDING
 - 4. Section 26 05 33 RACEWAYS & BOXES
 - 5. Section 26 05 19 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

1.03 REFERENCES

- A. Review the Drawings and all sections of the Specifications for equipment furnished by other Contractors and the Owner throughout the entire project.
- B. See references noted in Specification Section 26 05 01, Paragraph 1.03.
- C. ANSI/NECA 1-2006 – Good Workmanship in Electrical Contracting.
- D. Illuminating Engineering Society Lighting Handbook and Recommended Practices.

1.04 DEFINITIONS

- A. CRI: Color Rendering Index
- B. Luminaire: Complete lighting fixture, including ballast housing if provided.
- C. Pole: Luminaire support structure, including tower used for large area illumination.

1.05 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4 where pole mounted service platforms are used.
- B. Live Load: Single load of 500 lbs. distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
 - 1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 110 mph.
 - 2. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.06 SUBSTITUTIONS

- A. No substitutions will be accepted after bids are received. The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous performance requirements of this project.
- B. One Manufacturer or "Pre-Bid Approved Equal": When only one manufacturer is listed within the description of the luminaire, the engineering, performance, or aesthetics *MAY NOT* allow substitution of other manufacturers. "Pre-Bid Approved Equal" permits pre-bid submittal of a product for consideration under submittal guidelines established by this specification section.
- C. Three manufacturers: When three manufacturers are listed on the Luminaire Schedule, the design, engineering, or architectural aesthetics will allow the CONTRACTOR to choose one of the three manufacturers listed. The first manufacturer listed by name and catalog number is the basis of design. The second and third manufacturer's name will be noted along with the wording "EQUAL PRODUCT" instead of a catalog number. The second and third listed manufacturer's "EQUAL PRODUCT" shall be provided which meets or exceeds the manufacturer's product noted with catalog number in materials, finish, components and accessories. CDG Lighting will have final opinion of "EQUAL PRODUCT" interpretation. Contractor/Distributor/Representative must formally submit questions in writing. All submittals must be in CDG Lighting possession not later than ten (10) business days before the bid opening. CDG Lighting will issue a formal written response thru official channels.

- D. Luminaire Substitutions / Substitution Packages: Contractor may elect to submit to CDG Lighting a luminaire substitution package for review. All submittals must be in CDG Lighting possession not later than ten (10) days prior to bid date. All luminaire substitutions must meet or exceed the following Substitution Submittal Requirements or will be rejected outright by CDG Lighting.
- E. Substitution Submittal Requirements: A luminaire substitution (substitution package) shall consist of the following information or will be rejected outright by CDG Lighting:
1. Original luminaire cut sheet noting exact options/features of the proposed product in detail / dimensional accuracy.
 2. Color image of luminaire, in the configuration of the proposed product.
 3. Dimensioned drawing of luminaire to an identified scale per sheet print size.
 4. Electric data of the proposed luminaire with specified lamp, ballast, transformer, driver or power supply.
 5. IES format photometric files for the proposed luminaire with specified lamp. Photometric reports must list the actual candela values for the luminaires' distribution in at least three planes. Copies of candela curves, footcandle and lumen tables and iso-footcandle contours must also include IES format electronic photometric files identified by CDG Lighting for each proposed luminaire type.
 6. Calculations - Substitutions for luminaire types impacting "calculation / light level sensitive" project rooms/areas must be submitted with a complete point by point calculation grid of the area utilizing the substituted luminaire and adjacent luminaires contributing to the light levels. The point by point submittal must include a statistical chart showing all fixed and variable calculation factors including, but not limited to: initial / maintained lamp lumens, all LLFs (Light Loss Factors), lamp/luminaire mounting heights, calculation plane height(s), surface reflectance, complete luminaire model numbers and calculation point spacing. Calculations will be rejected outright by CDG Lighting without this information. CDG Lighting reserves the right to obtain an electronic copy of the calculation files and the substitute luminaire IES files. CDG Lighting may run a comparison calculation model using AGI.
- F. All substitution submittals shall be provided to CDG Lighting in electronic format:
1. Electronically posted files will be delivered thru Owner / Architect / Contractor established communication channels. No files shall be directly delivered to the CDG Lighting by vendors or their agents.
- G. CDG Lighting Fee Compensation
1. CONTRACTOR will be responsible for all costs (architecture time, CDG Lighting time, engineering time, manufacturer's costs, distributor costs, etc.) incurred to replace installed lighting equipment not approved by CDG Lighting.
 2. CONTRACTOR shall pay professional fees at current standard hourly rates and reimburse expenses directly to all design professionals for time

spent reviewing substitutions proposed by the Contractor after the bid has been awarded. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.

3. Additional fees will be required for all submittals / substitution reviews exceeding (2) shop drawing submittals per luminaire.

1.07 SUBMITTALS

- A. General: Furnish submittals in accordance with the requirements of the related section.
- B. Coordination: All luminaire drawings shall be coordinated with the drawings and details of the Architectural, Structural, Electrical, Mechanical, and other related trades to assure a perfect and efficient installation.
- C. No Variations: No variations from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance by the architect. All variations must be clearly marked on the drawings submitted for approval.
- D. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes and the following:
 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 2. Details of attaching luminaires and accessories.
 3. Details of installation and construction.
 4. Luminaire materials.
 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 6. Photoelectric relays.
 7. Lamps, including life, output, and energy-efficiency data.
 8. Materials, dimensions, and finishes of poles.
 9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 10. Anchor bolts for poles.

11. Manufactured pole foundations
 - a. Anchor bolt templates keyed to specific poles and certified by manufacturer.
 12. Wiring diagrams – Power and control wiring.
- E. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design. Field quality-control test reports.
- F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.
- H. Shop Drawings: Submit legible, dimensioned drawings of specified lighting assemblies including:
1. Modified or custom fixtures require factory issued shop drawing. Standard cut sheet with annotation/notes indicating 'modified' will not be permitted (even for lamping) the luminaire type will be REJECTED.
 2. No handwritten notes permitted on lighting shop drawings or submittals or type will be REJECTED AS NOTED.
 3. Cut sheets lacking sufficient data or detail to indicated compliance with contract documents will be REJECTED AS NOTED.
 4. Booklet format: Shop drawings shall be submitted in booklet form organized with a separate sheet for each grouping of luminaire, pole, ballast matrix and typical cut sheets, lamp matrix and typical cut sheets.
 5. Submittal Format: Submittals should be provided in (2) formats.
 - a. (1) hard copy should be provided to CDG in a 3-ring binder with remote storage device containing submittal.
 - b. Electronically posted file transmitted through Owner/ Architect /Contractor established channels. No files shall be directly delivered to CDG Lighting by vendors or their agents.
 6. Record Shop Drawings Required: Record shop drawings shall be delivered to the CDG Lighting at time of Substantial Completion. All "Approved as Noted" comments shall be corrected / picked-up in this record set. All shop drawing review comments shall be included in this set. Record luminaire shop drawings shall be three ring bound in a bright yellow or orange color binder and provided electronically on DVD/CD(s).
 7. Luminaire Ordering Schedules and Shop Drawing Schedules: All lighting equipment shall be ordered in a timely manner. The Contractor shall provide a spreadsheet to CDG Lighting with the following detailed information organized by luminaire type:
 - a. Originally quoted delivery dates (6-8 weeks, etc.) from time of Bidding.
 - b. Shop drawings delivery dates to CDG Lighting.
 - c. Dates when equipment orders are placed / finalized per approved

- d. shop drawings.
 - d. Final product delivery schedules.
 - e. Long Lead Items - At time of original quote/bid, Contractor is required to identify any long lead lighting items and identify in the master project construction schedule for trade coordination.
- I. Battery and charger data shall be submitted for emergency lighting units.
- J. Electrical Ratings and Photometric Data with certified results of independent laboratory tests for luminaires and specified lamps.
- K. Field test reports, indicating and interpreting test results, specified in Part 3 of this section.
- L. Maintenance Manual: Refer to Section 26 05 01 for general requirements. At the completion of the project, the luminaire manufacturer shall furnish to the owner a recommended maintenance manual. Each maintenance manual shall include:
 - 1. Tools Required.
 - 2. Types of cleaners to be used.
 - a. Replacement parts identification lists.
 - b. Final as built shop drawings.
- M. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of CDG Lighting. All variations must be clearly marked as such on the drawings submitted for approval.

1.08 QUALITY ASSURANCE:

- A. Standards: Materials, equipment, and appurtenances as well as workmanship provided under this section shall conform to the highest commercial standard as specified and as indicated on drawings.
- B. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- C. Listing and Labeling: Provide luminaires, emergency lighting units, and accessory components specified in this section that are listed and labeled for their indicated use and installation conditions on Project.
- D. Special Listing and Labeling: Provide luminaires for use in damp and wet locations that are specifically listed and labeled for such use.
- E. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

- F. Coordinate luminaires, mounting hardware, and trim with adjacent materials and other items, including work of other trades, required for installation. Confirm compatibility of luminaires with the final, as-ordered mounting materials/surfaces prior to ordering all luminaires. See SUBMITTAL section for required documentation.
- G. Codes and Standards: Provide luminaires and appurtenances conforming to the following:
 - 1. Conform to applicable sections of American Society for Testing and Materials (ASTM)
 - a. B 429, "Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube."
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. FA 1 Outdoor Floodlighting Equipment
 - b. OD 3 Physical and Electrical Interchangeability of Photo Control Devices
 - 3. Conform to applicable sections of National Fire Protection Association (NFPA) 70, "National Electrical Code."
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. 57 Electric Lighting Luminaire
 - 5. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and Luminaires.

1.09 DELIVERY, STORAGE & HANDLING

- A. Deliver, store and handle materials in accordance with Division 01 and Section 26 05 01.
- B. Package aluminum poles for shipping according to ASTM B 660.
- C. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- D. Retain factory-applied pole wrappings on fiberglass poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.10 WARRANTY

- A. General Warranty: The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
 - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Luminaire manufacturers indicated on fixture schedule.
- B. In Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- C. Pole manufacturers:
 - 1. Same manufacturer as luminaire manufacturer.
 - 2. KW Industries.
 - 3. Millerbernd.
 - 4. Union Metal.
 - 5. Valmont.

2.02 LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

- M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: Color Selected By Architect.

2.03 ACCESSORIES:

- A. Where indicated under Section 26 28 00 Low Voltage Circuit Protective Devices provide fuses for protection of individual pole wiring, ballast and lamps.

2.04 FINISHES:

- A. Unless specifically indicated otherwise, Architect shall select finish color from manufacturer's standard color selection.

2.05 SOURCE QUALITY CONTROL:

- A. Verification of Performance:
1. Contractor shall schedule a date and time with the Construction Manager, Architect and Owner to measure the lighting levels and performance of the site lighting fixtures.
 2. Contractor and a representative of the manufacturer of the site lighting fixtures shall measure the lighting levels on the surface of the ground taken on a five foot by five foot grid to verify that the performance meets the specified lighting criteria. The contractor shall make all of the necessary modifications to ensure that the performance of the lighting fixtures meets the specified lighting criteria

2.06 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS:

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 - 1. Relay with locking-type receptacle shall comply with NEMA C136.10.
 - 2. Adjustable window slide for adjusting on-off set points.

2.07 METAL POLES AND BASES:

- 1. Poles:
 - a. Poles shall be Round tapered.
 - b. Poles heights shall be as indicated on Drawings.
 - c. Provide a handhole near the base of each pole.
 - d. Color and finish of pole shall match furnished luminaire exactly.
- 2. Anchor bolts:
 - a. Provide a minimum of four galvanized anchor bolts per pole, minimum diameter and minimum length as recommended by pole manufacturer, with an additional 8-inch right angle bend on one end and 8 inches of threaded projection on the other end. Provide two flat washers, two lock washers, and two hexagonal nuts for each anchor bolt.
 - b. Provide bolt circle template for proper placement of anchor bolts. For relocated existing poles, duplicate existing bolt circle pattern for proper placement of new anchor bolts.
- 3. Pole and Pole Base Design:
 - a. All poles and pole bases shall properly support for the indicated lighting fixtures, and other equipment attached to the poles for the soil conditions encountered at the pole installation location and local wind velocity.
 - b. Provide each pole with a concrete base as indicated on the Drawings.
 - c. Provide each pole with a concrete base of sufficient size to support the pole, lighting fixtures, and other equipment attached to the pole for the soil conditions encountered at the pole installation location. This Contractor is responsible for the design and installation of all lighting poles, lighting poles bases, and lighting pole anchor bolts provided on this project under this Section.
- 4. All base edges shall be beveled where exposed.
- 5. Provide two spare 1-inch conduit stubs in each base.

2.08 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.09 ALUMINUM POLES:

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 1. Shape: As shown in the Lighting Fixture Schedule.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Provide vibration dampers on all poles.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

- F. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 2. Finish: Same as pole.
- G. Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - 5. Paint
 - a. Color: Per the Lighting Fixture Schedule.

2.10 DECORATIVE POLES

- A. Pole Material: Aluminum
- B. Mounting Provisions:
 - 1. Bolted to concrete foundation.
- C. Pole Finish: Per the Lighting Fixture Schedule.

2.11 POLE ACCESSORIES:

- A. Where indicated under Section 26 28 00 Low Voltage Circuit Protective Devices, provide fuses for protection of individual pole wiring, ballast and lamps.

2.12 LED LIGHTING SYSTEMS

- A. Complete System: The contractor shall furnish the completed LED-based lighting system. A 'Complete System' shall refer to an LED Luminaire and any power conditioning and/or interface equipment functioning together as a working unit.
- B. Thermal Management: The LED Luminaire manufacturer shall provide appropriate thermal management technology to ensure that temperatures do not exceed the limits established by the LED chip manufacturer.

- C. LED Luminaires: LED Luminaires shall provide a continuous light output. Luminaire output and dimensions shall be in accordance with the contract drawings and specifications. LED Luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED Luminaires to operate in ambient temperature of -20 degrees Celsius and +50 degrees Celsius. White LEDs to have a minimum life of 50,000 hours and color LEDs to a minimum of 70,000 hours. All LED Luminaire types shall be provided with complete photometric data including lumen output, lumen depreciation, life, and distribution.
- D. Performance Assessment: The performance of LED Luminaires shall be evaluated according to IESNA standards LM-79 'Electrical and Photometric Measurements of Solid-State Lighting Products' and LM-80 'Measuring Lumen Maintenance of LED Light Sources'. The results of such evaluation shall be reported by the LED Luminaire manufacturer.
- E. Performance Requirements:
 - 1. Driver shall operate from 60 Hz input source of 120V thru 277V with sustained variations of +/- 10% with no damage to the driver.
 - 2. Driver output shall be regulated to +/- 5% across published load range.
 - 3. Power Factor: Greater than 90%.
 - 4. Total Harmonic Distortion: Less than 20%
 - 5. Sound Rating: Class A.
 - 6. Minimum operating temperature: -40 deg F.
 - 7. Ballast shall tolerate sustained open circuit and short circuit output conditions.
 - 8. Dimmable drivers shall be controlled by Class 2 low voltage 0-10V DC controller.
- F. Regulatory Requirements:
 - 1. Driver shall be UL listed, Class 2 Outdoor.
 - 2. Comply with ANSI C62.41 Category A for transient protection.
 - 3. Comply with ANSI C82.11
 - 4. Comply with Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18 non consumer Class A for EMI/RFI (conducted and Radiated).

2.13 LAMPS

- A. All lamps in a source group must be provided / installed from the same manufacturer. A different manufacturer may be provided for each source group. Approved manufacturers:
 - 1. General Electric
 - 2. North American Philips
 - 3. Osram/Sylvania
- B. LED "lamps" and drivers are not all required to be provided by the same LED lamp supplier. It is understood each lighting manufacture will source LEDs from different

sub-vendors/suppliers.

- C. LED Lamps: Luminaire manufacturer shall be required to provide adequate heat sinking and thermal management. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Lumileds, Osram Sylvania, Nichia, or as noted in the Luminaire schedule.
 - 1. White Light LEDS – Color temperature as specified. Minimum rated lamp life 50,000 hours.
 - 2. Colored LEDS - RGB LED systems to be controlled as noted. Minimum rated lamp life 70,000 hours.

2.14 FINISHES

- A. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

2.15 LIGHTING CONTROLS

- A. General: See section Electrical Specification Lighting Control Devices for additional information.

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.02 POLE INSTALLATION:

- A. Install poles plumb and true. Install metal poles on base utilizing shims as necessary.
- B. Install underground wiring in conduit with watertight connections. Refer to Section 26 05 33.
- C. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- D. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 3. Trees: 5 feet.
- E. Construct of concrete with minimum dimensions indicated on detail. Verify proper size for soil type encountered at site and with pole manufacturer before construction.
- F. Install anchor bolts with a 6 inch projection above top of bases.
- G. Install anchor bolts with projection above top of bases to properly mount pole in accordance with pole manufacturer's recommendations.
- H. Provide a pole base cover on each pole. Individual mounting bolt/nut covers are not acceptable.
- I. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- J. Construct of concrete with minimum dimensions indicated on detail. Verify proper size for soil type encountered at site and with pole manufacturer before construction.
- K. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
1. Grout void between pole base and foundation. Use non shrink or expanding concrete grout firmly packed to fill space.
 2. Install base covers, unless otherwise indicated.
 3. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- L. Raise and set poles using web fabric slings (not chain or cable).

3.03 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES:

- A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.04 CORROSION PREVENTION:

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.05 GROUNDING:

- A. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.06 INSTALLATION OF LIGHTING CONTROLS

- A. General: Install lighting controls as indicated on the drawings and specifications and in accordance with manufacturer's written instructions.
 - 1. Controls: Connect lights to controls furnished under specification section.
 - 2. Adjustment: Provide two visits to the project within the 12 months of project Substantial Completion date to adjust or reset lighting controls.
 - a. Visit One shall occur 3 months after Substantial Completion.
 - b. Visit Two shall occur 11 months after Substantial Completion.
 - c. At a minimum, both visits require the following individuals to accompany the Contractor.
 - d. The local lighting controls sales representative and lighting controls factory trained service technician will be required at both visits.

3.07 TESTS AND DEMONSTRATIONS

- A. General: Upon completion of installation and after energizing branch supply circuitry, apply electrical energy to luminaires to demonstrate compliance with requirements.
 - 1. Check footcandle levels and uniformity of illumination.
 - 2. Check for excessive ballast noise.
 - 3. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

3.08 LAMP REPLACEMENT

- A. General: At time of substantial completion, replace lamps in luminaires which are observed to be not functioning properly after Contractor's use and during construction.

3.09 ATTIC STOCK

- A. General: Provide attic stock at time of substantial completion to meet the following:

1. LED Boards: None.
2. LED Drivers: Supply one (1) driver of each type utilized on the project at a minimum. Provide an additional driver when the driver count of that type exceeds 100 drivers for each 100 drivers provided. (Note that count is per driver type; not fixture type.)
3. LED Lamps: Where LED lamps are field replaceable by Owner (A-Lamps, PAR Lamps, MR16 Lamps, etc.) provide a quantity of three (3) of each type minimum. Provide an additional three (3) per 100 utilized for each 100 provided.

3.10 CLEAN LUMINAIRES

- A. Clean: During construction, installation, clean lighting Luminaires of dirt and debris to ensure proper performance and operational temperatures. At time of Substantial Completion, all luminaires must be clean of dirt and debris.
- B. Protection: Protect installed Luminaires from damage during the construction period.

END OF SECTION

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section includes common requirements for the telecommunications installation for division 27 specifications.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. When equipment is furnished by the Owner as indicated on the Drawings or specified, this Contractor shall make all connections to Owner furnished equipment. The Contractor shall verify exact requirements and locations before installation.
- B. The contractor shall seal ALL conduit sleeves above the ceiling after all the cabling is installed and tested with an approved sealant.
- C. The contractor shall seal ALL conduit sleeves in the floors after all the cabling is installed and tested with an approved sealant.
- D. The cabling contractor shall seal inside the box at the conduit connection after all the cabling is installed and tested with an approved sealant.
- E. The Contractor shall be required to cooperate with "Other Trades" at the site and other Contractors in the coordination of his Work to avoid interferences with installations by other trades and Contractors.
- F. The contractor shall provide coordination drawings with other trades to avoid any conflict.
- G. Deviations from the Drawings, to avoid interferences, shall be considered a "Job Condition" and no additional compensation will be considered applicable. In the event that such interferences occur in course of the Work, due to an error, omission, or oversight by the Contractor, no additional compensation shall be allowed. Interferences which may occur during the course of construction shall be brought to the immediate attention of the Architect/Engineer, and the Architect/Engineer decision, confirmed in writing, shall be final.

1.03 RELATED WORK

- A. Related sections include the following:
 - 1. Division 01 General Requirements.
 - 2. Division 26 Electrical
 - 3. Division 27 Communications
 - 4. Division 28 Electronic Safety and Security

1.04 DEFINITION AND TERMS USED.

- A. The word "Owner" shall mean the party mentioned in the prime contract agreement, or any representative of his party duly authorized to act in his behalf in the execution of the work.
- B. The word "Construction Manager" shall mean the person, firm or corporation entering into a contract with the Owner to manage construction operations.
- C. The word "Contractor" shall mean the person, firm or corporation entering into a contract to construct and complete the work as specified herein.
- D. The word "Engineer" shall mean Circle Design Group and their representatives assigned to this project.
- E. The word "furnish" or "supply" shall mean to purchase and deliver to project site, ready for unloading, unpacking, assembly, installation and similar subsequent requirements.
- F. The word "install" shall mean operations at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar requirements.
- G. The word "provide" shall mean to furnish and install complete and test and ready for intended use.

1.05 TECHNOLOGY ABBREVIATIONS

- A. Cable Pathway
 - 1. Shafts, conduits, surface mounted raceway, boxes, sleeves, floor boxes, cable tray, ladder tray, conduits, telecom handholes and floor penetrations that provide routing space for communications cabling.
- B. Telecommunications Rooms (TR or IT))
 - 1. A Telecommunications Room is a space used to make connections from the first level backbone cabling from the MCR to the horizontal structured cabling. TR's contain telecommunications equipment, control equipment, cable terminations, and cross connect wiring.
- C. Work Area Outlet (WAO)
 - 1. Work area outlet consists of junction box, data jacks 8P8C-RJ45, 4 PR UTP Category CAT 6A cables, terminations, testing, cover plate, label and all related material. (Minimum of 2-RJ45 data/cable drops per WAO unless otherwise noted) with 1.5 inch conduit to the nearest accessible corridor ceiling, or conduit to the nearest cable tray or conduit to the nearest Telecom Room unless otherwise noted.

1.06 REFERENCES

- A. Work shall be in accordance with codes, rules, ordinances, regulations of authorities, bodies, associations, and governments, having proper and legal jurisdiction. Specifically, the following requirements shall be met in their entirety.
1. State and Local Rules, Regulations, Codes, Statutes and Ordinances
 2. National Fire Protection Association - applicable requirements
 3. National Board of Fire Protection
 4. International Building Code and Amendments.
 5. Indiana Mechanical Code and Amendments.
 6. Indiana Plumbing Code and Amendments.
 7. Indiana Energy Code and Amendments.
 8. Indiana Fire Code (IFC) and Amendments.
 9. National Electric Code - applicable requirements and amendments
 10. ANSI/TIA/EIA 568.1 E Commercial Building Telecommunications Cabling Standards.
 11. ANSI/TIA/EIA 569-E Telecommunications Pathways and spaces.
 12. ANSI/TIA-1179A Healthcare Facility Telecommunications Infrastructure standards.
 13. ANSI/TIA 607-D Telecommunications Bonding and Grounding.
 14. BICSI, Telecommunications Distribution Methods Manual, 14 Edition.
- B. Electrical equipment shall be Underwriter's approved; also, shall meet requirements established by NFPA, NEMA, IEEE, TIA, and ANSI and as specified hereinafter.
- C. Abbreviation used in these Specifications:
1. ASTM - American Society of Testing Materials
 2. ANSI - American National Standards Institute, Inc
 3. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
 4. BICSI - Building Industry Consulting Service International
 5. EIA - Electronic Industries Association
 6. ETL - Electrical Testing Laboratories
 7. FCC - Federal Communications Commission
 8. IEEE - The Institute of Electrical and Electronics Engineers, Inc
 9. IPCEA - Insulated Power Cable Engineers Association
 10. NEC - National Electric Code - Latest Edition adopted by the National Fire Protection Association
 11. NEMA - National Electrical Manufacturers Association
 12. NFPA - National Fire Protection Association
 13. NICET - National Institute of Certification in Engineering Technologies
 14. NAB - National Association of Broadcasters
 15. NAEB - National Association of Educational Broadcasters
 16. RCDD - Registered Communication Distribution Designer
 17. UL - Underwriters Laboratories - Underwriters Laboratories

1.07 SUBMITTALS

- A. Provide shop drawing submittals and illustrations in accordance with requirements of Division 01 Submittal Procedures unless otherwise noted.
- B. Provide shop drawings for each spec section separately as follows:
 - 1. Provide one electronic file submittal for each section. (do not mix sections together)
 - 2. Provide an index with a complete material list in the Specification sequence.
 - 3. Each Specification Section have its own material list.
 - 4. Provide product cut sheet for each specified item in sequence.
 - 5. Each manufacturer's product cut sheet shall be identified/marked or highlighted.
- C. Provide coordination drawings for all systems/equipment/devices, coordinate with other trades.
- D. Provide wiring diagrams and system layout drawings showing all devices, equipment, home runs, labeling, dB loss, etc. for each of the following systems (one paper copy and one electronic copy):
 - 1. Structural Local area cabling infrastructure (showing labeling, routing, etc.)
 - 2. Show fiber optic backbone
 - 3. Data Network electronics
 - 4. Master Television.
 - 5. Sound systems
 - 6. Specialty sound systems
- E. Partial shop drawings from one section WILL NOT BE ACCEPTABLE.
- F. Submittals will be returned unchecked if they do not follow the outlines above.
- G. Any Shop drawing submittals that are not required will be returned unchecked.

1.08 QUALITY ASSURANCE

- A. The cabling system components and equipment shall be listed by Underwriters Laboratories, Inc., and the components shall bear the UL label. The system shall be installed in accordance with requirements set by National Electric Code.
- B. Installing Contractor shall have a minimum of three years' experience in cable installations.
- C. The contractor shall submit a list of Jobs performed (minimum of three) in the past three years, equal to one specified herein. Also, the contractor shall arrange a site visit of any job(s) selected by Architect/Engineer. The list shall include the following:
 - 1. Job location, and date when it was completed.
 - 2. Contact person at each job location.
 - 3. Brief description of each job.

- D. The contractor shall employ their staff or have a contract with a Registered Communications Distribution Designer (RCDD) registered with the Building Industries Consulting Services International (BICSI).
- E. The contractor shall submit the name, registration number, and seal of the RCDD on the contractors' staff as part of their shop drawing submittals.
- F. The RCDD shall certify the final installation in writing and provide written verification that they have inspected the completed installation and that the installation meets the terms and conditions of this bid, design requirements of the BICSI TDMM (Latest edition), and all TIA/EIA, NFPA, NEC, and all local codes and specifications related to this work this letter shall be provided with the closeout paperwork.
- G. All design documents, submittals, Project Record Drawings, test results, third party testing and other documentation provided by the Communications Contractor shall bear the name, registration number, and seal of the RCDD responsible for this Project. Cabling systems installation shall be provided by the Contractor's own work forces. Any subcontractor agreements for any portion of the work specified herein shall meet with approval of the A/E and Owner. It is the intent of the contract to have one Contractor provides sole responsibility for material, labor and service for the systems.
- H. Contractor Qualification:
 - 1. The Contractor or sub-contractor shall be a licensed Contractor with a minimum of three (3) years' experience installing and servicing systems of similar scope and complexity. The Contractor shall provide three (3) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references shall be including a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system. The Contractor shall provide copies of the system manufacturer certification for all technicians. The technicians shall have a minimum of three (3) continuous years of technical experience in cabling and terminations of low voltage equipment. The Contractor shall have a local service facility. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures. The Owner reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.
 - 2. The Contractor shall provide proof project superintendent with BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.
 - 3. Cable installers shall have on staff a Registered Communication Distribution Designer (RCDD) certified by Building Industry Consulting Service International. The staff member shall provide consistent oversight of the project cabling throughout design, layout, installation, termination and testing.

1.09 PRECEDENCE

- A. Contractors shall review both Drawings and Schedules of Communications Systems for any discrepancy.
- B. If there is a discrepancy in the number of rooms and quantities between the Drawings and the Schedules, the Contractor shall include the higher of the two quantities.
- C. If the products specified are no longer available, Contractor shall provide replacement products that meet or exceed performance specifications of the original specified model at no cost to the Project.
- D. If the Contractor bids products that do not meet or exceed the performance specifications or the original specified model, the Contractor shall provide products that meet the performance specifications as approved by the Architect/Engineer at no cost to the project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. For purposes of clarity and legibility, the Telecommunication drawings are essentially diagrammatic and, although size and location of equipment are closely drawn to scale whenever possible, Contractor shall make use of the data in all of the Contract Documents and shall verify this information at the building site.
- B. The Drawings indicate required size and points of termination of wiring and other related items and may suggest proper routes for such items to conform to structure, avoid obstructions and preserve clearances. It is not intended that Drawings indicate every necessary offset. It shall be the Work of the Contractor to install each item in a manner to conform to structure, avoid obstructions, preserve headroom, and keep opening and passageways clear.
- C. It is intended that apparatus be located in coordination with architectural elements and shall be installed at exact height and location stipulated.
- D. Contractor shall fully inform himself regarding peculiarities and limitations of the spaces available for the installation of work and materials provided under his Contract.
- E. The contractor shall carefully examine existing conditions, existing wiring and other materials on the premises and compare the documents with the existing conditions. Variances and necessary changes shall be adjusted by appropriate modifications.
- F. Contractor shall carefully examine the Division 26 drawings for pathway, sleeves, etc.

3.02 PERMITS, FEES, REGULATIONS, INSPECTIONS

- A. Contractor shall arrange and pay for permits, fees, and inspections required in connection with his work for this project, from local, county, state and public agencies, and shall obtain permits from railroad, state highway and utility companies.
- B. Work shall be inspected by approved local and state inspection bureaus, Electrical Inspection Agency, and/or authority, and local utilities.
- C. Upon completion of the Work, the Contractor shall furnish to the Architect/Engineer, a certification of inspection and approval from said Bureau or Agency before final payment on contract will be allowed.
- D. The contractor shall verify the right of way with all local and state agencies.

3.03 HOISTS, RIGGING, TRANSPORTATION, AND SCAFFOLDING

- A. The contractor shall provide scaffolding, staging, cribbing, tackle, hoists, and rigging necessary for placing of his materials and equipment in their proper places in the Project.
- B. The contractor shall pay costs for transportation of materials and equipment to the job site and shall include such costs in his proposal.
- C. Scaffolding and hoisting equipment shall comply with requirements of pertinent Federal, State, and Local Laws and Codes.

3.04 PROTECTION

- A. In addition to other requirements of the Contract, the Contractor shall provide various types of protection as follows:
 - 1. Protect finished floors during installation, etc.
 - 2. Protect equipment, finished surfaces from paint droppings, insulation adhesive, and sizing droppings by use of drop cloths.
 - 3. Protect countertops during cutting grommets.
 - 4. Protect video projectors, televisions, DVD, television studio, switches, sound system, clocks, access control, IP cameras, etc. from dirt.
- B. The contractor shall be responsible for the protection of finished work from other trades from damage or defacement by his operations and shall remedy such damage at his own expense.

3.05 CUTTING AND PATCHING

- A. Contractor shall do his own cutting and patching of building materials and piping, as required for the installation of his Work, but no structural members shall be cut without the approval of the Architect, and such cutting shall be done in a manner directed by the Architect.

- B. Patching of and repair of damage to Work in place shall be done in a neat and workmanlike manner, meeting with the approval of the Architect. Contractor whose operations require cutting of work in place, or who causes damage which entails repairs of such work, shall employ mechanics of the particular trade whose work shall be cut, or which is damaged, and shall pay the costs of such patching or repair.

3.06 SLEEVES

- A. The contractor shall examine the technology and electrical drawings for sleeve locations and shall verify the locations.
- B. The contractor shall be responsible for any additional sleeves and cores should they be required.
- C. NO change order shall be issued to provide sleeves in addition to those provided under the electrical contract.

3.07 LABELING

- A. The contractor shall label all work area outlet in the space per the owner labeling scheme, if owner does not have a scheme, then use this example and submit for owners' approval: A 1 fed from TR xx (TR room number) PP (patch panel) A xx. (port number).
- B. The contractor shall label all work area outlet at the patch panel per the owner labeling scheme, if owner does not have a scheme, then use this example and submit for owner's approval: PP (patch panel) A xx (port #) Rm xx, WAO A1.

3.08 FINAL COMPLETION

- A. The communication installation shall be cleaned prior to Substantial Completion of the Work.
- B. Retouch or repaint factory painted prime and finish coats, where scratched or damaged. Whenever retouching will not be satisfactory, the Architect/Engineer may require complete repainting until the desired appearance is obtained.
- C. The contractor shall clean equipment; restore damaged materials; remove grease, oil, chemical, paint spots, and stains; and generally, leave the Work in A-1 condition.
- D. Contractor and his subcontractors, on completion of his Work, shall remove tools, equipment, surplus materials, and rubbish pertaining to his operations, and pay costs for such removal and disposal from the site.

3.09 GUARANTEE AND WARRANTY

- A. The contractor shall submit written certificates, warranting that each item of equipment furnished complies with the requirements of the Drawings and Specifications.

3.10 SUPERVISION AND COOPERATION

- A. Work by the Contractor under this Division shall include the services of an experienced superintendent, who shall be constantly in charge of the Work, together with the qualified journeymen, helpers, and laborers required to properly unload, install, connect, adjust, start, operate, and test the Work involved, including related equipment and materials furnished under other contracts or by the Owner.

3.11 COLOR CHART FOR CABLE AND RACEWAY- 271510 and 270533

- A. All voice, video, and data cables and connectors to have the following colors:

Description Item	Jack	Cable	Patch Cables	I.D.	Conduit color	Notes
Data/Computer	Blue	Blue	Blue	C	Blue	4 Pair UTP Cable
Wireless Access point	Green	Green	Green	WAP	Blue	4 Pair UTP Cable
Sound System	-	Green		SS	Green	Multi-conductors
CCTV – IP	Purple	Purple	Purple	CCTV	Purple	4 Pair UTP Cable
Security		Gray		Sec	Purple	Multi conductors
Coax	-	Black/White	Black	CTV	Black	RG 6 or RG-11
Fire Alarm		RED		FA	Red	Multi Conductors

3.12 MATERIAL LIST

- A. Contractors shall provide within 24 hours after bid complete materials list on THEIR LETTER HEAD showing manufacturers name, catalog numbers, description, and quantities for each item in each system, per section number as follows:
1. Manufacturers Name.
 2. Manufacturer's catalog number.
 3. Quantities.
 4. Bonds.
 5. Training.
 6. Project managements.
 7. Shop drawings.
 8. Close out.
 9. Warranties.
 10. Allowance.
- B. The lowest responsible bidders shall provide unit pricing for all materials as described in Part "A" above, within 24 hours with NO exceptions.
- C. If a subcontractor is utilized for any portion of the work, all contact information, references, material list, and any other information shall be provided per the specified contract bid requirements.

- D. If the above requirements are NOT provided, then the contractor is considered a nonresponsive bidder subject to disqualification.

END OF SECTION 270500

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL-

1.01 DESCRIPTION

- A. This section identifies common and general grounding and bonding requirements of communication installations and applies to all sections of division 27 and 28.
- B. Grounding electrode system refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
- C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes methods and materials for grounding system for communications equipment:
 - 1. Grounding cable
 - 2. Grounding connectors
 - 3. Secondary Bonding Busbar-SBB
 - 4. Rack Bonding Busbar-RBB.
- B. Related section includes the following:
 - 1. Division 01 General Requirements
 - 2. Division 26 Electrical
 - 3. Division 27 Communications
 - 4. Division 28 Electronic Safety and Security

1.03 SUBMITTAL

- A. Provide grounding and bonding plans showing all grounding and bonding from each TR/IT/OIT/IDF to MCR/MDF, electrical grounding system.
- B. Provide rack/cabinet details showing the grounding and bonding.
- C. Provide cable tray showing the bonding and grounding.

1.04 QUALITY ASSURANCE

- A. Grounding shall be in accord with National Electrical Code NFPA 70 Article 250 and Article 800.
- B. The grounding system shall meet ANSI/J-STD-607D Telecommunications Bonding Grounding (Earthing) for Customer Premises.
- C. The grounding system shall comply with ANSI/TIA/EIA-758-B standard, Outside Plant Telecommunications Infrastructure Standards.

- D. The grounding system shall comply with BICSI (TDMM) standards.
- E. Equipment shall be provided with a suitable ground bus in the telecommunication rooms.

1.05 DEFINITIONS

- A. PBB (TMGB): Primary Bonding Busbar (Formerly Telecommunication main grounding bus bar).
- B. SBB (TGB): secondary Bonding Busbar (Formerly Telecommunication grounding bus bar).
- C. TBB: Telecommunication bonding backbone.
- D. TEBC: Telecommunications Equipment bonding conductor.
- E. TBC: Telecommunications bonding conductor.
- F. RBB: Rack bonding busbar.
- G. NRTL: Nationally recognized testing laboratory.

1.06 WARRANTY

- A. The grounding and bonding for communications systems shall have a warranty, as specified in the section titled "Demonstration, Training and Warranty of Communications Systems".

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Primary Bonding Busbar-PBB:
 - 1. The Primary Bonding Busbar (PBB) shall be constructed of .25 inch (6.4 mm) thick solid copper bar.
 - 2. The busbar shall be 4" (100 mm) high and 20" (510 mm) long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
 - 3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-D and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4mm hole center).
 - 4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
 - 5. The busbar shall be UL Listed as grounding and bonding equipment.
- B. Secondary Bonding Busbar-SBB:
 - 1. The Secondary Bonding Busbar (SBB) shall be constructed of .25 inch (6.4 mm) thick solid copper bar.
 - 2. The busbar shall be 2" (50 mm) high and 12" (300 mm) long and shall have 9 attachment points (one row) for two-hole grounding lugs.

3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-D and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
 5. The busbar shall be UL Listed as grounding and bonding equipment.
- C. Equipment Rack and Cabinet Ground Bars-RBB:
1. Solid copper ground bars designed for vertical mounting to framework of open racks or enclosed equipment cabinets:
 - a. 1.3 mm (0.05 inch) thick by 17 mm (0.68 inch) wide tinned copper strip.
 - b. 1997 mm (78 inches) high for mounting vertically on full height racks or cabinets.
 - c. Holes punched on 15.875 mm-15.875 mm-12.7 mm (5/8"-5/8"-1/2") alternating vertical centers to match EIA/ECA-310-E Universal Hole Pattern for a 45 RMU rack.
 - d. Three #12-24 zinc-plated thread forming hex washer head installation screws, an abrasive pad and antioxidant joint compound.
 2. Solid copper ground bars designed for horizontal mounting to framework of open racks or enclosed equipment cabinets:
 - a. 4.7 mm (3/16 inch) thick by 19.1 mm (3/4 inch) high hard-drawn electrolytic tough pitch 110 alloy copper bar.
 - b. 482 mm (19 inches) or 584 mm (23 inches) EIA/ECA-310-E rack mounting width (as required) for mounting on top of the racks or cabinets.
 - c. Eight 6-32 tapped ground mounting holes on 25.4 mm (1 inch) intervals.
 - d. Four 7.1 mm (0.281 inch) holes for attachment of two-hole grounding lugs.
 - e. Copper splice bar of same material to transition between adjoining racks.
 - f. Two each 12-24 x 19.1 mm (3/4 inch) copper-plated steel screws and flat washers for attachment to rack or cabinet.
 - g. Listed as grounding and bonding equipment.
- B. Ground Terminal Blocks: Provide screw lug-type terminal blocks at equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted.
1. Electroplated tin aluminum extrusion.
 2. Accept conductors ranging from #14 AWG through 2/0.
 3. Hold conductors in place by two stainless steel set screws.

4. Two 6 mm (1/4 inch) holes spaced on 15.8 mm (5/8 inch) centers to allow secure two-bolt attachment.
5. Listed as a wire connector.
- C. Splice Case Ground Accessories: Provide splice case grounding and bonding accessories manufactured by splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.
- D. Irreversible Compression Lugs:
 1. Electroplated tinned copper.
 2. Two holes spaced on 15.8 mm (5/8 inch) or 25.4 mm (1 inch) centers.
 3. Sized to fit the specific size conductor.
 4. Listed as wire connectors.
- E. Antioxidant Joint Compound: Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The grounding conductor shall be a continuous wire and carried throughout the grounding system.
- B. Each telecommunication grounding conductor shall be labeled, per latest J-STD-607B.
- C. Install PBB, SBB, RBB, TEBC and all related grounding and bonding equipment as shown and as described herein.
- D. Bond ferrous metallic conduit to ground.

3.02 GROUNDING AND BONDING

- A. All systems installed under these contracts shall comply fully with TIA/EIA 607-D and the BICSI TDMM Latest Edition as they relate with bonding and grounding systems.
- B. All bonding conductors and connectors shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL).
- C. All bonding conductors shall be insulated and copper.
- D. Bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place bonding conductors in ferrous metallic conduit of any length (conduit sleeves etc), provide grounding bushing at each end of the conduit and bond the grounding conductor to the bushing at each end of the conduit with a conductor sized as a No. 4 AWG, minimum and then ground these conduit sleeves to the cable tray at each side of the wall.

E. Labels, Color-Coding, and Markings

1. Each telecommunications bonding conductor shall be labeled. Labels shall be located on conductors as close as practicable (i.e., ease of access to read the label) to their point of termination. Labels shall be nonmetallic.
2. Each telecommunications bonding conductor shall be marked appropriately by a distinctive green color.
3. Each busbar shall be labeled Example: "SBB Bonded with PBB in Room xxx."

F. Telecommunications Room Bonding:

1. Telecommunications Bonding Busbars-PBB and SBB:

- a. Install busbar hardware no less than 950 mm (18 inches) A.F.F. on the telephone terminal board.
- b. Where other grounding busbars are located in same room, e.g. electrical panelboard for telecommunications equipment, bond busbars together as indicated on grounding riser diagrams.
- c. Make conductor connections with two-hole compression lugs sized to fit busbar and conductors.
- d. Attach lugs with stainless steel hardware after preparing bond according to manufacturer recommendations and treating bonding surface on busbar with antioxidant to help prevent corrosion.

2. Telephone-Type Cable Rack Systems:

- a. Aluminum pan installed on telephone-type cable rack serves as primary ground conductor within communications room.
- b. Make ground connections by installing bonding jumpers:
 - 1) Install minimum 16 mm² (6 AWG) bonding between telecommunications ground busbars and the aluminum pan installed on cable rack.
 - 2) Install 16 mm² (6 AWG) bonding jumpers across aluminum pan junctions.

3.03 COMMUNICATIONS SYSTEM GROUNDING AND BONDING

- A. Provide a minimum of #4 ground cable from the communications room bus (PBB and SBB) bar to the following:
1. Each communication cabinet/rack
 2. Each audio-video cabinet/rack
 3. Each voice communication switch (telephone)
 4. Each service entrance device
 5. Each sound systems
 6. Each security systems
 7. Access control
 8. Video surveillance system
 9. Any other communications systems provided by the Contractors.
 10. Cable tray and cable tray fittings.
 11. Ladder tray and ladder tray fittings.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SCOPE OF WORK

- A. Install raceway system, including underfloor and overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable tray, ladder tray, service poles, miscellaneous and positioning material to constitute complete system, as indicated for distribution of Telecommunications wiring which includes cables for Data, Voice, Video, Audio, Security and future signal requirements.
- B. Furnish and install split channel raceway and outlet boxes as specified in the Drawings and as specified herein.
- C. Furnish and install conduit stubs in walls and floors for cable routes.

1.03 SUMMARY

- A. This Section includes, but is not limited to the pathways for communications systems:
 - 1. Work area outlet.
 - 2. Cable supports
 - 3. Sleeves
 - 4. Cable ties
 - 5. Warning tape
- B. Related Sections include the following:
 - 1. Division 01 General Requirements
 - 2. Division 26 Electrical
 - 3. Division 27 Communications
 - 4. Division 28 Electronic Safety and Security

1.04 DESCRIPTION OF WORK

- A. Provide supports, cable ties, conduits, sleeves etc and all related equipment for the pathways for communications cabling as described herein and shown on the drawings.

1.05 QUALITY ASSURANCE

- A. Materials shall be new, complete with manufacturer's guarantee or warranty, and shall be approved by the Underwriters' Laboratories, Inc.

- B. Materials shall also comply with applicable standards of the National Electrical Manufacturers' Association, Insulated Power Cable Engineers Association, National Safety Code, and the American Institute of Electrical Engineers.
- C. Work shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed. Methods and techniques of installation shall be subject to the approval of the Architect.
- D. Materials of the same type or class shall be the product of the same manufacturer.

1.06 PROJECT CONDITIONS

- A. Contractor shall be responsible for the accurate location of his Work and for informing himself of the nature and arrangement of the materials, equipment, and construction to which his Work attaches or passes through.
- B. In general, cabling work shall be concealed in walls in conduit to the nearest accessible corridor ceiling and cable tray.
- C. Cables above the ceiling shall be installed in wire management system like cable tray, J-Hooks and other approved BICSI supports.
- D. Cables shall be installed in conduit in chases, in equipment rooms, mechanical rooms or/and in exposed installation.
- E. In general, wiring, and conduit shall be installed parallel (or at right angles) to the building walls, and at such heights as not to obstruct portions of windows, doorways, stairways, pipe space, tunnel, or passageway, and properly concealed to not interfere with the proper coordinated installation of other trades or Contractors. Where interferences develop in the field, the Work shall be offset or routed as required to clear such interferences. Consult Electrical Technology Drawings, Contractors, and other details before installing work.
- F. Contractor shall procure definite locations and connections before rough-in or installation. He shall then lay out his Work and be responsible for determining proper elevations, obliquity, acclivity, measurements, and locations required for the installation of his Work.

1.07 WARRANTY

- A. Provide warranty as specified in the section titled "Demonstration, Training and Warranty of Communications Systems.

1.08 TRAINING

- A. Provide training as specified in the section titled "Demonstration, Training and Warranty of Communications Systems.

PART 2 - PRODUCTS

2.01 TELECOM- WORK AREA OUTLET

- A. Provide work area outlets-WAO consists of one (1) 4-11/16" square by 2-1/8" deep flush mounted box with 3/8-inch mud ring. Each outlet box shall have an EMT conduit stubbed above the drop ceiling or extended into the hallway cable tray. If box does not come with 1.25 knockout, then the contractor shall provide the tools to provide the 1.25 inch knockout.
- B. Conduits size is as follows:
 - 1. Minimum conduit size shall be 1.25 inches.
 - 2. For Outlets with 2-4 cables (4PR UTP), use a minimum of 1.25" EMT conduit.
 - 3. For all other sizes over 1.25 inches, calculate fill ratio at 40% for proper sized conduit.
- C. All conduits from each WAO shall run to the cable tray or to the nearest accessible lay in ceilings, or cable tray, or telecom room, provide plastic grounded bushings at the end.
- D. All conduits shall be concealed in walls.
- E. Flexible conduits are NOT allowed.

2.02 CABLE SUPPORTS

- A. Provide adjustable cable support that meets UL, NEC, and TIA/EIA requirements for structured cabling systems.
- B. Provide wide base cable support that meets UL, NEC, and TIA/EIA requirements for structured cabling system.
- C. Cable support shall meet BICSI standards stated in Chapter 5.
- D. The cable support system shall provide support for various types of low voltage cables such as Category 6 and CAT 6A in addition to fiber optic cable, innerduct, multi-pair backbone cables, and coax cables.
- E. The support system shall attach structural elements to the building or be wall mounted.
- F. The supports shall be made of fire retardant and low smoke emission products, which meet UL 2034 requirements for air plenum spaces.
- G. The support products shall have a minimum of a 1-inch-wide platform for the cable to rest.
- H. Individual supports shall be installed at intervals not greater than 60 inches.
- I. Cable supports shall be installed a minimum of 6 inches above lay-in ceiling system. (Cable sags shall not allow the cable to touch ceiling grid or tiles, or additional supports shall be provided.)

- J. Minimum clearances from sources of EMI and RFI must be adhered to as specified in TIA/EIA-568B, TIA/EIA-569 and the latest version of the BICSI TDMM.
- K. Provide twelve spare units to the owner.
- L. Approved Manufacturers:
 - 1. Caddy adjustable cable support #CAT425.
 - 2. Thirty 5 Industries; phone 937/696-2785 #CAT35.
 - 3. Rapidtrak System by CPI; phone 800/834-4969.
 - 4. Panduit: J-PRO Cable Support System.

2.03 SLEEVES

- A. Provide four (4) four (4) inch sleeves from the corridor cable tray to the TR/MC/ER cable tray with plastic bushings at each end unless noted otherwise.
- B. Provide a minimum of three (3) four (4) inch sleeves (unless otherwise noted) in the corridor between cable trays when the cable tray passes thru a wall separation with doors with plastic bushings at each end.
- C. Provide a minimum of one (1) two (2) inch sleeve with plastic bushing at each end from the corridor cable tray to each room, install sleeve above the door.
- D. Fire stops all sleeves.

2.04 FIRE RATED SLEEVE ASSEMBLIES

- A. Provide fire rated sleeves assemblies in all rated wall, TR wall and MCR walls.
- B. Assemblies shall be 3x2, 3x4 or 6x4 with flange kit.
- C. Basis of Design: Hilti CFS-MSL modular fire sleeve.

2.05 CABLE TIES

- A. Provide plenum rated cable ties for cables in/or above ceiling.
- B. Cable ties shall be 4, 8, or 12 inches long.
- C. Cable ties shall meet UL 94V-O.
- D. Color shall be maroon.
- E. Provide one bag of 100 cable ties to the owner.
- F. Approved Manufacturers:
 - 1. Panduit PLT1M-C7024 (series) 4-inch
 - 2. Panduit PLT2S-C7024 (series) 8-inch
 - 3. Panduit PLT3S-C7024 (series) 12-inch
 - 4. Hubbell MCCMV9-10
 - 5. Leviton 4310X-XX series

2.06 CABLE HOOK AND LOOP FASTENERS

- A. Provide cable hook and loop fasteners to secure cable bundle to communication equipment cabinet and racks (not to be used above ceiling).
- B. UL listed.
- C. Color shall be maroon.
- D. Provide one bag of 100 units to the owner.
- E. Approved Manufacturers:
 - 1. Panduit, TTS – Series
 - 2. Hubbell MCCMV9BS10
 - 3. Leviton 4310X-XX series

2.07 UNDERGROUND WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct burial service
 - 3. Print legend shall indicate type of underground lines.
- B. Warning tape shall be installed 6-12 inches below grade on top of the communications duct bank.

PART 3 - EXECUTION

3.01 SITE PREPARATION

- A. Contractor shall do excavating of materials encountered, including backfilling necessary for the installation of underground wiring and equipment in his Contract. Provide and maintain bracing, shoring, or sheathing necessary to support the walls of excavations.
- B. Trenches shall be opened in straight lines and bottomed out at least 4 inches below conduit or ducts. Exterior trenches shall have a minimum depth of 36 inches which shall be maintained between top of largest conduit or duct and finish grade.
- C. Where roots of live trees are encountered in excavations, they shall be carefully protected during construction. Contractor shall cut or remove interfering trees, remove stumps, and rocks in the line of the excavation; however, approval of the Architect shall be obtained before a tree is removed or cut. Shrubbery in line of excavation shall be removed with a ball of dirt and replaced at completion of installation.
- D. Where excavation is necessary in existing pavements, Contractors for whose work the excavation is required shall pay fees and costs of opening street or pavement and costs of filling and repaving in accordance with requirements of and to the satisfaction of the Municipality, Utility, or other Owners of such paving.

- E. Where existing sidewalks, drives, and roadways must be cut, they shall be cut in straight lines, and shall present a neat appearance when re-laid and shall match existing work. At such locations the backfill medium shall be concrete from the bottom of the finished surface to the bottom of the trench except as may be otherwise approved by the Architect/Engineer.
- F. Where excavation is necessary in an existing lawn, carefully remove and restore sod. After backfilling trench, replace sod or apply top dressing of black dirt and seed to match existing lawn. Care shall be exercised during the work to see that no unnecessary damage is done to lawns in the storing of dirt or other construction material. Should unnecessary damage occur, in the opinion of the Architect, the Contractor shall be required to recondition lawns at his own expense.
- G. In addition, the Contractor shall provide and maintain warning barricades, flags, and warning lights, and shall conduct his work so as to create a minimum amount of inconvenience to others, traffic, construction, and the like. Temporary suspension of work does not relieve the Contractor of responsibility for the above requirements.
- H. Remove and legally dispose of debris, rubbish, and excavation spoils resulting from the Work.
- I. This Contractor shall "after one year" return to the jobsite and fill all trenches that have settled.

3.02 INSTALLATION

- A. Materials installed under this Division of Work shall be supported from the building structure, independent of other pipe, duct, equipment, ceiling grid, etc.
- B. The Contractor shall install communications equipment and shall make connections to major and secondary control equipment and/or apparatus, complete and assume full responsibility for the connections.
- C. Install jacks, fitting, and connectors in properly selected outlet boxes and junction boxes. (Install pull boxes only as required.)
- D. Cover and protect equipment, materials, enclosures, boxes, cabinets, racks, video projectors, sound systems, speakers, cameras, telephones, routers, switches, DA amplifiers, AV equipment, etc., before and after installation to prevent injury and to prevent entrance of grit, dirt, and foreign matter. If the contractor failed to do so, they are responsible for cleaning all the equipment or replacing it at NO cost to the owner.
- E. Cabling infrastructure shall be supported by cable supports that meet BICSI, EIA, TIA requirements and or in cable tray and must be provided by the cabling contractors unless otherwise noted. (NO cable shall be allowed to be supported at or on the building structure steel, ceiling grid, ceiling supports, mechanical piping etc).

- F. Cables in exposed area such as auditorium, gymnasium, mechanical rooms, boiler rooms, chiller rooms, art rooms, classrooms, locker rooms, corridors, etc. shall be installed in conduit from the device to the nearest accessible lay-in ceiling or the nearest telecommunication room. (It is the responsibility of the Cabling Contractor to verify this, and it is the Cabling Contractor responsibilities to provide all missing conduits and sleeves.)
- G. ALL sound system cables in exposed areas, such as the auditorium, gymnasium, and student dining, locker rooms etc shall be installed in conduit from the device to the area sound system cabinet.
- H. Install underground warning tape 12 inches above the conduit in the trench.
- I. Outdoor minimum separations from possible EMI exceeding 5KVA shall be 24 inches for power in nonmetallic pathways and 12 inches for power in grounded metal pathways. (Per BISC TDMM)

END OF SECTION 270528

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SECTION 270533 – RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SCOPE OF WORK

- A. Provide complete raceways and boxes for the communication systems, which include conduits, support, boxes, supports and all related materials.
- B. Furnish and install split channel raceway and outlet boxes as specified in the Drawings and as specified herein.
- C. Furnish and install conduit stubs in walls and floors for cable routes.

1.03 SUMMARY

- A. This Section includes, but is not limited to the pathways for communications systems:
 - 1. Rigid Galvanized Steel Conduit RGS
 - 2. Intermediate Metallic Conduit--IMC
 - 3. Electrical Metallic Conduit- EMT.
 - 4. Flexible Metallic Conduit-FMC.
 - 5. Direct Burial Plastic Conduit-HDPE.
 - 6. Communications Handholes.
 - 7. Communications Manholes.
 - 8. Cable supports.
- B. Related Sections include the following:
 - 1. Division 01 General Requirements
 - 2. Division 26 Electrical
 - 3. Division 27 Communications
 - 4. Division 28 Electronic Safety and Security

1.04 DESCRIPTION OF WORK

- A. Provide support, cable ties, conduits, sleeves etc. and all related equipment for the pathways for communications cabling as described herein and shown on the drawings.

1.05 QUALITY ASSURANCE

- A. Materials shall be new, complete with manufacturer's guarantee or warranty, and shall be approved by the Underwriters' Laboratories, Inc.

- B. Materials shall also comply with applicable standards of the National Electrical Manufacturers' Association, Insulated Power Cable Engineers Association, National Safety Code, and the American Institute of Electrical Engineers.
- C. Work shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed. Methods and techniques of installation shall be subject to the approval of the Architect.
- D. Materials of the same type or class shall be the product of the same manufacturer.

1.06 PROJECT CONDITIONS

- A. Contractor shall be responsible for the accurate location of his Work and for informing himself of the nature and arrangement of the materials, equipment, and construction to which his Work attaches or passes through.
- B. In general, cabling work shall be concealed in walls in conduit to the nearest accessible corridor ceiling and cable tray.
- C. Cables above the ceiling shall be installed in wire management systems like cable tray, J-Hooks and other approved BICSI supports.
- D. Cables shall be installed in conduit in chases, in equipment rooms, mechanical rooms or/and in exposed installation.
- E. In general, wiring and conduit shall be installed parallel (or at right angles) to the building walls, and at such heights as not to obstruct portions of windows, doorways, stairways, pipe space, tunnel, or passageway, and properly concealed to not interfere with the proper coordinated installation of other trades or Contractors. Where interferences develop in the field, the Work shall be offset or routed as required to clear such interferences. Consult Electrical Technology Drawings, Contractors, and other details before installing work.
- F. Contractor shall procure definite locations and connections before rough-in or installation. He shall then lay out his Work and be responsible for determining proper elevations, obliquity, acclivity, measurements, and locations required for the installation of his Work.

1.07 WARRANTY

- A. Provide warranty as specified in the section titled "Demonstration, Training and Warranty of Communications Systems."

1.08 TRAINING

- A. Provide training as specified in the section titled "Demonstration, Training and Warranty of Communications Systems."

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Minimum Communications Conduit Size: 1 1/2 inch unless otherwise noted.
- B. Conduit:
 - 1. Rigid Galvanized Steel: Conform to UL 6, ANSI C80.1 and NFPA 70. (1.5-6 inches)
 - 2. Rigid Intermediate Steel Conduit (IMC): Conform to UL 1242, ANSI C80.6 and NFPA 70, 1.5- 6 inches)
 - 3. Electrical Metallic Tubing (EMT):
 - a. Maximum Size: 4 inches.
 - b. Install only for cable rated 600 volts or less.
 - c. Conform to UL 797, ANSI C80.3.
 - 4. Flexible Galvanized Steel Metallic Conduit: Conform to UL 1.
 - 5. Liquid-tight Flexible Metal Conduit: Conform to UL 360.
 - 6. Direct Burial Plastic Conduit schedule 40 and 80: Conform to UL651A, heavy wall PVC, or high-density polyethylene (HDPE).
 - 7. Surface Metal Raceway and fittings: Conform to UL 5.
 - 8. Wireway, approved "Basket": Provide "Telecommunications Service" rated with approved length way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.
- C. Conduit Fittings:
 - 1. Rigid Galvanized Steel and Rigid Intermediate Steel Conduit Fittings:
 - a. Provide fittings meeting requirements of UL 514B, NFPA 70 and ANSI/ NEMA FB 1.
 - b. Sealing: Provide threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water and vapor. In concealed work, install sealing fittings in flush steel boxes with blank cover plates having same finishes as other electrical plates in room.
 - c. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - d. Locknuts: Bonding type with sharp edges for digging into metal wall of an enclosure.

- e. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into metallic body of fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - f. Erickson (union-type) and Set Screw Type Couplings:
 - 1) Couplings listed for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete.
 - 2) Use Set Screws of case-hardened steel with hex head and cup point to seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 - g. Provide OEM approved fittings.
2. Electrical Metallic Tubing Fittings:
- a. Conform to UL 514B, NFPA70 and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
 - b. Couplings and Connectors: Concrete tight and rain tight, with connectors having insulated throats.
 - 1) Use gland and ring compression type couplings and connectors for conduit sizes inches and smaller.
 - 2) Use set screw type couplings with four set screws each for conduit sizes over 2 inches.
 - 3) Use set screws of case-hardened steel with hex head and cup point to seat in wall of conduit for positive grounding.
 - c. Indent type connectors or couplings are not permitted.
 - d. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are not permitted.
 - e. Provide OEM approved fittings.
3. Flexible Steel Conduit Fittings:
- a. Conform to UL 514B and NFPA70; only steel or malleable iron materials are acceptable.
 - b. Provide clamp type, with insulated throat.
 - c. Provide OEM approved fittings.
4. Liquid-tight Flexible Metal Conduit Fittings:
- a. Conform to UL 514B, NFPA70 and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.

- b. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
 - c. Provide connectors with insulated throats to prevent damage to cable jacket.
 - d. Provide OEM approved fittings.
- 5. Direct Burial Plastic Conduit Fittings: Provide fittings meeting requirements of UL 514C and NEMA TC3, and as recommended by conduit manufacturer. Provide transition from PVC to IMC or Rigid conduit indoor above 3 inches of floor.
- 6. Surface Metal Raceway: Conform to UL 5 and "telecommunications service" rated with approved length-way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.
- 7. Surface Metal Raceway Fittings: As recommended by raceway manufacturer.
- 8. Expansion and Deflection Couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate 3/4-inch deflection, expansion, or contraction in any direction, and allow 30-degree angular deflections.
 - c. Include internal flexible metal braid sized to ensure conduit ground continuity and fault currents in accordance with UL 467, and NEC code tables for ground conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
- 9. Wireway Fittings: As recommended by wireway OEM.
- D. Conduit Supports:
 - 1. Parts and Hardware: Provide zinc-coat or equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 3. Multiple Conduit (Trapeze) Hangers: Minimum 1-1/2 by 1-1/2-inch, 12 gage steel, cold formed, lipped channels; with minimum 3/8-inch diameter steel hanger rods with washers and nuts on both sides of the bracket support.
 - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Splice, and Pull Boxes:
 - 1. Cast metal were required by NEC or shown and equipped with rustproof boxes.
 - 2. Sheet Metal Boxes: Galvanized steel, except where otherwise shown.

3. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with wall.
 4. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.
 5. All communications outlets shall be 4-11/16-inch boxes with a minimum of 2-1/8-inch-deep with single or two gang 3/4 mud ring as shown on the drawings.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.
- G. Flexible Nonmetallic Communications Raceway (Innerduct) and Fittings:
1. General: Provide UL 910 listed plenum, riser, and general purpose corrugated pliable communications raceway for optical fiber cables and communications cable applications; select in accordance with provisions of NEC Articles 770 and 800.
 2. Provide Communications Raceway with a factory installed 1250 lb. tensile pre-lubricated pull tape.
 3. Use only metallic straps, hangers and fittings to support raceway from building structure. Cable ties are not permitted for securing raceway to building structure.
 4. Provide fittings to be installed in spaces used for environmental air made of materials that do not exceed flammability, smoke generation, ignitability, and toxicity requirements of environmental air space.
 5. Size: Metric Designator trade size 2 or smaller.
 6. Outside Plant: Plenum-rated where each innerduct is 3 inches and larger.
 7. Inside Plant: Listed and marked for installation in plenum airspaces and minimum 1 inch inside diameter.
 8. Plenum: Non-metallic communications raceway.
 - a. Constructed of low smoke emission, flame retardant PVC with corrugated construction.
 - b. UL 94 V-O rating for flame spreading limitation.
 9. Provide innerduct reel lengths as necessary to ensure ducts are continuous; one piece runs from ENTR to MH; MH to MH; DEMARC to MCR/TER; TR to TR. Innerduct connectors are not permitted between rooms.
 10. Provide pulling accessories used for innerduct including but not limited to, inner duct lubricants, spreaders, applicators, grips, swivels, harnesses, and line missiles (blown air) compatible with materials being pulled.
- H. Provide WAO consists of one (1) 4-11/16" square by 2-1/8" deep flush mounted box with 3/8-inch mud ring. Each outlet box shall have an EMT conduit stubbed above the drop

ceiling or extended into the hallway cable tray. (if box does not come with 1.5 knockout, then the contractor shall provide the tools to provide the 1.5 inch knockout.

- I. Weatherproof Outlet Boxes: Surface mount two gang, 67 mm (2-5/8 inches) deep weatherproof cast aluminum with powder coated finish internal threads on hubs 19 mm (3/4 inch) minimum.
- J. Cable Tray:
 - 1. Provide wire basket type of sizes indicated, with all required splicing and mounting hardware.
 - 2. Materials and Finishes:
 - a. Electro-plated zinc galvanized (post plated) made from carbon steel and plated to ASTM B 633, Type III, SC-1.
 - b. Remove soot, manufacturing residue/oils, or metallic particles after fabrication.
 - c. Rounded edges and smooth surfaces.
 - 3. Provide continuous welded top side wire to protect cable insulation and installers.
 - 4. High strength steel wires formed into a 2 inches by 4 inches wire mesh pattern with intersecting wires welded together.
 - 5. Wire Basket Sizes:
 - a. Wire Diameter: (0.195 inch minimum on all mesh sections.
 - b. Usable Loading Depth: 6 inches.
 - c. Width: 12 inches, 18 inches or 24 inches.
 - 6. Fittings: Field-formed, from straight sections, in accordance with manufacturer's instructions.
 - 7. Provide accessories to protect, support and install wire basket tray system.
- K. Cable Duct: Equip with hinged covers, except where removable covers are accepted by COR.
- L. Cable Duct Fittings: As recommended by cable duct OEM.
- M. J-Hook can be used to support cables if cable tray is not available, unit shall be mounted at 5 feet apart and shall meet BICSI manual.
- N. Wire basket cable tray shall be installed per manufacturers' recommendations.

2.02 COMMUNICATIONS, HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND COMMUNICATIONS WIRING

- A. Description: Comply with ANSI/SCTE 77.
1. Color of Frame and Cover: Gray.
 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, as indicated for each service. "SIGNAL" or "COMMUNICATIONS"
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 30 inches wide by 42 inches long and 48 inches deep shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
 8. Structure Load
 - a. Tier 5 = Sidewalk applications.
 - b. Tier 8 = Sidewalk applications with safety factor for non-deliberate vehicular traffic.
 - c. Tier 15 = Driveways, parking lots, and off roadway applications subject to occasional non-deliberate heavy vehicular traffic.
 - d. Tier 22 = Driveways, parking lots, and off roadway applications subject to occasional non-deliberate heavy vehicular traffic.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with cover of polymer-concrete or reinforced concrete or fiberglass.

PART 3 - EXECUTION

3.01 SITE PREPARATION

- A. Contractor shall do excavating of materials encountered, including backfilling necessary for the installation of underground wiring and equipment in his Contract. Provide and maintain bracing, shoring, or sheathing necessary to support the walls of excavations.
- B. Trenches shall be opened in straight lines and bottomed out at least 4 inches below conduit or ducts. Exterior trenches shall have a minimum depth of 36 inches which shall be maintained between top of largest conduit or duct and finish grade.
- C. Where roots of live trees are encountered in excavations, they shall be carefully protected during construction. The contractor shall cut or remove interfering trees, remove stumps, and rocks in the line of the excavation; however, approval of the Architect shall be obtained before a tree is removed or cut. Shrubbery in line of excavation shall be removed with a ball of dirt and replaced at completion of installation.
- D. Where excavation is necessary in existing pavements, Contractors for whose work the excavation is required shall pay fees and costs of opening street or pavement and costs of filling and repaving in accordance with requirements of and to the satisfaction of the Municipality, Utility, or other Owners of such paving.
- E. Where existing sidewalks, drives, and roadways must be cut, they shall be cut in straight lines, and shall present a neat appearance when re-laid and shall match existing work. At such locations the backfill medium shall be concrete from the bottom of the finished surface to the bottom of the trench except as may be otherwise approved by the Architect/Engineer.
- F. Where excavation is necessary in an existing lawn, carefully remove and restore sod. After backfilling trench, replace sod or apply top dressing of black dirt and seed to match existing lawn. Care shall be exercised during the work to see that no unnecessary damage is done to lawns in the storing of dirt or other construction material. Should unnecessary damage occur, in the opinion of the Architect, the Contractor shall be required to recondition lawns at his own expense.
- G. In addition, the Contractor shall provide and maintain warning barricades, flags, and warning lights, and shall conduct his work so as to create a minimum amount of inconvenience to others, traffic, construction, and the like. Temporary suspension of work does not relieve the Contractor of responsibility for the above requirements.
- H. Remove and legally dispose of debris, rubbish, and excavation spoils resulting from the Work.
- I. This Contractor shall "after one year" return to the jobsite and fill all trenches that have settled.

3.02 INSTALLATION

- A. Materials installed under this Division of Work shall be supported from the building structure, independent of other pipe, duct, equipment, ceiling grid, etc.
- B. Contractor shall install communications equipment and shall make connections to major and secondary control equipment and/or apparatus, complete and assume full responsibility for the connections.
- C. Install jacks, fitting, and connectors in properly selected outlet boxes and junction boxes. (Install pull boxes only as required.)
- D. Cover and protect equipment, materials, enclosures, boxes, cabinets, racks, video projectors, sound systems, speakers, cameras, telephones, routers, switches, DA amplifiers, AV equipment, etc., before and after installation to prevent injury and to prevent entrance of grit, dirt, and foreign matter. If the contractor failed to do so, they are responsible for cleaning all the equipment or replacing it at NO cost to the owner.
- E. Cabling infrastructure shall be supported by cable supports that meet BICSI, EIA, TIA requirements and or in cable tray and must be provided by the cabling contractors unless otherwise noted. (NO cable shall be allowed to be supported at or on the building structure steel, ceiling grid, ceiling supports, mechanical piping etc).
- F. Cables in exposed area such as mechanical rooms, boiler rooms, chiller rooms, all other space cable shall be installed in conduit from the device to the nearest accessible lay-in ceiling or the nearest telecommunication room. (It is the responsibility of the Cabling Contractor to verify this, and it is the Cabling Contractor responsibilities to provide all missing conduits and sleeves.)
- G. Install underground warning tape 12 inches above the conduit in the trench.
- H. Outdoor minimum separations from possible EMI exceeding 5KVA shall be 24 inches for power in nonmetallic pathways and 12 inches for power in grounded metal pathways. (Per BISCITDMM).

3.03 CONDUIT/RACEWAY SYSTEM COLORS

- A. Provide the following conduit, junction box, wall boxes and complete raceway colors for each system as follows:
 - 1. Data system: Blue.
 - 2. WAP: Blue.
 - 3. Sound system: Green.
 - 4. CCTV-Cameras: Purple.
 - 5. Security: Purple
 - 6. MATV: Black.
 - 7. Fire alarm: Red.
 - 8. Electrical: Silver

END OF SECTION 270533

SECTION 27 05 36 - CABLE TRAY FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SCOPE OF WORK

- A. Provide complete continuous, rigid, welded wire mesh cable management system, which includes, cable tray, support, fittings, waterfall, 90 degree elbows and all related materials.

1.03 SUMMARY

- A. This Section includes, but is not limited to the pathways for communications systems:
 - 1. Cable tray, wire mesh.
 - 2. Ladder tray.
- B. Related Sections include the following:
 - 1. Division 01 General Requirements
 - 2. Division 26 Electrical
 - 3. Division 27 Communications
 - 4. Division 28 Electronic Safety and Security

1.04 DESCRIPTION OF WORK

- A. Provide supports, cable ties, cable tray, sleeves etc and all related equipment for the pathways for communications cabling as described herein and shown on the drawings.

1.05 QUALITY ASSURANCE

- A. Materials shall be new, complete with manufacturer's guarantee or warranty, and shall be approved by the Underwriters' Laboratories, Inc.
- B. Materials shall also comply with applicable standards of the National Electrical Manufacturers' Association, Insulated Power Cable Engineers Association, National Safety Code, and the American Institute of Electrical Engineers.
- C. Work shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed. Methods and techniques of installation shall be subject to the approval of the Architect.
- D. Materials of the same type or class shall be the product of the same manufacturer.

1.06 PROJECT CONDITIONS

- A. Contractor shall be responsible for the accurate location of his Work and for informing himself of the nature and arrangement of the materials, equipment, and construction to which his Work attaches or passes through.

- B. In general, cabling work shall be concealed in walls in conduit to the nearest accessible corridor ceiling and cable tray.
- C. Cables above the ceiling shall be installed in wire management system like cable tray, J-Hooks and other approved BICSI supports.

1.07 WARRANTY

- A. Provide warranty as specified in the section titled "Demonstration, Training and Warranty of Communications Systems.

1.08 TRAINING

- A. Provide training as specified in the section titled "Demonstration, Training and Warranty of Communications Systems.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Cablofil®, which is located at: 8319 State Rte. 4; Mascoutah, IL 62258; Toll Free Tel: 800-658-4641; Tel: 618-566-3230; Fax: 618-566-3250; Email: request info (info@cablofil.com); Web: www.legrand.us/Cablofil.aspx
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.02 WIRE MESH CABLE TRAY

- A. The Cable tray shall consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe-T-Edge T-welded top side wire to protect cable insulation and installers.
 - 1. Cable tray systems shall include, but are not limited to, straight sections, supports and accessories.
 - 2. Product: Cablofil CF (or ZF) Series Cable Tray as manufactured by Legrand.
 - 3. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
 - a. Mesh: 2 by 4 inches (50 by 100 mm).
 - b. Straight Section Lengths: 118 inches (3,000 mm).
 - c. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight.
 - d. Safe-T-Edge: Patented Safe-T-Edge technology on side wire to protect cable insulation and installers' hands.

- e. Fittings: Wire mesh cable tray fittings shall be field fabricated from straight tray sections, in accordance with manufacturer's instructions.
- f. Tape: Painted wire mesh cable tray to include metallic conductive UL tape.
- 4. Wire-Basket Depth: 4-inch (100-mm) usable loading depth.
 - a. 12 inches (300 mm) wide.
- 5. Length: Cable tray section length shall be 118.1 inches (3000 mm) unless otherwise shown on drawings.
- 6. Cable Tray Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.
 - a. Electrodeposited Zinc Plating: ASTM B 633, Type III, SC-1.
 - b. Hot-Dip Galvanizing After Fabrication: ASTM A 123.
 - c. Powder-Coated:
 - d. Black powder-coated surface treatment over Electrodeposited Zinc Plating using ASA 61 black polyester coating.
 - e. Custom Color Powder-Coated surface treatment. Color as scheduled.
- 7. Load Span Criteria:
 - a. Install and support cable management system in accordance with NEMA VE-1, with Safety Factor of 1.5.
 - b. Cable tray will be capable of carrying a uniformly distributed load of 25 pounds per foot on an 8 foot (2.4 m) support span, according to load tests of standard specified.
- 8. Fittings/Supports: Wire mesh cable tray fittings are field fabricated from straight tray sections, in accordance with manufacturer's instructions. Supports shall include the FAS (Fast Assembly System) where possible so that screws, bolts, and additional tools are not required for cable tray mounting to reduce installation time; and tray path can adapt to installation obstacles without the need for additional parts. Place supports so that support span does not exceed that shown on the drawings and is capable of supporting total fill capacity loading.
 - a. Ceiling-mounted supports mount to ceiling structure directly or with threaded rod sized for total fill capacity.
 - b. Wall-mounted supports.
 - c. Underfloor supports mount directly to floor or to floor posts.
 - d. Splices, including those approved for electrical continuity (bonding), as recommended by cable tray manufacturer.
- B. Outlet, Splice, and Pull Boxes:
 - 1. Cast metal where required by NEC or shown and equipped with rustproof boxes.

2. Sheet Metal Boxes: Galvanized steel, except where otherwise shown.
 3. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with wall.
 4. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.
 5. All communications outlets shall be 4-11/16-inch boxes with a minimum of 2-1/8-inch-deep with single or two gang 3/4 inch mud ring as shown on the drawings.
- C. Wireways: Equip with hinged covers, except where removable covers are shown.
- D. Cable Tray:
1. Provide wire basket type of sizes indicated, with all required splicing and mounting hardware.
 2. Materials and Finishes:
 - a. Electro-plated zinc galvanized (post plated) made from carbon steel and plated to ASTM B 633, Type III, SC-1.
 - b. Remove soot, manufacturing residue/oils, or metallic particles after fabrication.
 - c. Rounded edges and smooth surfaces.
 3. Provide continuous welded top side wire to protect cable insulation and installers.
 4. High strength steel wires formed into a 2 inches by 4 inches wire mesh pattern with intersecting wires welded together.
 5. Wire Basket Sizes:
 - a. Wire Diameter: (0.195 inch minimum on all mesh sections.
 - b. Usable Loading Depth: 6 inches.
 - c. Width: 12 inches, 18 inches or 24 inches.
 6. Fittings: Field-formed, from straight sections, in accordance with manufacturer's instructions.
 7. Provide accessories to protect, support and install wire basket tray system.
- E. Cable Duct: Equip with hinged covers, except where removable covers are accepted by COR.
- F. Cable Duct Fittings: As recommended by cable duct OEM.
- G. J-Hook can be used to support cables if cable tray is not available, unit shall be mounted at 5 feet apart and shall meet BICSI manual.
- H. Wire basket cable tray shall be installed per manufacturers' recommendations, communications handholes and boxes for exterior underground communications wiring.
- I. Description: Comply with ANSI/SCTE 77.
1. Color of Frame and Cover: Gray.
 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service. "SIGNAL" or "COMMUNICATIONS"
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 30 inches wide by 42 inches long and 48 inches deep shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
8. Structure Load
 - a. Light Duty = Pedestrian traffic only.
 - b. Tier 5 = Sidewalk applications.
 - c. Tier 8 = Sidewalk applications with safety factor for non-deliberate vehicular traffic.
 - d. Tier 15 = Driveways, parking lots, and off roadway applications subject to occasional non-deliberate heavy vehicular traffic.
 - e. Tier 22 = Driveways, parking lots, and off roadway applications subject to occasional non-deliberate heavy vehicular traffic.
- J. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- K. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
- L. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with cover of polymer-concrete or reinforced concrete hot-dip galvanized-steel diamond plate.

PART 3 - EXECUTION

3.01 INTALLATION

- A. Contractor shall install cable tray per the manufacturer's recommendations.
- B. Coordinate all work with other trades.
- C. Install ladder tray with all fitting for the Telecom room.

END OF SECTION 270536

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SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the identifications for communications systems:
 - 1. Labels
 - 2. Self-laminating labels
 - 3. Equipment cabinet labels
- B. Related Sections includes the following:
 - 1. Division 01 General Requirements
 - 2. Division 27 Communications
 - 3. Division 28 Electronic Safety and Security

1.03 DESCRIPTION OF WORK

- A. Provide identifications for communications and security systems as described herein and shown on the drawings.

1.04 SUBMITTALS

- A. Comply with requirements of the submittal section of the Specifications.

1.05 QUALITY ASSURANCE

- A. Materials shall also comply with applicable standards of the National Electrical Manufacturers' Association, Insulated Power Cable Engineers Association, National Safety Code, and the American Institute of Electrical Engineers.
- B. Work shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed. Methods and techniques of installation shall be subject to the approval of the Architect.
- C. Materials of the same type or class shall be the product of one manufacturer.
- D. Provide labeling per ANSI/EIA/TIA-606 requirement and in accordance with the Owner and Technology Consultant.

1.06 PROJECT CONDITIONS

- A. Contractor shall be responsible for the accurate location of his Work and for informing himself of the nature and arrangement of the materials, equipment, and construction to which his Work attaches or passes through.

- B. In general, label communication cables, equipment, cabinets, patch cord, data jacks, video jacks, cover plate, telecommunication rooms, MC/ER's video equipment, telephone system, etc.

PART 2 - PRODUCTS

2.01 LABELS

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Handwritten labels are NOT acceptable.
- C. Where insert type labels are used provide clear plastic cover over label.
- D. Outside plant labels shall be totally waterproof even when submerged.
- E. Equipment Room Copper, Fiber, and Coax Backbone Cable Labels
- F. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

2.02 SELF-LAMINATING LABELS

- A. Provide self-laminating labels to meet TIA/EIA-606-A.
- B. Labeling shall be per Class 2 and/or Class 3 requirements.
- C. Approved Manufacturers:
 - 1. Panduit PUR5504XXU
 - 2. Hubbell XPL11010 series
 - 3. Leviton LPH174

2.03 EQUIPMENT CABINETS/RACKS IDENTIFICATION LABELS

- A. Provide engraved, laminated acrylic label.
- B. Secure to equipment with screws.
- C. Label shall be white letters on a black background.
- D. Minimum letter height shall be 1/2-inch.

PART 3 - EXECUTION

3.01 IDENTIFICATION

- A. Equipment Identification:
 - 1. Provide nameplates on equipment such as Telecommunication Rooms (TR), Main Cross Connect/Equipment Room (MC/ER), patch panels, CPU, and the like.

2. Lettering shall include name of equipment, the specific unit number, and other instructions that are applicable.
 3. Nameplates shall be laminated phenolic with a black surface and white core. Use 1/16-inch-thick material for plates up to 2 inches by 4 inches. For larger sizes use 1/8-inch-thick material. Lettering of names should correspond to nomenclature specified for apparatus, corresponding with the Drawings, details, schedules, charts, wiring diagrams, and operating instructions, as approved by the Architect/Engineer.
 4. Lettering shall be condensed Gothic. The space between lines shall be equal to the width of the letters. Use 1/4-inch minimum height letters which occupy four to the inch. Increase letter size to 3/4 inch on largest plates.
 5. Attached directly to the apparatus in a manner approved by the Architect/Engineer.
- B. Labeling
1. Label each cable, work area outlet (WAO), each patch panel and jack outlet clearly, neatly, and completely, including "Spares." Labels shall not be subject to moisture or fading, shall be self-adhesive and must be typewritten.
 2. Type room label above patch panel port location to allow end user ease in identification of patch panel locations. Patch panels shall be labeled with a large 1/2-inch letter to designate patch panel I.D. (A-Z). This letter will correspond to the faceplate labeling at the station faceplate. (Example: TR-B1.1 A22 where the closet "TR-B1.1" and the patch panel port "A22" number are both identified)
 3. Use the following format to identify plate/connectors:
 - a. Individual jack designations shall begin at the main entry point of a room or space and continue in a clockwise rotation. The following labeling codes shall be used:
 - 1) C – communication
 - 2) V – video
 - 3) F – coax cable
 - 4) S – security
 - 5) DC – door contact
 - 6) PT – power transfer
 - 7) MD – motion detectors
 - 8) REQ – required for exit
 - 9) SS – sound system
 - 10) WAP – wireless access points
 - 11) CAM - camera
 4. Labeling scheme shall be submitted with the system submittal drawings and approved prior to termination of devices. Contractor shall submit a detailed drawing or sample plate with connectors installed to depict the intended labeling scheme.
 5. Label shall be applied within 6 inches from end of each of the cables.
 6. Cabling at the patch panels shall be terminated in numerical order so as to provide a logical pattern that will provide the end user the greatest ease in system administration.
 7. For fiber cabling, labels shall be applied at the patch panels in the space that is provided. Label shall include the room and location where fiber is routed to or from.
 8. Labels shall be clean and level.

9. Final labels should reflect the Owner's room designation scheme, which may not match the construction drawing numbers. The final room number scheme shall be confirmed with the Architect/Engineer prior to labeling the faceplate and patch panels. If the final room numbers are not available at the time of cable installation, architectural numbers shall be permitted for cable labeling only. If architectural numbers are used, a cross reference sheet shall be submitted in a spreadsheet format. This may require that the Contractor shall have to re-label the patch panels to match the final room numbers.
 10. Refer to drawing for patch panel and faceplate labeling detail.
 11. Provide blue dot with the IP address for all WAP's, Cameras, Video projectors etc, mount the label on the grid below the device.
- C. Other Items
1. Provide identification as required in other subsections of these Specifications and as denoted on the Drawings.
- D. It shall be the responsibility of the Cabling Contractor to clearly and logically label all terminal blocks, cables, and equipment (with length and room number).
- E. Labels shall be clearly typed and shall appear at all cable ends within 6 inches of the jack or patch panel termination on the outer jacket, on the faceplate of the station jacks, and on the patch panels. All patch cables shall be numbered 1 through X within 1/2 inch of each termination. Station runs shall be labeled indicating the room number of the station and its MC/ER and TR termination point as well as a unique identifier. (Handwritten labeling is not allowed.)
- F. Security door controller labeling: The door controller shall be labeled with the electrical circuit number and patch panel/TR location.
- G. Video coax cable shall be tagged with a distance at the MC/ER and TR end as well as a regular identifier. Backbone cables will be identified with an identifier that identifies where each cable end is terminated.
- H. Provide labeling for the following items with room name and room number:
1. Television and television remote
 2. Document Camera
 3. Cameras
 4. Security devices
 5. Miscellaneous equipment, etc.

3.02 COLOR CHART FOR CABLE AND RACEWAY

- A. All voice, video, and data cables and connectors to have the following colors:

Description Item	Jack	Cable	Patch Cables	I.D.	Conduit color	Notes
Data/Computer	Blue	Blue	Blue	C	Blue	4 Pair UTP Cable
Wireless Access point	Green	Green	Green	WAP	Blue	4 Pair UTP Cable
Intercom	-	White		IS	Breen	Multi-Conductors
CCTV – IP	White	White	White	CCTV	Purple	4 Pair UTP Cable
Security		Gray		Sec	Purple	Multi conductors
Coax	-	Black/White	Black	CTV	Black	RG 6 or RG-11
Fire Alarm		RED		FA	Red	Multi Conductors

END OF SECTION 270553

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SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes, but is not limited to the following:
 - 1. Free-standing equipment cabinets. (45RU)
 - 2. 2 post equipment racks
 - 3. Uninterruptible Power Supply (UPS)
 - 4. Telecom rooms cable trays
 - 5. Grounding and Bonding
 - 6. Miscellaneous items
- B. Related section includes the following:
 - 1. Division 01 General Requirements
 - 2. Division 26 Electrical
 - 3. Division 27 Communications
 - 4. Division 28 Electronics Safety and Security

1.03 DESCRIPTION OF WORK

- A. Provide labor, material, equipment, cabinets, racks, UPS's, wire managements, shelves, tie wraps, Velcro and accessories necessary for a complete installation of the communication equipment rooms as described in this section and as shown on the drawings.
- B. The Contractor shall coordinate the extension of the electrical service from the electrical junction box located in the room to each communications cabinets/rack with the Site Electrical Contractor.

1.04 QUALITY ASSURANCE

- A. See section - "Common Work Results for Communications" for more information.
- B. All equipment must be UL listed.
- C. All equipment and installation shall comply with latest ANSI/NFPA-70 National Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607D grounding and bonding standards.
- E. All equipment installations shall comply with the latest BISC (TDM) standards.

- F. All equipment racks and cabinets shall comply with the latest ANSI-EIA-310 standard.
- G. All UPS shall meet IEEE C62.41 standard.
- H. Provide labeling per ANSI/EIA/TIA-606 requirement and in accordance with the Owner and the Technology Consultant.

1.05 SUBMITTALS / RECORD DRAWINGS / MAINTENANCE MANUAL

- A. Shop Drawings
 - 1. The Contractor shall provide shop drawings of all equipment. Drawings shall indicate the interconnection of equipment and wiring external to the various patch panels (MC/ER and TRs). These drawings shall be included in the submittal to the Architect/Engineer for approval.
 - 2. Complete and comprehensive shop drawings shall be submitted to the Architect/Engineer for review.
 - 3. Drawings shall be provided in latest revision of AutoCAD.
 - 4. Provide equipment isometric with labeling.
 - 5. Every port shall be labeled per specs.
- B. See Common Work Results for Communications section 270500 for more submittal requirements. Provide record drawings and maintenance manual, per section titled "Operation and Maintenance of Communications Systems".

1.06 WARRANTY

- A. Components, parts, and assemblies supplied by the Cabling Contractor/manufacturer shall be guaranteed against defects in materials and workmanship as specified in the section titled "Demonstration, Training, and Warranty of Communications Systems", commencing upon system start. Warranty services shall be provided by the installer of the equipment manufacturer during normal working hours.

1.07 TRAINING

- A. Provide training as specified in the section titled "Demonstration, Training, and Warranty of Communications Systems".

PART 2 - PRODUCTS

2.01 FREE STANDING SEVEN (7) FOOT EQUIPMENT CABINETS

- A. All communications equipment shall be housed in free-standing cabinets.
- B. The equipment cabinets shall have solid sides and vented back panels and lockable and latching front and back doors. Units to have front Plexi-glass hinged door. (All locks/keys shall be keyed alike for all provided cabinets).
- C. Rack/Cabinet units: 45 RU.

- D. The equipment cabinets shall be 24 inches wide by 30 inches deep and 83-1/8 inches high with leveling feet.
- E. The equipment cabinets shall be made of steel construction and fully welded corners.
- F. The equipment cabinets shall have powder coat finish, finish shall be black or as selected by the owner.
- G. Provide integrated quiet fan with 450 - 550 CFM in each equipment cabinet with fan guards (external and internal), fan shall have less than 47 - 49 dBA noise rating.
- H. Provide PDU as specified in section 27 11 26 communications rack mounted power protection.
- I. At each equipment cabinet provide wire management devices between each patch panel. Horizontal and vertical slotted openings and plastic wire holding clips.
- J. Provide wire management panels as shown on the drawing. Provide three (3) extra wire management units in each TR/MC/ER room.
- K. If equipment cabinets are ganged together, then the inner side panels are not required. Provide four (4) ganging grommet rings between each cabinet for cables to pass through.
- L. Provide rack copper grounding busbar (1/8 inch thick and threaded 10-32, 1-inch-wide x 44 space).
- M. Provide 100 spare mounting screws for each equipment cabinet.
- N. Provide 100 spare cage nuts for each equipment cabinet.
- O. Provide mounting rails. (Confirm Mounting Rail Type, EIA Tapped or Cage Nuts)
- P. Provide vented panels
- Q. Provide blank panels
- R. Provide "1" spare adjustable vented shelves in each cabinet, with a weight capacity of 200 Lbs, steel with black powder finish.
- S. Equipment cabinet shall be UL listed.

- T. Basis Of Design:
 - 1. Middle Atlantic SNE or DKR or WMRK Series with all related material.

2.02 TWO POST EQUIPMENT RACKS

- A. All communication equipment shall be housed in steel or aluminum equipment racks.
- B. The equipment racks shall be 11 gauge steel channels.
- C. The equipment racks shall have powder coat black finish.
- D. The equipment racks shall be 19 inches wide.
- E. The equipment racks shall be 84 inches high.
- F. Provide wire management panels as shown on the drawing. Provide three (3) extra wire management units in each TR/MC/ER room.
- G. Provide copper bus bar (1/8 inch thick and threaded 10-32, 1 inch wide x 44 space).
- H. Provide PDU as specified in section 27 11 26 communications rack mounted power protection
- I. The equipment racks shall have vertical cable management. (One on each side)
- J. The equipment racks shall have 3RU shelves.
- K. At each equipment cabinets provide wire management devices between each patch panel. Horizontal and vertical slotted openings and plastic wire holding clips.
- L. Basis Of Design: Panduit CMR19X84 - Series.

2.03 RACK/CABINET MOUNTED UNINTERRUPTABLE POWER SUPPLY(COORDINATE WITH OWNER BEFORE ORDERIND)

- A. Provide UPS in each TR or MC/ER per the communication room schedules.
- B. Provide rack mounted UPS to fit at the bottom of each rack/cabinet.
- C. UPS shall have an output voltage of 120 volts or 208V, as needed (verify in the field).
- D. UPS shall have an input voltage of 120 volts or 208V, as needed.
- E. The UPS shall have output receptacles as follows:
 - 1. 2000VA - (4) NEMA 5 – 20R
 - 2. 3000VA - (4) NEMA 5 – 20R
 - (1) NEMA L5 – 30R
 - 3. 2700VA – (2) NEMA L6 - 15R
 - (1) NEMA L6 – 20R

- F. UPS shall have sine wave waveform.
- G. UPS shall have maintenance free sealed lead acid battery.
- H. UPS shall have DB-9, RS-232; Smart SNMP card.
- I. Provide PC computer network card in the UPS.
- J. UPS shall be connected to the LAN switches in the telecommunications rooms.
- K. UPS shall have management software.
- L. UPS shall have control panel with LED status display.
- M. UPS shall have audible alarm.
- N. Provide a rear mounted rail to support the UPS in the MC/ER cabinets and provide center mount shelf for equipment racks in each TR.
- O. UPS shall have two years warranty for labor and material.
- P. UPS shall be UL Listed 1778.
- Q. Power cord on the 2,000VA to have a 5-20P plug with 5-20R receptacle.
- R. Power cord on the 3,000VA to have L5-30P plug with L5-30R receptacle.
- S. Battery run time (minimum):
 - 1. 2000VA – 6 minutes at full load
- 14 minutes at 50% load
 - 2. 3000VA – 5 minutes at full load
- 16 minutes at 50% load
 - 3. 2700VA – 5 minutes at full load
- 16 minutes at 50% load
- T. Provide external battery cabinet, as shown in the telecommunication room/MC/ER Schedule.
- U. Provide one (1) spare 2,000 VA UPS.
- V. Basis of Design:
 - 1. Emerson Network Power (Liebert) GXT3-2000 RT120 / GXT2 – 48V battery.
 - 2. Emerson Network Power (Liebert) GXT3-3000 RT120 / GXT2 – 72V battery.

2.04 POWER STRIPS

- A. Provide vertical power strip in each cabinet/rack as follows:
 - 1. 12-20 amp receptacles, 120 volts.
 - 2. Cord with NEMA 5-20P plug.
 - 3. 50 to 60 inches long.

4. Single circuit.
 5. UL listed 1363.
- B. Provide horizontal power strip as follows (in the sound system cabinets):
1. 6 – 20 amp receptacles
 2. Cord with NEMA 5 – 20 plug
 3. Single circuit
 4. UL listed 1419
- C. Unit shall be rack or cabinet mounted.
- D. Provide one (1) spare vertical power strip and one (1) spare horizontal power strip.
- E. Approved Manufacturers:
1. Middle Atlantic PD-1220C-NS. (vertical)
 2. Middle Atlantic PDS-620R (horizontal)
 3. Hubbell
 4. Hoffman
 5. CPI

2.05 TELECOMMUNICATION ROOMS CABLE TRAY

- A. Provide 12 or 24 inches wide 1 1/2 inches high sectional cable tray under the ceiling and above the TR and MC/ER cabinet.
- B. Run cable tray from the equipment cabinet/racks to the telephone terminal board.
- C. Provide 90° Elbows, waterfall, downs and ups, fittings, and supports.
- D. Approved Manufacturer:
1. Snake Tray
 2. Flex Tray
 3. Cablofil
 4. Hubbell
 5. Panduit
 6. Husky
 7. B-Line

2.06 WATERFALL ACCESSORIES

- A. Provide cable management waterfall at each location where cable exists or enters the cable tray.
- B. Approved Manufacturer:
1. Panduit CMW-Kit, CMWB and CMWW
 2. Hubbell
 3. CPI
 4. Commscope
 5. B-Line

2.07 STACKABLE CABLE RACK SPACERS

- A. Provide stackable cable rack spacers in each telecommunication room in cable tray.
- B. Approved Manufacturer:
 - 1. Panduit CRx – xx Series
 - 2. Hubbell
 - 3. CPI
 - 4. Commscope
 - 5. B-Line

2.08 GROUNDING COMPONENTS

- A. Provide #4 green grounding conductors from the grounding bus on the TTB to each telecommunications cabinet/rack.
- B. Provide two-hole ground lugs to meet J-STD-607A requirements

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install communications equipment room fittings as specified herein and as shown on the drawings.

3.02 LABELING AND MARKING

- A. Provide labeling and markings for all communications equipment cabinets/racks.
- B. Provide labeling for telecommunications rooms as follows:
 - 1. Black on white with TR # for each cabinet. (for example, TR.A1.1 fed from MC/ER-C1.1 panel A6-12)
- C. Section titled "Identifications for Communications Systems" for more information.

3.03 EQUIPMENT CABINETS

- A. Each telecommunication room provide communications equipment, cabinets or racks as shown on the drawings and as specified here.
- B. The communication equipment cabinets shall be arranged as shown on the drawings:
- C. Provide complete equipment cabinet layout showing patch panels, wire management, and switches.
- D. Coordinate the extension of the electrical service from the electrical junction box located in the room to each communications cabinet/rack.

3.04 COMMUNICATION GROUNDING AND BONDING

- A. Provide grounding and bonding to each cabinet or rack with ground cable from the grounding bus bar in the TR and MC/ER to each cabinet/rack.
- B. The grounding conductor shall be insulated copper with minimum of #4 AWG.
- C. The grounding conductor shall be marked by distinctive green color.
- D. Provide a minimum of #4 ground cable from the communications room busbar to the following:
 - 1. Each communication cabinet/rack
 - 2. Each file server cabinet/rack
 - 3. Each audio-video cabinet/rack
 - 4. Each voice communication switch (telephone)
 - 5. Each service entrance device
 - 6. Any other communications systems provided by this Contractor.

3.05 TELECOMMUNICATION ROOMS

- A. The data cable, the telephone cable, and the video control cable shall be terminated on RJ45 copper patch panels.
- B. The video coax cable shall be terminated with F-connectors on each end of the cable.
- C. Provide fire-rated plywood terminal board, (quantity as shown) 4 foot by 8 foot by 3/4 inches (minimum of 1) in each telecommunication room. (Paint to match wall.)
- D. Provide two (2) 4-inch sleeves with plastic bushings above each terminal board. (Verify exact location in the field).
- E. Provide ladder trays, as shown on the drawings.
- F. Room 109 TR-1 Provide the following:
 - 1. Provide (1) equipment "racks" with all miscellaneous items.
 - 2. Provide (1) 2-post racks with all miscellaneous items.
 - 3. Bond to the building grounding system with #4 copper.
 - 4. Provide ground bus bar.
 - 5. Provide (24) port fiber optic patch panels. (MM)
 - 6. Provide (4) 6 port SC coupling panels. (MM)
 - 7. Provide (2) 48 port copper patch panels for work area outlets.
 - 8. Provide (1) 24 port copper patch panels for IP cameras.
 - 9. Provide (1) 24 port copper patch panels for WAP.
 - 10. Provide (2) 2,000VA, 120V, 60Hz UPS, rack mounted.
 - 11. Provide (2) 3,000VA, 120V, 60Hz UPS, rack mounted.
 - 12. Provide horizontal and vertical wire management panels.
 - 13. Provide wire duct or wire management duct to bring cables from the ceiling to the equipment racks.
 - 14. Provide (1) rack mounted PDU and (1) mounted vertical power strip, per cabinet.
 - 15. Provide shelves as specified.

16. Provide space for owner provided data switches.
17. Provide one **BLUE** patch cord for each data ports with 20% spare cables; provide 50% three (3) foot patch cables, 30% five (5) foot patch cables, and 20% seven (7) foot patch cables.
18. Provide one **GREEN** patch cord for each wireless access point ports with 20% spare cables; provide 50% three (3) foot patch cables, 30% five (5) foot patch cables, and 20% seven (7) foot patch cables.
19. Provide one **WHITE** patch cord for each IP CCTV camera ports with 20% spare cables; provide 50% three (3) foot patch cables, 30% five (5) foot patch cables, and 20% seven (7) foot patch cables.
20. Provide one **BLUE** station patch cable for each data port with 20% spare cables; provide 90% ten (10) foot patch cable and 10% fifteen (15) foot patch cable.
21. Provide one Fifteen (15) foot **GREEN** station patch cord at the Wireless Access point location plus 20% spare.
22. Provide one ten (10) foot **WHITE** station patch cord for each IP CCTV camera ports with 20% spare cables.

END OF SECTION 271100

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SECTION 271126 COMMUNICATIONS RACK MOUNTED POWER PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Rack-Mounted Power Distribution Units (PDUs).
- B. Related Requirements:
 - 1. Section 27 11 00 "Communications Equipment Room Fittings.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EIA: Electronic Industries Alliance.
- C. TIA: Telecommunications Industry Association
- D. ANSI: American National Standard Institute
- E. NFPA: National Fire Protection Association
- F. NEC: National Electrical Code

1.4 REFERENCES

- A. ANSI/TIA-569-E Telecommunications Pathways and Spaces.
- B. ANSI/TIA-568.0-D Generic Telecommunications Cabling for Customer Premises.
- C. ANSI/TIA – 568.1-D Commercial Building Telecommunications Cabling Standard..
- D. ANSI/TIA-942-B Telecommunications Infrastructure Standard for Data Centers.
- E. ANSI/TIA – 606-C Administration Standard for Telecommunications Infrastructure.
- F. ANSI/TIA – 607-D Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises.
- G. ANSI/TIA-862-B Structured Cabling Infrastructure Standard for Intelligent Building Systems.
- H. ANSI/NFPA 70 – National Electric Code.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for rack-mounted power protection and power strips.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include workspace requirements and access for cable connections.
3. Grounding: Indicate any chassis bonding requirements.
4. Network Connection and Programming: Indicate networking and configuration requirements and connections.

1.6 QUALITY ASSURANCE

- A. Product Certifications:
1. UL & cUL 62368.
 2. IEC 62368.
 3. CE.
 4. FCC Part 15, Class A.
 5. EN 55022 and RoHS Compliant.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION UNITS (PDUs)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Chatsworth Products Monitored eConnect PDU or/and Monitored Pro eConnect PDU or/and Switched eConnect PDU or/and Switched Pro eConnect PDU or APC 8870, with the following features:
1. Field-replaceable controller with the following connections:
 - a. Ethernet Connection (RJ45): 10/100/1000 Mbps
 - b. Serial Port (RJ45): For serial connection and console bench configuration
 - c. Serial Port (USB-Mini Type B): For serial connection and console bench configuration
 - d. Two Secure Array IP Consolidation Ports (RJ45) for linking PDUs through a shared Ethernet connection
 - e. Two Electronic Access Control Auxiliary Ports (RJ45) for attaching front and rear electronic door locks
 2. Power Measurement: Built-in power meter with ± 1 percent metering accuracy. Power (kW), Energy (kWh), Voltage (V), Current (A) and Power Factor (PF) will be measured at each breaker.
 3. Secure Array IP Consolidation Ports (RJ45): Two serial PDU linking ports that allow multiple PDUs to be connected in a continuous Secure Array of up to 48 PDUs for IP consolidation through one physical network connection. Maintains connection across the array even if an individual unit within the array stops reporting. Allows a second network connection for redundancy.
 4. USB Type-A Port: Two USB Type-A ports for attaching Temperature and Humidity Sensors and for installing firmware upgrades locally. When attached, the PDU will display measured temperature and humidity values.

5. Built-in Web Interface: Accessed through any web browser using the PDU's assigned IP address. Supports IPv4 or IPv6, Zero Touch Provisioning (ZTP), web authentication, multiple user accounts, data logging, and download and export of data logs. Displays a list of PDUs that are linked using Secure Array IP Consolidation, a power summary for each unit, an alarm summary for all units, cabinet access control and monitoring, built-in event logging, notification, and cloning/firmware upgrade through arrayed units.
6. Software Integration to Third-Party Software: Communication with any third-party Data Center Infrastructure Management (DCIM) software, power/facility monitoring software or building management system through SNMP protocol, or RESTful API using the Ethernet connection.
7. Electronic Lock Integration: Allows attachment of electronic locks to the PDU for power and network connection. Monitor and control locks attached to a single PDU or up to 32 PDUs on a Secure Array through a single built-in web interface or DCIM software integration. Assign individual user access rights in the PDU or from a RADIUS or LDAP database. Log each access attempt, including unauthorized attempts. Record user, date/time and access event for each authorized user. Condition of swinghandle opened or closed. Condition of door opened or closed. Set lock open time. Alarms for badge scan, door open/closed, lock open/closed, door open longer than alarm period. Open locks remotely.
8. Outlet Monitoring and Grouping: Measure voltage, current, power (kW) and energy (kWh) at each outlet. The Built-in web interface shall: Allow the user to name each outlet, to view detailed power readings (voltage, current, kW and kWh) for each outlet; to set upper and lower alarm limits for each outlet; to view summarized alarms; to group monitored outlets on individual and linked PDUs to see combined power usage for redundantly powered or multiple pieces of equipment.
9. Outlet Control and Grouping: switched outlets that can be turned on, off or cycled remotely. The built-in web interface: Allow the user to name each outlet; to set on and cycle delays for each outlet; and to group switched outlets on individual and linked PDUs to turn redundantly powered or multiple pieces of equipment off or on with a single click. Each outlet shall have an LED indicating if the outlet is ON or OFF. In case of an alarm, the LED should blink to facilitate location of the alarm.
10. Graphical Display: Centrally located LCD display indicating the following:
 - a. Combined voltage, current and power (kW) for the PDU.
 - b. Voltage, current, power (kW) and power factor values for each breaker on the PDU
 - c. Line input current on three-phase units
 - d. Current for each outlet on Monitored Pro and Switched Pro units
 - e. Temperature and Humidity values for external sensors
 - f. Display screens and options shall be navigated with three push buttons located under the display
 - g. Alarms will be indicated by a flashing red LED above the display and indicator on screen
 - h. The image on the display screen will rotate 180° for easy viewing when the PDU is mounted with the power cord toward the top of the rack/cabinet.
 - i. The display can be used to setup PDU Linking settings, fixed IP address

and firmware update.

11. Description:

a. Mounting Style:

- 1) Vertical PDUs: Shall be capable of being preinstalled in either 42U or 45U Cabinets. Universal tool-less mounting hardware, a pair of aluminum shoulder washers attached to the back of the PDU chassis that can be spaced 64.8 inches (1645 mm) or 61.3 inches (1556 mm) apart to match most rack/cabinet mounting brackets.
- 2) Horizontal PDUs: Shall include a pair of mounting brackets compatible with 19"EIA rack-mount systems.

b. Power Input:

- 1) Voltage:
 - a) 120/208V Single-Phase Input.
 - b) 120/208V Three-Phase Input
- 2) Breaker(s): 1, 2, 3 or 6 UL489 hydraulic magnetic breakers fully rated to 20A each, Single-Pole or Double-Pole depending on input plug type and UL requirements. Must have 10 kAIC-rated breakers with any 240/415 Volt configurations.
- 3) Cord: Attached cord: One single input cord permanently attached; 3 to 15 feet (0.9 to 4.6 m) long. Detachable cord, with C19 connector for the PDU and plug identified below; 8 ft (2.4 m) long..
- 4) Plug: to be coordinated/verified with owner
 - a) 20 Inlet to L5-20P
 - b) L5-30P
 - c) C20 Inlet to L6-20P
 - d) L6-30P
 - e) L14-30P
 - f) L15-30P
 - g) L21-20P
 - h) L21-30P

c. Power Output:

- 1) Voltage: The nominal output voltage for 5-20R outlets is 120V and for C13/C19 is 208V. Convenience outlets are not monitored or switched.
- 2) Phase-balance outlets on three-phase units: Each outlet in the sequence draws power from a sequential phase-breaker combination in order to facilitate load balancing, wiring and avoid circuit overload
- 3) Outlet combination:
(12) C13 (6) C19 and (4) 5-20 Convenience outlets.

12. Cable Management: Locking eConnect; C13 and C19 outlets shall have an integrated mechanism for securing power cords that will accept any standard power cord with a straight or angled plug. The low-profile locking outlets feature a lever that secures the power cord in place.
13. PDU Temperature Rating: Rated for use in high ambient air temperatures up to 149°F (65°C) and suitable for use in hot aisle containment and ducted exhaust cabinet applications.
14. Grounding/Bonding: Grounded inlet/power plug and a separate external M5 threaded ground attachment point.
15. Color & Finish: Available in black and Glacier White with powder coat paint.
 - a. Power outlets: molded black
 - b. Field-replaceable controller: black
 - c. Color-coded labels printed on metal to associate breakers and outlets
 - d. Redundancy Pack – A pack of 2 PDUs; one black PDU and one Glacier White PDU to easily identify A&B feeds

2.2 WARRANTIES

- A. Minimum of 3 years of standard warranty with ability to extend by at least 2 additional years. Advanced replacement of defective PDUs shall be offered as a standard service.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. PDU shall be capable of being preinstalled in the channel dat racks, cabinets.
- B. Two PDUs on the same side of the cabinet using two-piece or full-height brackets. One PDU on either side of the cabinet using two-piece or full-height brackets.

END OF SECTION 271126

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SECTION 271510 - COMMUNICATIONS STRUCTURED CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 00 COMMON WORK FOR COMMUNICATIONS INSTALLATIONS.

1.02 SUMMARY

- A. Section includes, but is not limited to the following:
 - 1. Work Area Outlet-WAO.
 - 2. 48 positioned angled patch panels with 45 RJ jacks.
 - 3. 4 PR UTP Horizontal copper cabling.
 - 4. Connectors.
 - 5. Local area network
 - 6. Patch panels compatible with the structured cabling system
 - 7. Patch cords compatible with the structured cabling system
 - 8. Modular jacks
 - 9. Boxes.
 - 10. Cover plates.
 - 11. Labeling
 - 12. Termination of all horizontal cabling
 - 13. Testing of all horizontal cabling
 - 14. All related material as described herein.
 - 15. Layout drawings, elevations, and complete shop drawings.
- B. This section includes the minimum requirements for Copper Horizontal Cabling and all associated materials.
- C. Horizontal (to desktop) cable shall consist of Category 6A- 4 PR UTP (unshielded twisted pair) or STP (shielded twisted pair) copper cable for all Data and Voice applications.
- D. At each location, horizontal cabling to typical work area outlets (including offices, cubicles, classrooms, conference room, and other spaces as shown on the drawings) shall consist of two Category 6A with 4 PR UTP/STP copper cables serving each work area outlet (WAO).
- E. Outlets for wall-mounted "telephone only" installations shall consist of one Category 6A cable as a minimum.
- F. Outlets for wireless access points (WAPs, WIFI's) shall consist of one Category 6A cable as a minimum.

- G. Related section includes the following:
1. Division 01 – All Sections
 2. Division 26 - Electrical
 3. Division 27 – Communications Sections

1.03 DESCRIPTION OF WORK

- A. Provide labor, material, equipment, terminations, and accessories necessary for a complete and operational communications copper horizontal cabling system as indicated on the Drawings and specified herein. The contractor shall furnish the equipment, accessories and necessary material as described herein.
- B. Provide communications copper horizontal cabling from each communication jack to each TR/MC/ER as described here and as shown on the drawings.
- C. The voice and data horizontal cabling system shall be capable of 10 Gig transmissions via 4 PR UTP/STP copper Category 6A cables.
- D. Horizontal cable shall comply with TIA/EIA 568-C.2-10 Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
- E. Horizontal cable shall comply with TSB-155 requirements-Guidelines for the Assessment and Mitigation of Installing Category 6A cables to support 10GBASE-T.
- F. The cabling for the voice and data horizontal cabling system shall include but not limited to the following:
 - 1. Provide UTP cables (horizontal).
 - 2. Provide patch panels and patch cords compatible with the horizontal cabling system.
 - 3. Provide modular jacks and cover plates compatible with the horizontal cabling system.
 - 4. Provide and terminate cabling within each room and the data cabinets (MC/ER's and TR's).
- G. The modular computer/data eight-position jack shall match the color scheme of EIA-568 B as follows:
 - 1. Pair 1: Pin 4 - Blue; Pin 5 - White-Blue
 - 2. Pair 2: Pin 1 - White-Orange; Pin 2 - Orange
 - 3. Pair 3: Pin 3 - White-Green; Pin 6 - Green
 - 4. Pair 4: Pin 7 - White-Brown; Pin 8 - Brown
- H. The contractor shall coordinate the extension of the electrical service from the electrical junction box located in the room to each communications cabinets/rack with the Site Electrical Contractor.

1.04 QUALITY ASSURANCE

- A. Communications cabling system components and equipment shall be listed by Underwriters Laboratories, Inc. for Computer use, and the components shall bear the UL label.
- B. The system shall be installed in accordance with requirements set by NFPA-70 National Electric Code.
- C. All equipment shall comply with the latest ANSI-J-STD-607D grounding and bonding standards.

- D. All equipment and installation practices shall comply with the latest BICSI (TDMM) standards.
- E. All equipment shall comply with the latest ANSI/TIA/EIA-568, 569, 60, 607, and 862 standards, as applicable.
- F. Cables shall be installed in accordance with ANSI/EIA/TIA and BICSI standards.
- G. Provide labeling per ANSI/EIA/TIA-606 requirement and in accordance with the Owner and the Technology Consultant.
- H. All cabling shall be tested in accordance with the ANSI/TIA/EIA-568-C.2 standards with the required testing equipment.

1.05 CERTIFICATION

- A. The Cabling Contractor shall provide the services of a component manufacturer and provide equipment listed by Underwriters Laboratories, Inc. The Contractor shall issue a equipment certification stating that the equipment and connected wiring and devices which form the specified system, together with installation have a 20-year Application Assurance and 20-year Extended Product Warranty on Registered Installation and are in compliance with the requirements established by TIA/EIA 568, 569, and BICSI Standards. Also, this Contractor shall submit with his/her bid a letter from the manufacturer indicating that his/her installation will be certified for a 20-year Application Assurance and 20-year Extended Product Warranty on Registered System Installation.

1.06 SUBMITTALS / RECORD DRAWINGS / MAINTENANCE MANUALS

- A. Shop Drawings
 - 1. Provide complete and comprehensive shop drawings with labeling to the Architect/Engineer for approval.
 - 2. Drawings shall be provided in the latest Releases of AutoCAD or REVIT.
 - 3. One set of PDF'S is also required.
- B. See front end submittals specification section for more information.
- C. See Common Work Results for Communications section 270500 for more submittal requirements.
- D. Provide record drawings and maintenance manual, per section – "Operation and Maintenance of Communications Systems".
- E. The contractor shall include the following with their submittal:
 - 1. Manufacturer's Certificate stating each testing device used on the project and shall contain the most current revision of software.
 - 2. Manufacturer's Certificate stating that each testing device used on the project has been calibrated within the last 12 months.

1.07 WARRANTY

- A. Components, parts, and assemblies supplied by the Communications Contractor/manufacturer shall be guaranteed against defects in materials and workmanship for a period as specified in section – Demonstration, Training, and Warranty of Communications Systems, commencing upon system start-up. Warranty services shall be provided by an installer certified by the equipment manufacturer during normal working hours. The manufacturer's statement of warranty shall be included in the submittals.

1.08 TRAINING

- A. Provide training as specified in the section titled "Demonstration, Training, and Warranty of Communications Systems.

PART 2 - PRODUCTS

2.01 VOICE AND DATA CABLE AND COMPONENT PRODUCTS

- A. Contractors must provide a system where the component and cable manufacturer have formed a partnership to create a complete channel solution. This solution shall be guaranteed by the component manufacturer.
- B. Basis of Design: Panduit/Belden/General Cable, Hubbell, Berk-Tek, CommScope.
- C. Other manufacturers will be considered by providing complete shop drawing submittal 10 days prior to bid.

2.02 VOICE AND DATA JACKS

- A. Provide a flush mounted modular data jack RJ-45 to fit in a one or two gang 3-1/2-inch-deep box and/or to fit in the surface mounted raceway or floor boxes as shown on the Drawings and as specified herein. (box to receive 1 ½ inch conduit knockout)
- B. Data jacks shall be 8-position configurations and shall meet all the transmission performance of the specified cable.
- C. The data jacks shall be UL listed and must meet TIA/EIA 568B.2-AD10 requirements.
- D. The data jacks to be wired to TIA/EIA 568B .2-AD10 color scheme.
- E. Modular data jacks shall be mounted in modular wall plates for one, two, three, four, five, and/or six modular openings.

2.03 MODULAR COVER PLATES (TWO GANG)

- A. Provide decorative modular cover plates with a number of modular data jack as shown on the drawing and (minimum one each) as specified in this section.

- B. Provide modular mounting frames for all jacks in the exposed surface raceway only.
- C. Provide floor cover plate to match receptacle cover plates (verify with site electrical contractor).
- D. Wall jacks shall be mounted on a stainless-steel plate.
- E. Cover plate shall be adjustable either in field or by factory (1/4 inch minimum).
- F. Provide blanks for wall and floor boxes.

2.04 STAINLESS STEEL COVER PLATES

- A. Provide stainless steel cover plates to fit the modular jacks as shown on the Drawings.
- B. Stainless steel cover plate shall single gang or double gang.
- C. Provide stainless steel cover plates in the following areas:
 - 1. Lobby
 - 2. Corridors
 - 3. Kitchen
 - 4. Training room.
 - 5. Bays
 - 6. Any other areas as directed by Owner or Architect/Engineer.

2.05 COVER PLATE COLOR

- A. The color of the modular communications cover plates shall be white or as selected by Architect/Engineer.

2.06 COPPER PATCH PANELS

- A. Provide 24 port angled patch panels for termination of all UTP cable with 24-RJ45 jacks.
- B. Provide 48 port angled patch panels for termination of all UTP cables with front and back cable management with 48-RJ45 jacks.
- C. Patch panels shall meet or exceed all transmission performance for augmented category 6A as outlined in the latest TIA/EIA-568
- D. Each RJ45 jack shall be terminated with 4 pairs of UTP wire and shall be wired to meet TIA/EIA 568B color scheme.
- E. Provide three (3) extra horizontal wire management for data switches in each rack/cabinet.

2.07 CATEGORY 6A PATCH CORDS

- A. Provide Category 6A patch cords with modular RJ45 at each end, UL listed and shall meet T568C2 wiring scheme.
- B. The Modular Patch Cords shall meet or exceed the channel specifications of Amendment 1 to ISO/IEC 11 801:2002 Class EA and ANSI/TIA-568-C2 Category 6A up to 500 MHZ when used as part of a UTP Channel.
- C. Technical Characteristics:
 - 1. Length: Minimum 1.5 m (5 feet).
 - 2. Cable: Category 6A.
 - 3. Connector: CAT 6A RJ-45 male on each end.
 - 4. Color Coding: Required, data industry standard.
 - 5. Size: Minimum 22 AWG for CAT 6A.
- D. Patch Cords shall be 3-foot (1m) 5-foot (1.5m), 7-foot (2.1 m), 10-foot (3 m), and 14- foot (4.3 m) long.
- E. Provide 10-foot station patch cords for each WAO plus 10% spare.
- F. In the Telecommunications rooms provide patch cords as follows:
 - 1. 50% 3 foot-long.
 - 2. 25% 5-foot-long.
 - 3. 10% 7 foot-long.
 - 4. 10%- 10 foot-long.
 - 5. And 5% 14 foot-long.

2.08 HORIZONTAL CAT 6A CABLE

- A. The cable shall be four unshielded twisted pair (UTP) solid bare copper 22-23 AWG.
- B. The insulated conductors shall be twisted in pairs and shall be insulated with FEP material, and all 4 insulated pairs shall be laid into an insulated plastic jacket.
- C. UL listed CMP with transmission characteristics that meet or exceed those of FCC-68/ TIA /EIT, 568A-5 and TIA /EIT TSB-95 performance and NEMA low loss, extended frequency, jacket shall be sequentially marked at 2-foot intervals and must be plenum rated. UL listed 1459 and 1863.
- D. Pair twisting shall be maintained to meet the cable performance, but maximum cable, untwisting allows is one half (1/2) inch.
- E. Cable shall meet ANSI/TIA-568.C2-10 transmission performance specifications for 4 pair UTP augmented category 6A cabling and ISO/IEC 11801 Class Ea.
- F. Typical work area outlets shall have 8 position, 8 contact (8P8C).

G. Design bandwidth - 500 MHZ, cable bandwidth - 500+ MHZ, standard data rate 10 Gig.

H. Minimum bending radius: 1.00 inches.

I. Maximum installation tension: 25 lb (110 N)

J. Technical Characteristics:

1. Cable diameter: 0.326 mm² (22 AWG) cable or less
2. Working no shielded: 300 Volts.
3. Working Shield: 350 V.
4. Bend Radius: 10 times cable outside diameter.
5. Impedance: 100 Ohms + 15%, BAL.
6. Bandwidth: 500 MHz for CAT 6A.
7. DC Resistance: Maximum 9.38 Ohms/100m (328 ft.) at 20 degrees C.
8. Maximum Mutual Capacitance: 5.6 nF per 100 m (328 ft.).
9. Data cable color: BLUE or as shown on the drawings.
10. CMR (riser) Cable shall have star filler and rip cord.
11. CMP (plenum) cable shall have filler and rip cord.
12. NEXT loss headroom +5dB
13. PSNEXT loss Headroom +5dB
14. ACRF headroom +6dB
15. PSACRF headroom +6dB
16. Shield Coverage:
 - a. Overall Outside (if OEM specified): 100 percent.
 - b. Individual Pairs (if OEM specified): 100 percent.

K. Cable Electrical Specifications

1. Maximum operating voltage:
2. Nominal capacitance at 1 KHz:
3. Nominal velocity of propagation:
4. Nominal capacitance unbalance:
5. Maximum capacitance unbalance:

300V RMS
15 PF/FT

72 percent plenum
PF/100M – 25.00 PF/M
PF/100M – 66.00 PF/M

L. The cable shall meet the following minimum industry standards.

Freq (MHz)	Insertion Loss (dB)	PS ANEXT (dB)	PS AACR-F (dB)	NEXT (dB)	ACR-N (dB)	PS NEXT (dB)	ACR-F (dB)	PS ACR-F (dB)	Return Loss (dB)	Delay Skew (ns)
1	2.1	82.0	79.0	75.7	73.5	75.3	69.3	68.3	20.0	40
4	4.0	76.0	67.0	66.0	62.0	65.5	57.2	56.2	20.0	40
10	6.3	72.0	59.0	59.6	53.3	59.0	49.3	48.3	20.0	40
20	8.9	69.0	53.0	54.6	45.7	54.0	43.2	42.2	18.5	40
100	20.3	62.0	39.0	42.9	22.7	42.1	29.3	28.3	13.0	40
200	29.2	57.5	33.0	37.8	8.6	36.9	23.2	22.2	10.0	40

250	32.9	56.0	31.0	36.1	3.2	35.2	21.3	20.3	9.0	40
300	36.2	54.8	29.5	34.7	-1.5	33.8	19.7	18.7	8.2	40
400	42.3	53.0	27.0	32.6	-9.8	31.6	17.2	16.2	7.0	40
500	47.8	51.5	25.0	30.9	-17.0	29.8	15.3	14.3	7.0	40

2.09 OUTDOOR COMPUTER/DATA CABLE (CATEGORY 6E)

- A. The cable shall be four unshielded twisted pair (UTP), 23 AWG, solid bare CU, insulation for all 4 pairs to reduce skew (skew shall be less than 18 nsec).
- B. UL listed CM with transmission characteristics that meet or exceed ANSI/TIA 568.2-D and ISO/IEC 11801 performance and NEMA low loss, extended frequency, jacket shall be sequentially marked at 2-foot intervals.
- C. UL listed 1459 and 1863.
- D. Pair twisting shall be maintained to meet the cable performance.
- E. Maximum cable untwisting allowed is one half (1/2) inch, cable diameter .2-inch.
- F. Design bandwidth - 100 MHZ, standard data rate 100 Mbps.
- G. Color Code = Pair #1 - White/Blue and Blue
Pair #2 - White/Orange and Orange
Pair #3 - White/Green and Green
Pair #4 - White/Brown and Brown
- H. Cable Electrical Specifications
 - 1. Mutual capacitance at 1 Khz: 4.6nF/100M Nom.
 - 2. Nominal velocity of propagation:70 percent

2.10 CAT 5 OSP PROTECTOR

- A. Provide solid sheet CAT 5 OSP protector for each 4 pair data cabling entering the building.
- B. Unit shall be UL497 listed.
 - 1. Basis of Design:
 - a. Systimax C5P4T-16.
 - b. Circa 4B1FS
 - c. Marconni R4C1S
 - d. Cylix CAT 6-PPC
 - e. Emerson R4C1S

2.11 WIRELESS ACCESS POINTS, CAMERA AND VIDEO PROJECTOR LOCATIONS

- A. Provide one 4 PR UTP to each device unless noted otherwise from the TR room.

- B. Provide a minimum of 15 foot loop at each device, coil and bag near each device.
- C. Cable Connection
 - 1. Provide two ports UL listed plenum rated surface mount box to terminate the RJ45 jack and cable.
 - 2. Provide 5-foot patch cord and/or as required.
 - 3. Patch the wireless access point, camera and video projector to the data jack in the box above the ceiling.
 - 4. Provide one 4-inch square box with cover plate as shown for CEILING mounted devices.
 - 5. Mount the biscuit in a 4 square junction box with cover plate and mounting hardware to attach to the ceiling grid, box to be mounted with face up.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide communications copper horizontal cabling, connectors, jacks, cover plate, blank inserts, patch panels, cords, etc., as specified here and as shown on the drawings.
- B. Cabling at patch panels shall be terminated in numerical order, so as to provide a logical pattern that will provide the end user the greatest ease in the system administration.
- C. See labeling details for more information.

3.02 UNSHIELDED TWISTED PAIR CABLE (UTP)

- A. Provide a minimum of two 4-PR UTP for every work area outlet, terminate on 8P8C jack in the WAO box, and on angled patch panels in the telecommunication room.
- B. Provide the following additional UTP runs:
 - 1. Provide one (1) 4-pair UTP to the telephone headend equipment and also to the telephone back-up power supply in same room.
 - 2. Provide two (2) 4-pair UTP to each file server from MC/ER.
 - 3. Provide 20 additional 4-pair UTP cables, jacks, labeling, testing, etc (180 feet each) to the nearest telecommunications rooms. (Install as directed by the Architect/Engineer.)
- C. The maximum pulling force shall be as recommended by the manufacturers and the maximum bending radius shall be (10) times the cable diameter.
- D. Outdoor computer/data cable shall be used in all floor box locations where concrete is slab on grade.
- E. Terminate the data jacks per the manufacturer's recommendations and ensure the termination bar is positioned as close as possible to the cable jacket edge.

3.03 CABLE PULLING

- A. Cable rollers shall be used when pulling cable. Cable pulleys must be used when pulling cable around bends and corners of wireways. Pulleys shall have a minimum diameter of 6 inches.
- B. The contractor shall use basket grips wherever possible and exercise care while pulling cable as not to exceed the maximum allowable pulling tension of the cable.
- C. Cable rollers used for pulling cable in cable tray shall be mounted close to wireway supports and shall be placed at the beginning of the run and spaced every 25 feet along the run.
- D. Provide 18-inches service loop at each WAO location.
- E. Provide 15-foot service loop in each Telecom room and MC/ER.
- F. Support service loop above ceiling from the building structure by cable tray properly.

3.04 LABELING AND MARKING

- A. See Drawings for Technology Schedules for more information.
- B. The contractor shall install labels as follows:
 - 1. One label at each end of each cable at the end of the cable sheath, after stripping.
 - 2. One label on the outside of each face plate in the space provided.
 - 3. Label as shown on drawings.
 - 4. All markings shall be carefully done so as to present a neat, professional appearance.
 - 5. Cross connect color coded shall be as follows:
 - a. Green - circuits from the central office/RBOC/Telco
 - b. Purple - circuits from the switch ports
 - c. Yellow - circuits from the auxiliary cabinet
 - d. Blue - wiring from the workstation information outlets
 - e. White - house pairs from riser cable between the equipment room and satellite closets.
 - f. Orange - wiring originating from electronic equipment.
 - g. Grey - Tie cables between satellite closets.

3.05 CABLE SEPARATION FROM POWER WIRING

- A. Between the cabling system and any fluorescent, neon, incandescent, or high intensity discharge lamp fixtures, the minimum distance shall be 5 inches.
- B. Cable may be installed closer to lighting and convenience outlet power cable (single phase, 120V, 20A maximum), in metal cable channels for limited distances if the following guidelines are observed:
 - 1. Coincident (parallel) runs of no more than 15 feet are permissible if a 1-inch separation between the power cable and the cabling system cable is maintained by separators or suitable retention hardware. If necessary, the separation may be less than 1 inch for a

run of up to 6 inches if no contact between the cabling system cable and the power cable occur.

2. Coincident runs of no more than 30 feet are permissible if a 2-inch separation is maintained. The separation may be less than 2 inches for a run of up to 12 inches if no contact occurs between the cable and the power cable.

3.06 WIRING COLOR SCHEME

Wire Pair	Color	8-Position T568B
1 Tip	White - Blue	5
1 Ring	Blue	4
2 Tip	White - Orange	1
2 Ring	Orange	2
3 Tip	White - Green	3
3 Ring	Green	6
4 Tip	White - Brown	7
4 Ring	Brown	8

3.07 TESTING

- A. The Cabling Contractor shall be responsible for testing each horizontal cable run, patch panel, and patch cables to verify the performance of the channel warranty for the horizontal cabling system as defined in TIA/EIA TSB-67.
- B. The contractor shall configure the tester for the cable and connectors used in the installation.
- C. The contractor shall calibrate the tested to the newest software.
- D. The contractor shall use the same tester(s) from the same manufacturer for the entire project(s).
- E. All test reports shall look the same and all test reports shall be done with the same manufacturer to assure all test results have the same appearance.
- F. The contractor shall turn in all tests, partial or quick tests shall NOT be accepted, all test results shall be in a PDF format when submitted with the close out documents.
- G. System and Wiring Testing, Checking, and Reports:
 1. Cabling Contractor shall provide necessary technical personnel and testing instruments as required to perform complete testing of all systems installed by Contractor and coordinate this testing activity with the Architect/Engineer and Owner's representative.

2. All wiring, terminations, equipment, etc. shall be checked and tested by qualified field representative or equipment vendor. A report shall be submitted to Architect/Engineer and Commissioning Agent by vendor representative and/or Contractor indicating results of such final check-out and testing processes. Final payment will not be approved until such report is submitted and any "failure" results are corrected.
 3. Cabling Contractor shall conduct such other tests and make necessary adjustments of equipment and installation infrastructure required by Architect/Engineer and/or Commissioning Agent, as requested or necessary to verify performance requirements. Submit all data gathering information taken during such tests to Architect/Engineer and Commissioning Agent.
 4. Cabling Contractor must input the specified cable parameters, manufacturers' name and number in the tester. (Test results will not be accepted with generic cable type.)
 5. Reporting to be done in compliance with standards and schedules published by authority and agencies defined in the Specifications. Provide third party contractor (with RCDD) to test cables, as approved by the Owner and Architect/Engineer. (See above for more information.) This third party shall test 10 percent of the installed Communications Cabling in each TR/MC/ER or as selected by the Owner. All costs for this testing shall be included in the Communications Cabling Contractors' bid price. The Owner or Architect/Engineer shall coordinate third party testing directly with the testing contractor. The Architect/Engineer shall review all test results. Should discrepancies be found between the contractor results and the third-party test results, the Owner or Architect/Engineer will request the third party to test an additional 10 percent of the Communications Cabling. This process shall be followed until the Owner or Architect/Engineer is convinced that all the cables were installed and terminated as specified. All costs for the testing shall be borne by the Communications Cabling Contractor.
- H. The third-party contractor SHALL NOT USE the building cabling contractors tester.
- I. Cable test results shall be stored and presented to the architect/engineers in both hard copy and electronic format for approval, and cable tester records designations shall match the associated cable labels and associated patch panel label designations.
- J. Submit one complete cable test results in electronic format and 1 complete set of paper format in a 3-ring binder. (Both the Contractors' original test results and the third-party test results must be submitted at the same time).
- K. CD-Rom test results must NOT require special software download to read/open.
- L. Provide testing with the following typical parameters:

Scanner Certification Report

Circuit ID:				Scanner:				Remote:			
Project:											
Owner:								SW:			
Autotest											
Type:											
Cable Type:				Adapter				Adapter			
NVP:											
Site											
Building:											
Floor:											
Closet:											
Limit				12				36			
Length								45			
Delay (ns):								78			
Resistance											
(Ohms):											
Wiremap				Expected				Actual			
Scanner:								Skew(ns):			
Remote:								Bandwidth(MHZ)			
Attenuation				Overall Margin (dB)				NEXT			
Scanner								Overall Margin (dB)			
Pairs				dB				Remote			
Margin				MHZ				Db			
12								Margin			
36								MHZ			
45											
78											
RETURN LOSS				Overall Margin (dB)				ACR			
Scanner								Overall Margin			
Pairs				dB				Remote			
Margin				MHZ				dB			
12/36								Margin			
12/45								MHZ			
12/78											
36/45											
36/78											
45/78											

ELFEXT				Overall Margin (dB)				PSNEXT				Overall Margin (dB)			
Scanner				Remote				Scanner				Remote			
Pairs	dB	Mar- gin	MHZ		dB	Mar- gin	MHZ	Pair s	dB	Mar- gin	MHZ		dB	Mar- gin	MH z
12/3 6								12							
12/4 5								36							
12/7								45							

8															
								78							
36/1 2															
36/4 5								PSELFEXT			Overall Margin (dB)				
36/7 8								Scanner					Remote		
								Pairs	dB	Mar- gin	Pairs	dB	Mar- gin	Pairs	dB
45/1 2								12			12			12	
45/3 6								36			36			36	
45/7 8								45			45			45	
								78			78			78	
78/1 2															
78/3 6								PSACR			Overall Margin				
78/4 5								Scanner					Remote		
								Pairs	dB	Mar- gin	Pairs	dB	Mar- gin	Pairs	dB
								12			12			12	
								36			36			36	
								45			45			45	
								78			78			78	

3.08 TELECOMMUNICATION ROOMS

- A. See section – "Communications Equipment Room Fittings" for more information.
- B. The data cable, the telephone cable, and the video control cable shall be terminated on RJ45 copper patch panels with modular insert jacks.

3.09 COLOR CHART FOR CABLE AND RACEWAY- 270500 and 270533"

3.10

END OF SECTION 271510

SECTION 27 17 00 -TESTING, IDENTIFICATION AND ADMINISTRATION OF BALANCED TWIST PAIR INFRASTRUCTURE

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

1.02 SCOPE

- A. This Section includes the minimum requirements for the test certification, identification, and administration of horizontal balanced twisted pair cabling.
- B. This Section includes minimum requirements for:
 - 1. Copper cabling test instruments
 - 2. Copper cabling testing
 - 3. Identification
 - a) Labels and labeling
 - 4. Administration
 - a) Test results documentation
 - b) As-built drawings
- C. Testing shall be carried out in accordance with this document.
- D. Testing shall be performed on each cabling link. (100% testing)
- E. All tests shall be documented.

1.03 QUALITY ASSURANCE

- A. All testing procedures and field-test instruments shall comply with the latest applicable requirements of:
 - 1. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - 2. ANSI/TIA-568-0. D, Generic Telecommunications Cabling for Customer Premises.
 - 3. ANSI/TIA-568-1. D, Commercial Building Telecommunications Cabling Standard
 - 4. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.

5. ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.
- B. Trained technicians who have successfully attended an appropriate training program 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 connectors or cable.
 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)
- C. 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 business days before testing commences.
 2. The Owner or the Owner's representative will select a random sample of five percent of the installed links. The contractor/testing agency 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 two percent of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the owner's representative shall repeat one hundred percent testing at no cost to the Owner.

1.04 SUBMITTALS

- A. Manufacturers catalog sheets and specifications for the test equipment.
- B. A schedule (list) of all balanced twisted-pair copper links to be tested.
- C. Sample test reports.

1.05 ACCEPTANCE OF TEST RESULTS

- A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in tested for:
 1. Wire Map
 2. Length
 3. Propagation Delay
 4. Delay Skew
 5. DC Loop Resistance
 6. DC Resistance Unbalance within a pair
 7. DC Resistance Unbalance between pairs
 8. Insertion Loss
 9. NEXT (Near-End Crosstalk)
 10. PS NEXT (Power Sum Near-End Crosstalk)

11. ACR-N (Attenuation to Crosstalk Ratio Near-End)
 12. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 13. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 14. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 15. Return Loss
 16. TCL (Transverse Conversion Loss)
 17. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 18. PS ANEXT (Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
 19. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
 20. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2
 21. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2
- B. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any Permanent Link 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 Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links 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.

PART 2 - PRODUCTS

2.01 BALANCED TWISTED-PAIR CABLE TESTERS

- A. The field-test instrument shall be within a 6-month calibration period.
- B. Certification tester
1. Accuracy
 - a) Level III accuracy in accordance with ANSI/TIA-1152
 - b) Independent verification of accuracy shall be provided.
 - c) Acceptable manufacturer
 - 1) Fluke Networks
 2. Permanent Link Adapters
 - a) RJ45 plug shall meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
 - b) Twisted pair Category 5e, 6, 6A, 7 or 7_A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
 3. Results Storage

- a) Must be capable of storing > 10,000 results for all measurements.
- 4. Measurement capabilities
 - a) Wire Map
 - b) Length
 - c) Propagation Delay
 - d) Delay Skew
 - e) DC Loop Resistance
 - f) DC Resistance Unbalance within a pair
 - g) DC Resistance Unbalance between pairs
 - h) Insertion Loss
 - i) NEXT (Near-End Crosstalk)
 - j) PS NEXT (Power Sum Near-End Crosstalk)
 - k) ACR-N (Attenuation to Crosstalk Ratio Near-End)
 - l) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 - m) ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - n) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - o) Return Loss
 - p) TCL (Transverse Conversion Loss)
 - q) ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - r) Time Domain Reflectometer
 - s) Time Domain Xtalk Analyzer
 - t) PS ANEXT (Power Sum Alien Near-End Crosstalk)
 - u) Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
 - v) PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
 - w) Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

C. PC Software

- 1. LinkWare PC

2.02 **IDENTIFICATION**

A. Labels

- 1. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- 2. Shall be preprinted using a mechanical means of printing (e.g., laser printer).
Handwritten labels are NOT acceptable.
- 3. Where used for cable marking, provide vinyl substrate with a white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable. If cable

- jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.
4. Where insert type labels are used provide clear plastic cover over label.
 5. Provide plastic warning tape 6 inches wide continuously printed and bright colored 18" above all direct buried services, underground conduits and duct-banks.
 6. Acceptable Manufacturers:
 - a) Brothers
 - b) Silver Fox
 - c) Brady Corporation

2.03 ADMINISTRATION

- A. Administration of the documentation shall include test results of each Permanent Link.
- B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. The test result records saved within the field-test instrument shall be transferred to LinkWare PC via LinkWare Live.
- D. Alien Crosstalk measurements shall be stored to a PC upon completion of the test.

PART 3 – EXECUTION

3.01 GENERAL

- A. All work area outlets (WAO), cables, patch panels, patch cords 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.

3.02 BALANCED TWISTED PAIR CABLE TESTING

- A. Field-test instruments shall have the latest firmware installed.
- B. Permanent Link test results, including the individual frequency measurements from the tester, shall be recorded in the test instrument upon completion of each test for subsequent uploading to LinkWare PC via LinkWare Live in which the administrative documentation (reports) may be generated.
- C. Permanent Link testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- D. Alien Crosstalk testing shall be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations of up to 500,000 links shall be used. The following table represents this sampling level.

Total number of links (N)	Sample size (No. of links to test)
3 – 33	3 or 0.1 x N (whichever is greatest)

34 – 3,200	33
3,201 – 35,000	126
35,001 – 150,000	201
150,001 – 500,000	315

- E. Disturbed (Victim) links chosen for Alien Crosstalk testing shall be an equal combination of short, medium and long links.
- F. Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 or 7_A cords are NOT permitted as their performance degrades with use and can cause false Return Loss failures.
- G. The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 6A Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.
- H. Wire Map Measurement
- The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors.
 - For each of the eight conductors in the cabling, the wire map indicates:
 - Continuity to the remote end.
 - Shorts between any two or more conductors.
 - Reversed pairs.
 - Split pairs.
 - Transposed pairs.
 - Distance to open on shield.
 - Any other miss-wiring.
 - The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568-C.2. Two color schemes are permitted. The user shall define which scheme is to be used. The field tester shall document which color scheme was used. Examples are given below:



I. Length Measurement

- The length of each balanced twisted pair shall be recorded.

2. Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.
3. The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a failure is reported.

J. Propagation Delay measurement

1. Is the time it takes for a signal to reach the end of the link.
2. The measurement shall be made at 10 MHz per ANSI/TIA-1152.
3. The propagation delay of each balanced twisted pair shall be recorded.
4. Is not to exceed 498 ns per ANSI/TIA-568-C.2 Section 6.3.18.

K. Delay Skew Measurement

1. Is the difference in propagation delay @ 10 MHz between the shortest delay and the delays of the other wire pairs.
2. The delay skew of each balanced twisted pair shall be recorded.
3. Is not to exceed 44 ns per ANSI/TIA-568-C.2 Section 6.3.19.

L. DC Loop Resistance

1. Often reported as Resistance, is the DC loop resistance of both conductors in the pair.
2. The DC Resistance shall be reported for all four pairs.
3. Is not to exceed 21 Ω for all four pairs per ANSI/TIA-568-C.2 Section 6.3.1.

M. DC Resistance Unbalance within a pair

1. Is the difference in DC resistance of the two wires within the same pair.
2. The DC Resistance Unbalance within a pair shall be reported for all four pairs.
3. Is not to exceed 200 m Ω or 3%, whichever is the greatest per ANSI/TIA-568-C.2 Section 6.2.2.

N. DC Resistance Unbalance between pairs

1. Is the difference in DC parallel resistance of the conductors of a pair compared to the DC parallel resistance of another pair, given in the formula below:

$$Resistance\_Unbalance_{Between\_pairs} = \left(\frac{|R_{P1} - R_{P2}|}{R_{P1} + R_{P2}} \right) 100\%$$

Where:

R_{P1} is the DC parallel resistance of the conductors of a pair.

R_{P2} is the DC parallel resistance of the conductors of another pair.

2. The DC Resistance Unbalance shall be reported for the following pairs
 - a) 1,2-3,6
 - b) 1,2-4,5

- c) 1,2-7,8
 - d) 3,6-4,5
 - e) 3,6-7,8
 - f) 4,5-7,8
3. Is not to exceed 200 mΩ or 7.5%, whichever is the greatest.

O. Insertion Loss

- 1. Is the loss of signal strength over the cabling (in dB).
- 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
- 3. Both worst case and worst margins shall be reported in one direction for all four pairs.
- 4. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- 5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.7.

P. NEXT (Near-End Crosstalk)

- 1. Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
- 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
- 3. Both worst case and worst margins shall be reported in both directions for the following pair combinations
 - a) 1,2-3,6
 - b) 1,2-4,5
 - c) 1,2-7,8
 - d) 3,6-4,5
 - e) 3,6-7,8
 - f) 4,5-7,8
- 4. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.8.

5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
6. The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.

Q. PS NEXT (Power Sum Near-End Crosstalk)

1. Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.9.
5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
6. The Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.

R. ACR-N (Attenuation Crosstalk Ratio Near-End)

1. Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for the following pairs
 - a) 1,2-3,6
 - b) 1,2-4,5
 - c) 1,2-7,8
 - d) 3,6-4,5
 - e) 3,6-7,8
 - f) 4,5-7,8
4. Although not specified in ANSI/TIA-568-C.2, it shall be recorded for all twelve possible combinations.

S. PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End)

1. Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.

2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Although not specified in ANSI/TIA-568-C.2, it shall be recorded for all eight possible combinations.

T. ACR-F (Attenuation Crosstalk Ratio Far-End)

1. Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for the following pairs
 - a) 1,2-3,6
 - b) 1,2-4,5
 - c) 1,2-7,8
 - d) 3,6-1,2
 - e) 3,6-4,5
 - f) 3,6-7,8
 - g) 4,5-1,2
 - h) 4,5-3,6
 - i) 4,5-7,8
 - j) 7,8-1,2
 - k) 7,8-3,6
 - l) 7,8-4,5
4. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.11.
5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).

U. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)

1. Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.

2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.13.
5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).

V. Return Loss

1. Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.6.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
7. The Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.

W. TCL (Transverse Conversion Loss)

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 6A limits found ANSI/TIA-568-C.2 Section 6.2.14.

X. ELTCTL (Equal Level Transverse Conversion Transfer Loss)

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 6A limits found in ANSI/TIA-568-C.2 section 6.2.16.

Y. PS ANEXT (Power Sum Alien Near-End Crosstalk)

1. Takes into account the combined alien crosstalk (statistical) on a receive pair from all external near-end disturbers operating simultaneously.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.
4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.21.

Z. Average PS ANEXT (Power Sum Alien Near-End Crosstalk)

1. Is calculated by averaging the individual PSANEXT loss values, in dB, for all four pairs in the disturbed (victim) link.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz

3. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.22.

AA.PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

1. AFEXT loss is the coupling of crosstalk at the far-end from external link pairs into a disturbed (victim) pair of the 4-pair link under test. PS AACR-F is the calculated power sum from all external pairs into the disturbed (victim) pair.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.
4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.25.

BB.Average PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

1. Is calculated by averaging the individual PS AACR-F values, in dB, for all four pairs in the disturbed (victim) link.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.
4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.26.

3.03 ADMINISTRATION

A. Test results documentation

1. The Permanent Link test results (excluding alien xtalk testing) shall be uploaded to LinkWare Live at the end of each working day for inspection by the Owner or the Owner's representative.
2. Test results uploaded to LinkWare Live shall be transferred into LinkWare PC to allow for the maintenance, inspection and archiving of the test records.
3. The database for the complete project, including fiber links, if applicable, shall be stored in LinkWare PC format (*.flw) and delivered on CD or DVD prior to Owner acceptance of the building. This CD or DVD shall include a copy of LinkWare PC to allow the inspection and printing of the test reports.
4. Circuit IDs reported by the test instrument should match the specified label ID (see of this Section).
5. For Permanent Link testing, the detailed test results documentation data is to be provided in LinkWare PC for each tested balance twisted-pair and shall contain the following information
 - a) The overall Pass/Fail evaluation of the link-under-test.
 - b) The date and time the test results were saved in the memory of the tester.
 - c) The identification of the customer site as specified by the end-user.
 - d) The name of the test limit selected to execute the stored test results.
 - e) The name of the personnel performing the test.
 - f) The version of the test firmware and the version of the test limit database held within the test instrument.
 - g) The manufacturer, model and serial number of the field-test instrument.
 - h) The adapters used.
 - i) The factory calibration date.
 - j) Wire Map.
 - k) Propagation Delay values, for all four pairs.
 - l) Delay Skew values, for all four pairs.
 - m) DC Resistance values, for all four pairs.
 - n) DC Resistance Unbalance within a pair, values for all four pairs.
 - o) DC Resistance Unbalance between pairs, values for all four pairs.
 - p) Insertion Loss, worst case values for all four pairs.
 - q) NEXT, worst-case margin and worst-case values, both directions.
 - r) PS NEXT, worst-case margin and worst-case values, both directions.
 - s) ACR-N, worst-case margin and worst-case values, both directions.
 - t) PS ACR-N, worst-case margin, and worst-case values, both directions.
 - u) ACR-F, worst-case margin, and worst-case values, both directions.
 - v) PS ACR-F, worst- case margin and worst-case values, both directions.

- w) Return Loss, worst-case margin, and worst-case values, both directions.
 - x) TCL, worst-case margin, and worst-case values, both directions.
 - y) ELTCTL, worst-case margin and worst-case values, both directions.
 - z) Time Domain Crosstalk data if the link is marginal or fails.
 - aa) Time Domain Reflectometer data if the link is marginal or fails.
6. For Alien Crosstalk testing, the detailed test results documentation data is to be provided in AxTalk Analyzer for each tested balance twisted pair and shall contain the following information
- a) The overall Pass/Fail evaluation of the link-under-test.
 - b) The date and time the measurements were made.
 - c) The identification of the customer site as specified by the end-user.
 - d) The name of the test limit selected to execute the stored test results.
 - e) The name of the personnel performing the test-
 - f) The version of the test software.
 - g) PS ANEXT, worst case margin for all four pairs.
 - h) Average PS ANEXT, worst case margin.
 - i) PS AACR-F, worst case margin for all four pairs.
 - j) Average PS AACR-F, worst case margin.
- B. Record copy and as-built drawings
1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on a CD or DVD. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:
- a) Field directed changes to pull schedule.
 - b) Horizontal cable routing changes.
 - c) Associated detail drawings.

END OF SECTION

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SECTION 27 41 33 MASTER ANTENNA TELEVISION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 00 COMMON WORK FOR COMMUNICATIONS INSTALLATIONS.

1.02 SUMMARY

- A. Section includes, but is not limited to the following:
 - 1. Work Area Television outlets.
 - 2. F- connectors.
 - 3. RJ45 jacks
 - 4. Coax Horizontal cabling RG6.
 - 5. Coax Horizontal cabling RG11.
 - 6. LMR-400 Coax cabling.
 - 7. Cabling.
 - 8. Boxes.
 - 9. Cover plates.
 - 10. Labeling
 - 11. Termination of all cabling
 - 12. Testing of all cabling
 - 13. All related material as described herein.
 - 14. Layout drawings, elevations, and complete shop drawings.
- B. This section includes the minimum requirements for MATV system and all associated materials.
- C. At each TV location, provide one run of coax and one run of 4PR UTP horizontal cabling to the MATV cabinet in the IT room.
- D. Related section includes the following:
 - 1. Division 01 – All Sections
 - 2. Division 26 - Electrical
 - 3. Division 27 – Communications Sections

1.03 DESCRIPTION OF WORK

- A. The system shall consist of cable television service or direct broadcast satellite service and a coaxial cable distribution system.
 - 1. Distribution of cable television service signals, which includes coordinating with Owner's selected service provider for installation of cable to the service point ready for connection into the distribution system. Obtain signal levels and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
 - 2. Cable distribution system consisting of coaxial cables, signal taps and splitters, RF amplifiers, and required hardware, complying with EIA/ECA 310-E and CTA-2032-B and resulting in performance parameters specified in this Section. The system shall be capable of distributing television channels according to CTA-542-D.

- B. Hardware Requirements: Use plug-in, modular, solid-state electronic components. Mount amplifiers and other powered equipment in standard 19-inch (483-mm) cabinet complying with EIA/ECA 310-E.

1.04 QUALITY ASSURANCE

- A. Communications cabling system components and equipment shall be listed by Underwriters Laboratories, Inc. for Computer use, and the components shall bear the UL label.
- B. The system shall be installed in accordance with requirements set by NFPA-70 National Electric Code.
- C. All equipment shall comply with the latest ANSI-J-STD-607D grounding and bonding standards.
- D. All equipment and installation practices shall comply with latest BICSI (TDM) standards.
- E. All equipment shall comply with the latest ANSI/TIA/EIA-568, 569, 60, 607, and 862 standards, as applicable.
- F. Cables shall be installed in accordance with ANSI/EIA/TIA and BICSI standards.
- G. Provide labeling per ANSI/EIA/TIA-606 requirement and in accordance with the Owner and the Technology Consultant.
- H. All cabling shall be tested in accordance with the ANSI/TIA/EIA-568-C.2 standards with the required testing equipment.

1.05 SUBMITTALS / RECORD DRAWINGS / MAINTENANCE MANUALS

- A. Shop Drawings
 - 1. Provide complete and comprehensive shop drawings with labeling to the Architect/Engineer for approval.
 - 2. Drawings shall be provided in AutoCAD Release 2002 format or higher.
- B. See front end submittals section for more information.
- C. See Common Work Results for Communications section 270500 for more submittal requirements.
- D. Provide record drawings and maintenance manual, per section – "Operation and Maintenance of Communications Systems".
- E. The contractor shall include the following with their submittal:
 - 1. Manufacturer's Certificate stating each testing device used on the project and shall contain the most current revision of software.
 - 2. Manufacturer's Certificate stating that each testing device used on the project has been calibrated within the last 12 months.

1.06 WARRANTY

- A. Components, parts, and assemblies supplied by the Communications Contractor/manufacturer shall be guaranteed against defects in materials and workmanship for a period as specified in

section – Demonstration, Training, and Warranty of Communications Systems, commencing upon system start-up. Warranty services shall be provided by an installer certified by the equipment manufacturer during normal working hours. The manufacturer's statement of warranty shall be included in the submittals.

1.07 TRAINING

- A. Provide training as specified in the section titled "Demonstration, Training, and Warranty of Communications Systems.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. The system shall consist of cable television service or direct broadcast satellite service and a coaxial cable distribution system.
 - 1. Distribution of cable television service signals, which includes coordinating with Owner's selected service provider for installation of cable to the service point ready for connection into the distribution system. Obtain signal levels and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
 - 2. The Cable distribution system consisting of coaxial cables, user interfaces, signal taps and splitters, RF amplifiers, signal equalizers, power supplies, fiber equipment and required hardware, complying with EIA/ECA 310-E and CTA-2032-B and resulting in performance parameters specified in this Section. The system shall be capable of distributing television channels according to CTA-542-D.
- B. Hardware Requirements: Use plug-in, modular, solid-state electronic components. Mount amplifiers and other powered equipment in standard 19-inch (483-mm) cabinet complying with EIA/ECA 310-E.
- C. Off-Air Stations: Install antennas for the reception and distribution of selected stations.
- D. The MATV shall be connected to the Westville correctional facilities VIA PATH Offenders services, contractor shall coordinate.

2.02 PERFORMANCE REQUIREMENTS

- A. The minimum acceptable performance of distribution system at all user-interface points shall be as follows:
 - 1. RF Video-Carrier Level: Between 3 and 12 db mV.
 - 2. Relative Video-Carrier Level: Within 3 db to adjacent channel.
 - 3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 db during a 60-minute period.
 - 4. Carrier Level Stability, Long Term: Level shall not change more than 2 db during a 24-hour period.
 - 5. Channel Frequency Response: Across any 6-MHz channel in the 54- to 220-MHz frequency range, referenced to video; signal amplitude shall be plus or minus 1 db, maximum.
 - 6. Carrier-to-Noise Ratio: 45 db or more.
 - 7. RF Visual Signal-to-Noise Ratio: 43 db or more.
 - 8. Antenna Combiner Insertion Loss: 40 db maximum.
 - 9. Signal Power Splitter and Isolation Tap Return Loss: 17 db maximum.

10. Cable Connectors Attenuation: Less than 0.1 db.

2.03 SYSTEMS REQUIREMENTS

- A. Components: Plug-in, modular, heavy-duty, industrial- or commercial-grade units.
- B. Equipment: Silicon-based, solid-state, integrated circuit devices.
- C. Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages within the range of 105 to 130 V.
- D. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for that purpose. Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
- E. Provide ac-powered equipment with integral surge protection devices complying with UL 1449.
- F. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.04 MATV EQUIPMENT

- A. Description: Signal-source components, signal-processing and amplifying equipment, distribution components, and interconnecting wiring, fiber optic cables, fiber optic equipment's. System shall receive, amplify, process, and distribute signals to outlets for receiving sets. Equipment shall translate UHF channels to VHF channels before distribution to outlets.
- B. MATV System Qualitative and Quantitative Performance Requirements: Reception quality of color-television program transmissions at each system outlet from each service and source shall be equal to or superior than that obtained with performance checks specified in "Field Quality Control" Article, using standard, commercial, cable-ready, multiple A/V input color-television receivers.

2.05 DISTRIBUTION COMPONENTS

- A. Signal Power Splitters and Isolation Taps: Metal-enclosed directional couplers with brass connector parts. Where installed in signal circuits used to supply cable-powered amplifiers, power throughput capacity shall exceed load by at least 25 percent.
 - 1. Return Loss: 17 db.
 - 2. RFI Shielding: 100 db.
 - 3. Isolation: 25 db.
 - 4. I/O Impedance: 75 ohms.
- B. Distribution System Amplifiers: Powered by coaxial cable system and equipped with surge protection device and external test points to allow convenient signal monitoring.
- C. Cable System Power Supplies: Plug-in, modular construction, with surge, short-circuit, and overload protection.

- D. Signal Traps: Packaged filters tuned to interference frequencies encountered in Project.
- E. Attenuators: Passive, of fixed value, and used to balance signal levels.
- F. Terminating Resistors: Enclosed units rated 0.5 W and matched for coaxial impedance.
- G. Jack: Flush, female-type outlets, designed to mimic power duplex outlet; for mounting in standard outlet box; with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semi recessed, so its protrusion is flush with the plane of device plate. Feed-through-type cable connection shall not be used. Cell TV connectors shall be coordinated with the Steel Cell manufacturer.
 - 1. Cable Connector: Female, Type F.
 - 2. Wall Plates: Match materials and finish of power outlets in same space.
 - 3. Attenuation: Less than 0.1 db.
 - 4. Voltage Standing-Wave Ratio: Less than 1.15 to 1.
- H. Two Way indoor optical node: Wall mounted inside the MATV cabinet, unit to convert the optical signal received from the headend into +44 dBmV RF output. The unit includes an optical receiver, RF AGC, RF amplifier and return path optical transmitter. Three frequency splits are available, 5-42 MHz, 5-85 MHz and /or 5-204 MHz returns. Unit shall have tri-color LED indicating the optical input status, control keys, adjustable attenuator, one bi-color LED indicating return transmitter status as well as calibrated DC test points for receive and transmit optical power.

2.06 ENCLOSURES

- A. Provide cabinets to match cabinets as specified in Communications Room Fitting specifications.
- B. Enclosures for Interior, Controlled Environments: NEMA 250, Type 1.
- C. Enclosures for Interior, Uncontrolled Environments: NEMA 250, OR Type 3R.
- D. Enclosures for Exterior Environments: NEMA 250, OR Type 3.

2.07 COVER PLATE

- A. Cover plate shall house the COAX connector and the RJ45 connector.

2.08 COPPER/COAX PATCH PANELS

- A. Provide 24 port angled patch panels for termination of all UTP cable with 24-RJ45 jacks and to terminate the Coax cable on F or BNC connectors.
- B. Patch panels shall meet or exceed all transmission performance for augmented category 6A as outlined in the latest TIA/EIA-568
- C. Each RJ45 jacks shall be terminated with 4 pair of UTP wire and shall be wired to meet TIA/EIA 568B color scheme.

2.09 HORIZONTAL CAT 6A CABLE

- A. See Communications Structured Cabling for more information.

2.10 INDOOR RF HORIZONTAL CABLING (RG6U)

- A. Provide RG6/U coax cable. Cable shall be run from each video outlet to their respective MATV cabinet as shown on the Drawings. (Below 250 feet)

- B. The RG6 cable shall have the following:

1. Conductor size: 18 AWG
2. Conductor type: Solid Base Copper
3. Dielectric type: Foam FEP, .170 inch
4. Shield type: AL foil and 60 percent AL braid 9.0μ per kft.
5. Jacket type: PVDF, .015/.016 inch
6. Cable dimension: .233 inch
7. Nominal capacitance: 16.0 PF/ft.
8. Nominal velocity of propagation: 83 percent
9. Nominal impedance: 75μ
10. Operating temperature: 60°C
11. Nominal attenuation:

1 MHZ	.25 dB/100 ft
10 MHZ	.85 dB/100 ft
100 MHZ	2.10 dB/100 ft
200 MHZ	3.10 dB/100 ft
400 MHZ	4.5 dB/100 ft
700 MHZ	6.0 dB/100 ft
900 MHZ	6.9 dB/100 ft
1,000 MHZ	7.3 dB/100 ft
2,000 MHZ	12.6 dB/100 ft
3,000 MHZ	15.4 db/100 ft

- C. The RG6 cable shall have the following:

1. Conductor size: 18 AWG
2. Conductor type: Solid Base Copper
3. Dielectric type: Foam FEP, .170 inch
4. Shield type: AL foil and 60 percent AL braid 9.0μ per kft.
5. Jacket type: PVDF, .015/.016 inch
6. Cable dimension: .233 inch
7. Nominal capacitance: 16.0 PF/ft.
8. Nominal velocity of propagation: 83 percent
9. Nominal impedance: 75μ
10. Operating temperature: 60°C
11. Nominal attenuation:

1 MHZ	.25 dB/100 ft
10 MHZ	.85 dB/100 ft
100 MHZ	2.10 dB/100 ft
200 MHZ	3.10 dB/100 ft
400 MHZ	4.5 dB/100 ft
700 MHZ	6.0 dB/100 ft
900 MHZ	6.9 dB/100 ft
1,000 MHZ	7.3 dB/100 ft
2,000 MHZ	12.6 dB/100 ft
3,000 MHZ	15.4 db/100 ft

- D. Each reel of RG6/U coaxial cable used in the system shall be sweep tested. Transmission sweep tests shall establish conformance to guaranteed loss values from 5-1000MHz.
- E. Coaxial cables shall be run in continuous lengths. No splices shall be permitted.
- F. Cable shall be installed to avoid sharp bends or physical distortion.
- G. The coaxial cable shall be terminated and tested with approved connectors as recommended by the cabling manufacturer.
- H. All coax cable shall be plenum rated.
- I. Approved Manufacturer:
 - 1. Belden 633938 – RG6 coax.

2.11 50 Ohm low loss flexible LMR-400 coaxial cable

- A. Provide LMR-400 coaxial cable from the roof antenna to the IT room.
- B. The LMR-400 coax cable shall have the following characteristics:
 - 1. Overall Diameter: .405 inches.
 - 2. Characteristic Impedance: 50 Ohm.
 - 3. Maximum Voltage: 2500V.
 - 4. Cable Capacitance(pF/ft): 23.9
 - 5. Inductance (uH/ft: .060.
 - 6. Attenuation (dB/100ft, 900 MHz): 3.9
 - 7. Insulation: Foam Polyethylene
 - 8. Minimum Bend Radius: 1.00
 - 9. Conductor type: Solid copper-clad conductor.
 - 10. Operating Temperature: -40 to 85 deg C.
 - 11. Color: Black Jacket.
 - 12. Velocity of Propagation: 85%.
 - 13. Attenuation at 1 Ghz: 4.25 dB.
 - 14. Frequency, Max: 8 GHz.
 - 15. Flex Type: Flexible.
 - 16. No. Of Shields: 2
- C. Coaxial cables shall be run in continuous lengths. Splices will not be allowed.
- D. Cable shall be installed to avoid sharp bends or physical distortion.
- E. The coaxial cable shall be terminated and tested with approved connectors as recommended by the cable manufacturer.
- F. Approved Manufacturer:
 - 1. Fairview Microwave LMR-400 coax cable.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for antenna to verify actual locations of cable connections before antenna installation.

- B. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where television equipment is to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install signal line surge suppressors on coaxial cables entering headend equipment space and at antenna-mounted amplifiers. Comply with requirements of "Surge Protection for Low-Voltage Electrical Power Circuits."
- B. Install conduct and weather head as shown, coordinate with vendor.
- C. Run RG6 from each TV outlet to the MATV cabinet for 0-250 feet.
- D. Run 4PR UTP for each TV outlet to the MATV cabinets for 0-295 feet.

3.03 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Cap all unused connectors and seal weathertight.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain MATV equipment.
 - 1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
 - 2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
 - 3. Demonstrate programming and tuning of satellite receivers.

END OF SECTION

SECTION 275116 - PUBLIC ADDRESS SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes but is not limited to the following:
 - 1. Loud speakers.
 - 2. Ceiling speakers.
 - 3. Program sources and recorders.
 - 4. Power amplifiers.
 - 5. Audio signal processors.
 - 6. 2/3 octave graphic equalizer.
 - 7. Mic/line mixers.
 - 8. Automatic mic/line mixers.
 - 9. Wired microphones
 - 10. Wireless microphones.
 - 11. Sound system equipment cabinets and accessories.
 - 12. Miscellaneous sound equipment, cables, hardware,
etc.
- B. Related section includes the following:
 - 1. Division 01 – General Requirements
 - 2. Division 26 – Electrical
 - 3. Division 27 – Communications Sections.
 - 4. Division 28 – Electronic Safety and Security

1.3 SECTION DEFINITIONS

- A. HF: High frequency.
- B. IR: Infrared.
- C. LAN: Local area network.
- D. LF: Low frequency.
- E. SPL: Sound Pressure Level.
- F. VU: Volume unit.

- G. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
- H. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 SUBMITTALS

- A. Shop Drawings: Signed and sealed by a qualified sound system engineer.
 - 1. Design Calculations: Calculate requirements for selecting seismic restraints for central control cabinets.
 - 2. Equipment Details: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection.
 - 3. Console layouts.
 - 4. Control panels.
 - 5. Rack arrangements.
 - 6. Wiring Diagrams: Power, signal, and control wiring.

Include the following:

 - a). Identify terminals to facilitate installation, operation, and maintenance.
 - b). Single-line diagram showing interconnection of components.
 - c). Cabling diagram showing cable routing.
 - 7. Loudspeakers mounting details.
 - 8. Loudspeakers locations and aiming details.
- B. Quality Assurance/Control Submittals:
 - 1. Product Data: For each item specified.
 - 2. Calculations: For sizing backup battery.
 - 3. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - a). Ceiling-mounted items include lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data: For public address and music equipment to include emergencies, operation, and maintenance manuals.
 - 2. Extra Materials: Receipt for extra materials.
 - 3. Loose Equipment: Receipt for loose materials not fastened in place.

- D. See Common Work Results for Communications section 270500 for more submittal requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Not more than 2 hours' normal travel time from Installer's place of business to Project site.
 - 2. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.
 - 3. Installation shall be by personnel certified by National Institute for Certification in Engineering Technologies as audio systems Level III technician.
- B. Source Limitations: Obtain public address and music equipment through a single source authorized by manufacturer to distribute each product.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70 – National Electrical Code.
- E. Comply with UL 50.
- F. TIA/EIA-607 Telecommunications grounding.
- G. Latest edition of BISC – TDMM – manual
- H. Americans with Disabilities Act (ADA)
- I. Federal Communications Commission, Part 15
- J. Sound System Engineering (Davis and Patronics) 3rd Edition 2006.
- K. Audio System Design and Installation (Giddings) 1990.
- L. NICET – Certified Audio Technician Level I
- M. NSCA – Certified Systems Installer, C-SI
- N. InfoComm International – Certified Technology Specialist, CTS.
- O. Provide labeling per ANSI/EIA/TIA-606 requirement and in accordance with the Owner and Technology Consultant.

1.6 COORDINATION

- A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. The public address and mass notifications system shall carry a warranty as specified in Section "Demonstration and Training of Communications Systems".

1.8 TRAINING

- A. Provide training per Section "Demonstration and Training of Communications Systems".

1.9 RECORD DRAWINGS/OPERATION AND MAINTENANCE MANUALS

- A. Provide record drawings and operation and maintenance manuals as described in Sections "Operation and Maintenance of Communications" and "Common Works Results for Communication Systems".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers and their products are approved products to be used, shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. AKG Acoustics; A Harman International Company (AKG).
 - 2. Ashly Audio, Inc. (Ashly).
 - 3. Atlas Soundolier; Atlas Sound (Atlas).
 - 4. Crown Audio, Inc.; A Harman International Company (Crown).
 - 5. D & M Professional; Denon Professional products (Denon).
 - 6. D & M Professional; Marantz Professional products (Marantz).
 - 7. Dukane Corporation; Communications Systems Div. (Dukane).
 - 8. Electro-Voice, Inc.; Telex Communications, Inc. (EV).
 - 9. Gentner ALS; A Starin Company (Gentner).
 - 10. JBL Professional; A Harman International Company (JBL).
 - 11. Lowell Manufacturing Company (Lowell).
 - 12. Peavey Electronics Corporation; Architectural Acoustics by Peavey products. (Peavey).
 - 13. QSC Audio Products, Inc. (QSC).

14. Quam Nichols Company (Quam).
15. Rane Corporation (Rane).
16. Rauland-Borg Corporation (Rauland).
17. Renkus-Heinz, Inc.
18. Shure Incorporated (Shure).
19. Soundcraft; A Harman International Company
(Soundcraft).
20. TASCAM; a division of TEAC America, Inc. (TASCAM).
21. Telex Communications, Inc. (Telex).
22. TOA Electronics, Inc. (TOA).
23. Yamaha Corporation of America (Yamaha).

2.2 EQUIPMENT AND MATERIALS

- A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- C. Waterproof Equipment: Listed and labeled for outdoor use.

2.3 CEILING LOUDSPEAKERS

- A. 4-Inch Ceiling Loudspeaker System.
 1. Approved Manufacturer:
 - a). Atlas Model FAP42T-6B/FAP95-6 series.
 - b). Electro-Voice, Inc. EVID C4.2 series
 - c). JBL Professional, Control 24CT-BK series
(microphones).
 - d). Lowell Manufacturing Company.
 - e). QSC Audio Products, Inc.
 - f). Quam Nichols Company.
 - g). TOA Electronic, Inc.
 - h). Community D4LP Series
 2. Provide 4-inch coaxial ceiling loudspeaker system with ported bass reflex enclosure and press-fit grille., as follows:
 - a). LH Transducer: 4 inch cone.
 - b). HF Transducer: 3/4 inch diaphragm.
 - c). Voice Coil Diameter: 1 inch.
 - d). Magnet Weight: 10 oz., nominal.
 - e). Impedance: 8 ohms, nominal.
 - f). Power Rating: 25 W RMS.
 - g). Sensitivity: 88 dB average.
 - h). Frequency Response: 75 to 20,000 Hz, plus or
minus 7 dB.
 - i). Dispersion Angle: 130 deg.

- j). Enclosure: 285 cu. in. fiberglass lined 18 gauge steel, textured white finish with 24 gauge steel tile bridge.
- k). Grille: Round one-piece perforated steel, textured white finish.
- l). Transformer: 25/70 V, 1.5 dB insertion loss, rated 16 W with at least 5 primary taps, and bypass position for direct-coupled 8 ohm operation.

B. 8-Inch Coaxial Loudspeaker with Transformer

- 1. Approved Manufacturer:
 - a). Atlas Model SD72W series.
 - b). Electro-Voice, Inc., 309-8T series
 - c). JBL Professional.
 - d). Lowell Manufacturing Company.
 - e). QSC Audio Products, Inc.
 - f). Quam Nichols Company.
 - g). TOA Electronic, Inc., PC-671R9V) series
 - h). Community D8 series
- 2. Provide 8-inch coaxial loudspeaker with transformer, as follows:
 - a). LH Transducer: 8 inch cone.
 - b). HF Transducer: 3 inch cone.
 - c). Voice Coil Diameter: 1 inch.
 - d). Magnet Weight: 10 oz., nominal LF; 2.35 oz, nominal HF.
 - e). Impedance: 8 ohms, nominal.
 - f). Power Rating: 16 W RMS.
 - g). Sensitivity: 98 dB peak, 95 dB average.
 - h). Frequency Response: 70 to 15,500 Hz, plus or minus 5 dB.
 - i). Crossover Frequency: 2800 Hz, first order.
 - j). Dispersion Angle: 120 deg.
 - k). Transformer: 25/70 V, 1.5 dB insertion loss, rated 5 W with at least 4 primary taps.
- 3. Accessories:
 - a). Tile Bridge: 24 gauge steel.
 - b). Recessed Enclosure: 0.36 cu. ft. steel.
 - c). Surface Enclosure: 1.5 cu. ft., 18 gauge steel enclosure, lined with acoustic fiber board and 1-1/2-inch-thick fiberglass with 1-1/2-lb per cu. ft. density, textured white finish.
 - d). Grille: [Round] one-piece perforated steel, textured white finish.

2.4 OUTDOOR WALL LOUDSPEAKERS

A. Outdoor Loudspeaker System.

- 1. Approved Manufacturer:
 - a). Crutchfield RSM-400 series.

- b). Crutchfield Definitive AW550 series
- c). Boss FS4SE series
- d). Rockville WET-7029B series .
- e). Or approved equal.
- 2. Provide outdoor coaxial ceiling loudspeaker system
- , as follows:
- a). 4-inch injected molded polypropylene woofer.
- b). ¾ inch titanium compression driver.
- c). Impedance: 8 ohms, nominal.
- d). Power Rating: 40 Watts.
- e). Sensitivity: 85 dB average.
- f). Frequency Response: 79- 20,000 Hz, plus or minus 4 dB.
- g). IPX6 rated weather resistant.
- h). Weight: 4.25 Lb.
- i). Dimension: nominal: 10 inches wide by 7 inches high by 7 deep.
- j). 5 year warranty.
- k). Finish to be selected by the architect: White or Black.

2.5 POWER AMPLIFIERS

- A. Approved Manufacturers:
 - 1. Crown Audio, Inc. Ct or Cdi- series.
 - 2. Electro-Voice, Inc. Q- series
 - 3. Peavey Electronics Corporation IPA Series.
 - 4. QSC Audio Products, Inc., CX- series
 - 5. TOA Electronics, Inc. 900-series
 - 6. Crest Audio, Pro- series
- B. Provide power amplifiers, as shown, that meets to the following requirements:
 - 1. Comply with TIA/EIA SE-101-A.
 - 2. Mounting: TIA/EIA-310-D, standard 19-inch rack mounted.
 - 3. Output Power: As indicated on the system riser diagram, balanced lines (minimum 120 watts).
 - 4. Frequency Response: 20 – 20KHz +1dB / -3dB
 - 5. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
 - 6. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
 - 7. Output Regulation: Less than 2 dB from full to no load.
 - 8. Controls: On/off, input levels, and low-cut filter.
 - 9. Outputs: 8 ohms at 25 / 70V balanced

10. Input Sensitivity: Matched to preamplifier and providing full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

C. Accessories

1. Rack-mount kit
2. Power cable

D. Rack Spaces

1. Up to 1200 watt – 2U

2.6 DIGITAL SIGNAL PROCESSORS (DSP)

A. 4-Input, 8-Output Audio Processor with Feedback Reduction.

1. Approved Manufacturer
 - a). Shure Model P4800 series
 - b). Rane Corporation, RPM 88 series
 - c). Ashly Audio Protea System 4.8 SP series
 - d). BIA NEXIA Sp series
 - e). Sabine NAV4802-series.
 - f). Community dspec 226 series
2. Provide a 4 input, 8 output audio processor with feedback reduction, as follows:
 - a). Supplied Windows software displays interaction between dynamics processes.
 - b). 5-, 10-, and 16-filter, automatic, adaptive, feedback filters in single-channel and stereo modules
 - c). Parametric and graphic EQ.
 - d). 20 seconds of delay.
 - e). Mono and stereo compressors and limiters.
 - f). Gate/downward expander.
 - g). Ducker.
 - h). Automatic gain control.
 - i). 2 to 5-way crossovers.
 - j). Route any of 4 inputs to any of 8 outputs in any combination.
 - k). Adjust signal levels at crosspoints.
 - l). 128 presets.
 - m). Frequency response: 20 – 20kHz ± 1.0 dB, -3dB loss
3. Accessories
 - a). External control options:
 - 1) DRS-10: 10-position rotary encoder and wall plate for selecting up to 10 presets.
 - 2) Control Inputs: Contact closures and potentiometers as preset, gain and mute controls.
 - 3) Logic Outputs: Provide indication of preset changes and mutes.

- 4) RS-232 Control: Compatible with AMX and Crestron systems.
- b). Rack-Mount Bracket: TIA/EIA-310-D, standard 19-inch.

2.7 WIRELESS MICROPHONES

A. Approved Manufacturer:

- 1. Shure Model ULXS124/85 series
- 2. Audio Technica, 2000 series
- 3. Sennheiser Electronic Corporation, G2 300 series
- 4. Telex Communications, Inc. FMR500L w/WT60 belt packs etc.
- 5. EVI FMR-500HL/FMR-500 series
- 6. EV RE 2-G series

B. Provide combination wireless systems as follows:

- 1. Professional wireless receivers.
- 2. Wireless body pack transmitter.
- 3. Cardioids microphone.
- 4. Lavalieres condenser microphone.
- 5. Provide one receiver and transmitter for each microphone.

C. Wireless headset microphone:

- 1. Approved manufacturer:
 - a). Country Man E6
 - b). Shure
 - c). EV
 - d). Crown CM-312A
 - e). Sennheiser
 - f). Audio technical AT-889cW
- 2. Provide wireless microphones, as follows:
 - a). Head worn condenser microphone, 3 foot plug-in cable, battery belt pack.
 - b). Electrets condenser
 - c). Freq. response: 50 Hz to 17,000Hz
 - d). Impedance: 75 ohm balanced
 - e). Load impedance: 1,000 ohms or greater
 - f). Signal to noise ratio: 63 dB at 94 dB SPL
- 3. Provide UHF wireless, as follows:
 - a). UHF wireless frequency agile, diversity microphone system
 - b). Handheld transmitter
 - c). Rack mounted receiver
 - d). Body pack transmitter
 - e). Omni-directional lapel microphone
 - f). Two (2) 1/4-wave rack mounted antennas

- g). UHF Anenna distribution system
- 4. Provide water resistant microphones, as follows:
 - a). Water resistant head-worn microphone
 - b). Aerobic sports pouch for housing bodypack transmitter.
- 5. Approved Manufacturers:
 - a). Shure model WH30TQG and custom pouch.
 - b). Sennheiser Electronic Corporation.
 - c). Telex models WPHS-746 and WP-23.
 - d). Audio-Technica U.S., Inc. model AT889cW and custom pouch.

2.8 FREE STANDING SOUND EQUIPMENT CABINETS

- A. All sound equipment shall be housed in free-standing steel protective cabinets.
- B. The equipment cabinets for shall have solid sides and vented back panels and lockable and latching front and back doors. Units to have front plexi-glass hinged door. (All locks shall be keyed alike for all provided cabinets).
- C. The sound system equipment cabinets shall be 22 inches wide by 25 inches deep and 83-1/8 inches high with leveling feet/or casters as required.
- D. The equipment cabinets shall be made of steel construction and fully welded corners.
- E. The equipment cabinets shall have powder coat finish, finish shall be black.
- F. Provide integrated quiet fan with 150-250 CFM in each equipment cabinet with fan guards (external and internal), fan shall have less than 47 - 49 dBA noise rating.
- G. Provide vertical power strip with 20 amp receptacles for each cabinet.
- H. At each equipment cabinet provide plastic wire holding clips.
- I. Provide copper bus bar.
- J. Provide 100 spare mounting screws for each equipment cabinet.
- K. Provide mounting rails.
- L. Provide vented panels between sound equipment as needed.
- M. Provide blank panels between sound equipment as needed.
- N. Provide adjustable vented shelves, shelf shall adjust from 23 to 32 inches, with a weight capacity of 200 Lbs, steel with black powder finish.
- O. Provide telescoping full depth heavy duty vented shelves ,shelf shall adjust from 16 to 44 inches, with a weight capacity of 500 Lbs, 16 GA steel with durable black powder finish.

- P. Provide heavy duty sliding shelf , full 14 " extension, heavy gauge steel with black powder finis, weight capacity of 50 Lbs.
- Q. Equipment cabinet shall be UL listed.
- R. Provide 3U space for future equipment.(Provide (3) -one U blank covers)
- S. Provide 2 U drawers.
- T. Approved Manufacturer:
 - 1. Middle Atlantic ERK-series (22"W x 25"D)
 - 2. CPI C-series.
 - 3. Hoffman EER-series type I
 - 4. B Line V-Line series.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wiring Method: Install wiring in raceways unless otherwise noted.
- B. All work shall be coordinated with the LOCUTION system.
- C. Wiring Method: Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where cable wiring method may be used. Use plenum cable in environmental air spaces including plenum ceilings.
- D. 6 inches from cabinets, boxes, or fittings.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.
- F. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.
- G. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
- H. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- I. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

- J. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- K. Wall-Mounting Outlets: Flush mounted.
- L. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
- M. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- N. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
- O. Connect wiring according to local and national codes.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
- C. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Schedule tests with at least seven days' advance notice of test performance.
 - 2. After installing public address and music equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 - 4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - a). Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.

- b). Repeat test for each separately controlled zone of loudspeakers.
 - c). Minimum acceptance ratio is 50 dB.
 - 5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
 - 6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in the same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
 - 7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
 - 8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
 - B. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare a written record of tests.
 - C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
- 3.4 STARTUP SERVICE
- A. Engage a factory-authorized service representative to perform startup service.
 - B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
 - C. Complete installation and startup checks according to manufacturer's written instructions.
- 3.5 ADJUSTING
- A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

END OF SECTION 275116

SECTION 280510 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. When equipment furnished for or by the Owner is indicated on the Drawings or specified, this Contractor shall provide the proper electronic safety and security systems required; and make connections to Owner furnished equipment. The Security Contractor shall verify exact requirements and locations before installation.
- B. Related Work Specified Elsewhere: Division 07 Penetration Fire Stopping and Fire-Resistive Joint Sealants.
- C. The Electronic Safety and Security Contractor shall take field measurements necessary for his Work and shall be responsible for the accurate location and size of openings, recesses, slots, ferrules, and the like.
- D. The Electronic Safety and Security Contractor shall be required to cooperate with "Other Trades" at the site and other Contractors in the coordination of his Work to avoid interferences with installations by other trades and Contractors.
- E. Deviations from the Drawings, to avoid interferences, shall be considered a "Job Condition" and no additional compensation will be considered applicable. In the event that such interferences occur in course of the Work, due to an error, omission, or oversight by the Contractor, no additional compensation shall be allowed. Interferences which may occur during the course of construction shall be brought to the immediate attention of the Architect/Engineer, and the Architect/Engineer decision, confirmed in writing, shall be final.
- F. Related work specified elsewhere: Communications sleeves.
- G. Related sections include the following:
 - 1. Division 1 General Requirements.
 - 2. Division 26 Electrical
 - 3. Division 27 Communications
 - 4. Division 28 Electronic Safety and Security

1.3 REFERENCES

- A. Work shall be in accordance with codes, rules, ordinances, regulations of authorities, bodies, associations, and governments, having proper and legal jurisdiction. Specifically, the following requirements shall be met in their entirety.
 - 1. State and Local Rules, Regulations, Codes, Statutes and Ordinances
 - 2. National Fire Protection Association - applicable requirements
 - 3. National Board of Fire Protection
 - 4. National Electric Code - applicable requirements
 - 5. Other Codes and Standards as specifically noted in each Section of the Specifications

- B. Electrical equipment shall be Underwriter's approved; also, shall meet requirements established by NFPA, NEMA, and ANSI and as specified hereinafter.
- C. Abbreviation used in these Specifications:
 - N.E.C. - National Electric Code - Latest Edition adopted by the National Fire Protection Association
 - N.E.M.A. - National Electrical Manufacturers Association
 - I.P.C.E.A. - Insulated Power Cable Engineers Association
 - A.N.S.I. - American National Standards Institute, Inc.
 - F.C.C. - Federal Communications Commission
 - N.A.B. - National Association of Broadcasters
 - N.A.E.B. - National Association of Educational Broadcasters
 - I.T.L. - Independent Testing Laboratories
 - E.T.L. - Electrical Testing Laboratories
 - U.L. - Underwriters Laboratories
 - B.I.C.S.I. - Building Industry Consulting Service International
 - I.E.E.E. - The Institute of Electrical and Electronics Engineers, Inc.
 - T.I.A. - Telecommunications Industry Association
 - E.I.A. - Electronic Industries Association
 - R.C.D.D. - Registered Communication Distribution Designer
 - N.I.C.E.T. - National Institute of Certification in Engineering Technologies

1.4 SUBMITTALS

- A. Provide shop drawing submittals and illustrations in accordance with requirements of Division 01 Submittal Procedures unless otherwise noted.
- B. Provide shop drawings for each section separately as follows:
 - 1. Provide one electronic file submittal for each section. (do not mix sections together)
 - 2. Provide an index with a complete material list in the Specification sequence.
 - 3. Each Specification Section shall have its own material list.
 - 4. Provide product cut sheet for each specified item in sequence.
 - 5. Each manufacturer's product cut sheet shall be identified/marked or highlighted.
- C. Wiring diagrams and system layout drawings shall show all devices, equipment, home runs, labeling, etc. for the following systems:
 - 1. Physical Access control system.
 - 2. Video surveillance system
 - 3. Fire alarm system
 - 4. VESDA Smoke Detection
- D. Partial shop drawings WILL NOT BE ACCEPTABLE.
- E. Each piece of shop drawing shall be in the sequence of the specifications and shall be clearly marked.
- F. Submittals will be returned unchecked if they do not follow the outlines above.

1.5 QUALITY ASSURANCE

- A. The security cabling system components and equipment shall be listed by Underwriters Laboratories, Inc., and the components shall bear the UL label. The system shall be installed in accordance with requirements set by National Electric Code.

- B. Installing Security System Contractor shall have five years' experience in the system installations.
- C. Security System Contractor shall submit a list of Jobs performed (minimum of three) in the past three years, equal to one specified herein. Also, the contractor shall arrange a site visit of any job(s) selected by Architect/Engineer. The list shall include the following:
 - 1. Job location, and date when it was completed.
 - 2. Contact person at each job location.
 - 3. Brief description of each job.
- D. Security cabling systems installation shall be provided by the Contractor's own work forces. Any subcontractor agreements for any portion of the work specified herein shall meet with approval of the A/E and Owner. It is the intent of the contract to have one Contractor provide sole responsibility for material, labor and service for the systems.
- E. The Security System Contractor shall have on-staff, qualified security system engineers. The engineer shall test and certify the security systems installation.

1.6 PRECEDENCE

- A. Security System Contractors shall review both Drawings and Schedules of Security Systems.
- B. If there is a discrepancy in the number of rooms and quantities between the Drawings and the Schedules, the Security Contractor shall include the higher of the two quantities.
- C. If the products specified are no longer available, Security System Contractor shall provide replacement products that meet or exceed performance specifications of the original specified model at no cost to the Project.
- D. If the Security System Contractor bids products that do not meet or exceed the performance specifications or the original specified model, the Security System Contractor shall provide products that meet the performance specifications as approved by the Architect/Engineer at no cost to the project.

1.7 COORDINATION

- A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
 - 1. To allow maximum possible headroom, unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components, as they are constructed.
- C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames".
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "penetration Firestopping".

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. For purposes of clarity and legibility, the Telecommunication and security drawings are essentially diagrammatic and, although size and location of equipment are closely drawn to scale whenever possible, Contractor shall make use of the data in all of the Contract Documents and shall verify this information at the building site.
- B. The Drawings indicate required size and points of termination of wiring and other related items and may suggest proper routes for such items to conform to structure, avoid obstructions and preserve clearances. It is not intended that Drawings indicate every necessary offset. It shall be the Work of the Security System Contractor to install each item in a manner to conform to structure, avoid obstructions, preserve headroom, and keep opening and passageways clear.
- C. It is intended that apparatus be located in coordination with architectural elements and shall be installed at exact height and location stipulated.
- D. Security Contractor shall fully inform himself regarding peculiarities and limitations of the spaces available for the installation of work and materials provided under his Contract.
- E. Security System Contractor shall carefully examine existing conditions, existing wiring and other materials on the premises and compare the documents with the existing conditions. Variances and necessary changes shall be adjusted by appropriate modifications.
- F. Security System Contractor shall carefully examine the Division 26 and Division 27 drawings for pathway, sleeves, conduits, power requirements, etc.

3.2 PERMITS, FEES, REGULATIONS, INSPECTIONS

- A. Security System Contractor shall arrange and pay for permits, fees, and inspections required in connection with his work for this project, from local, county, state and public agencies, and shall obtain permits from railroad, state highway and utility companies.
- B. Work shall be inspected by approved local and state inspection bureaus, Electrical Inspection Agency, and/or authority, and local utilities.
- C. Upon completion of the Work, the Security System Contractor shall furnish to the Architect/Engineer, a certification of inspection and approval from said Bureau or Agency before final payment on contract will be allowed.

3.3 HOISTS, RIGGING, TRANSPORTATION, AND SCAFFOLDING

- A. Security System Contractor shall provide scaffolding, staging, cribbing, tackle, hoists, and rigging necessary for placing of his materials and equipment in their proper places in the Project.
- B. Security System Contractor shall pay costs for transportation of materials and equipment to the job site and shall include such costs in his proposal.
- C. Scaffolding and hoisting equipment shall comply with requirements of pertinent Federal, State, and Local Laws and Codes.

3.4 PROTECTION

- A. In addition to other requirements of the Contract, the Security System Contractor shall provide various types of protection as follows:
 - 1. Protect finished floors during installation, etc.
 - 2. Protect equipment, finished surfaces from paint droppings, insulation adhesive, and sizing droppings by use of drop cloths.
 - 3. Protect countertops during cutting for grommets.
 - 4. Protect cameras, door controllers, motion detectors, etc. from dirt.
- B. Security Contractor shall be responsible for the protection of finished work from other trades from damage or defacement by his operations and shall remedy such damage at his own expense.

3.5 CUTTING AND PATCHING

- A. Contractor shall do his own cutting and patching of building materials and piping, as required for the installation of his Work, but no structural members shall be cut without the approval of the Architect and such cutting shall be done in a manner directed by the Architect.
- B. Patching of and repair of damage to Work in place shall be done in a neat and workmanlike manner, meeting with the approval of the Architect. Contractor whose operations require cutting of work in place, or who causes damage which entails repairs of such work, shall employ mechanics of the particular trade whose work shall be cut or which is damaged, and shall pay the costs of such patching or repair.
- C. Contractor shall be responsible for any additional sleeves and cores should they be required. NO change order shall be issued to provide sleeves in addition to those provided under the electrical contract.

3.6 FINAL COMPLETION

- A. Security system installation shall be cleaned prior to Substantial Completion of the Work.
- B. Retouch or repaint factory painted prime and finish coats, where scratched or damaged. When retouching, it may not be satisfactory, the Architect/Engineer may require complete repainting until the desired appearance is obtained.
- C. Security System Contractor shall clean equipment; restore damaged materials; remove grease, oil, chemical, paint spots, and stains; and generally, leave the Work in A-1 condition.
- D. Security System Contractor and his subcontractors, on completion of his Work, shall remove tools, equipment, surplus materials, and rubbish pertaining to his operations, and pay costs for such removal and disposal from the site.

3.7 GUARANTEE AND WARRANTY

- A. Security System Contractor shall submit written certificates, warranting that each item of equipment furnished complies with the requirements of the Drawings and Specifications.

3.8 SUPERVISION AND COOPERATION

- A. Work by the Security System Contractor under this Division shall include the services of an experienced superintendent, who shall be constantly in charge of the Work, together with the qualified journeymen, helpers, and laborers required to properly unload, install, connect, adjust, start, operate, and test the Work involved, including related equipment and materials furnished under other contracts or by the Owner.

3.9 COLOR CHART

- A. All security cables and connectors to have the following colors unless noted otherwise:

Description Item	Jack	Cable	I.D.	Notes
Security Cable	-	White	S	Multi-conductors
Door Contact	-	White	DC	22/2
Power Transfer	-	Gray	PT	12/6 and 18/6
Request for Exit	-	Blue	REQ	18/4 or 22/4
Card Reader	-	Orange	CR	22/6
Motion Detector	-	White	MD	22/4
CCTV – IP	-	White	CCTV	4 pair UTP cable
Keypad	-	White	K	22/6
Door Release	-	Red	DR	18/4

3.10 MATERIAL LIST

- A. Contractors shall provide a complete materials list(per front end section) on THEIR LETTER HEAD showing manufacturers name, catalog numbers, description, and quantities for each item in each system, per section number as follows:
1. Manufacturers Name.
 2. Manufacturer's catalog number.
 3. Quantities.
 4. Bonds.
 5. Training.
 6. Project managements.
 7. Shop drawings.
 8. Close out.
 9. Warranties.
 10. Allowance.
- B. The lowest responsible bidders shall provide unit pricing for all materials as described in Part "A" above, within 24 hours with NO exceptions.

- C. If a subcontractor is utilized for any portion of the work, all contact information, references, material list, and any other information shall be provided per the specified contract bid requirements.
- D. If the above requirements are NOT provided, then the contractor is considered a nonresponsive bidder subject to disqualification.

3.11 RECORD DRAWINGS

- A. Record Drawings shall be provided to the Owner/Architect/Engineer in the latest Auto CAD releases. Mark-up drawings or scanned drawings are NOT acceptable.

END OF SECTION 280510

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SECTION 280523 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

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. Provide cables, connectors, installation, testing and all related material for the electronic safety and security systems as specified here and shown on the drawings.
- B. PACS systems which includes, but is not limited to the following:
 - 1. Door Contact switches: 1 PR 20 AWG or as recommended by the system manufacturer.
 - 2. Motion Detector: 2 PR 20 AWG or as recommended by the system manufacturer.
 - 3. Card Reader: 3 PR 18 AWG or as recommended by the system manufacturer.
 - 4. Keypad: 3 PR 18 AWG or as recommended by the system manufacturer.
 - 5. Electric locking system: 6 C 18 AWG or as recommended by the system manufacturer.
 - 6. Door Release: 4 C 18 AWG or as recommended by the system manufacturer.
 - 7. Lock Down: 4 C 18 AWG or as recommended by the system manufacturer.
 - 8. Request for Exit (REX): 4 C 18 AWG or as recommended by the system manufacturer.
 - 9. Knox Box: 4 C 18 AWG or as recommended by the system manufacturer.
 - 10. Mics. cabling
- C. Video Surveillance camera system which includes, but is not limited to the following:
 - 1. 4 PR UTP cabling
 - 2. 4 PR STP cabling
 - 3. Connectors.
 - 4. Surface modular.
 - 5. Patch cables.
 - 6. Mics. cabling
- D. Fire Alarm system which includes, but is not limited to the following:
 - 1. No. 18/ AWG cable or as recommended by the system manufacturer.
 - 2. No. 14/ AWG cable or as recommended by the system manufacturer.
 - 3. No. 12/AWG cable or as recommended by the system manufacturer.
 - 4. Mics. cabling
- E. Related Sections:
 - 1. Division 26, Electrical
 - 2. Division 27, Communications
 - 3. Division 28, Safety and Security

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. RCDD: Registered Communications Distribution Designer.

- E. UTP: Unshielded Twisted Pair.
- F. STP: Shielded Twisted Pair
- G. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- H. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

1.4 SUBMITTALS

- A. Quality Assurance/Control Submittals:
 - 1. Product Data: For each type of product indicated.
 - a. For coaxial cable, include the following installation data for each type used:
 - 1) Nominal OD.
 - 2) Minimum bending radius.
 - 3) Maximum pulling tension.
 - 2. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
 - 3. Source quality-control reports.
 - 4. Field quality-control reports.
- B. Closeout Submittals:
 - 1. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 50.
- D. TIA/EIA-607 Telecommunications grounding.
- E. Latest edition of BISC I – TDMM – manual
- F. Americans with Disabilities Act (ADA)
- G. Federal Communications Commission, Part 15
- H. Sound System Engineering (Davis and Patronics) Latest Edition .
- I. Audio System Design and Installation (Giddings) Latest Edition.

1.6 WARRANTY

- A. The security system shall carry a warranty as specified in Section "Demonstration and Training of Communications Systems".

1.7 TRAINING

- A. Provide training per Section "Demonstration and Training of Communications Systems".

1.8 RECORD DRAWINGS/OPERATION AND MAINTENANCE MANUALS

- A. Provide record drawings and operation and maintenance manuals as described in Sections "Operation and Maintenance of Communications" and "Common Works Results for Communication Systems".

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Manufacturers:
 - 1. Belden CDT Inc.; Electronics Division.
 - 2. Carol Brand; a division of General Cable Technologies Corporation.
 - 3. Coleman Cable Inc.
 - 4. Genesis Cable Products; Honeywell International, Inc.
 - 5. West Penn Wire; a division of Belden CDT Inc.

2.2 ALL IN ONE

- A. All in one composite cable:
 - 1. This cable is composite construction of 6 conductors (3PR) 18 AWG strand bare copper conductor insulated with color coded FRP, shielded with drain wire an FRP jacket; 4 conductors 18 AWG strand bare copper conductors insulated with color coded FRP, shielded with a drain wire with FRP jacket; 4 conductors 16 AWG strand bare copper conductor insulated with color coded FRP, shielded with drain wire and FRP jacket and 4 conductors 22 AWG stranded bare copper conductor insulated with copper, insulated, shielded with drain wire and FRP jacket. color coded FRP, shielded with drain wire and an FRP Jacket; a yellow overall SGPVC jacket is applied overall, Type CMP, UL listed 444, NEC 800 and 910, cable shall be plenum rated.
 - 2. Card Reader Cable: 6 conductor (3PR) 18 AWG, bare copper, insulated, shielded with drain wire and FPR jacket. (Orange)
 - 3. Request for Exit/Motion cable: 4 conductor 18 AWG, bare copper, insulated, shielded with drain wire and FPR jacket. (Blue or Yellow)
 - 4. Electronic Lock Power cable: 4 conductor 16 AWG, bare copper, insulated, shielded with drain wire and FPR jacket. (Gray)
 - 5. Door contact/switch cable: 4 conductor 22 AWG, bare copper, insulated, shielded with drain wire and FPR Jacket. (White)
 - 6. Overall Jacket, yellow, .4 OD to .5 O.D. with Ripcord under jacket.
 - 7. UL listed.
 - 8. 300 Volts.

2.3 RS-232 CABLES

- A. Standard Cable: NFPA 70, Type CM.
 - 1. Paired 1,2,3,4 pair(s), No. 20 AWG, stranded (7x28) copper conductors.
 - 2. Polypropylene insulation.
 - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Pairs are cabled on common axis with No. 20 AWG, stranded (7x28) copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired 1,2,3,4 pair(s), No. 20 AWG, stranded (7x28) copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 20 AWG, stranded (7x28) copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.4 DOOR CONTACT CABLE

- A. Standard Cable: NFPA 70, Type CM
1. Paired, 1 pair, No. 20 AWG, stranded (7 x 28) copper conductors.
 2. Polyolefin insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. PVC jacket.
 5. Pairs are cabled on common axis with No. 20 AWG, stranded (7 x 28) copper drain wire.
 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-rated Cable: NFPA 70, Type CMP
1. Paired, 1 pair, No. 20 AWG, stranded (7 x 28) copper conductors.
 2. Fluoropolymer installation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. Plastic jacket.
 5. Pairs are cabled on common axis with No. 20 AWG, stranded (7 x 28) copper drain wire.
 6. Flame Resistance: Comply with NFPA 262

2.5 MOTION DETECTOR CABLE

- A. Standard Cable: NFPA 70, Type CM
1. Paired, 2 pair, No. 22 AWG, stranded (7 x 30) copper conductors.
 2. Polyolefin insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. PVC jacket.
 5. Pairs are cabled on common axis with No. 22 AWG, stranded (7 x 30) copper drain wire.
 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-rated Cable: NFPA 70, Type CMP
1. Paired, 2 pair, No. 22 AWG, stranded (7 x 30) copper conductors.
 2. Fluoropolymer installation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. Plastic jacket.
 5. Pairs are cabled on common axis with No. 22 AWG, stranded (7 x 30) copper drain wire.
 6. Flame Resistance: Comply with NFPA 262

2.6 CARD READER CABLES

- A. Standard Cable: NFPA 70, Type CM.
1. Paired 3 pair(s), No. 18 AWG, stranded (7x26) copper conductors.
 2. Polypropylene insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. PVC jacket.
 5. Pairs are cabled on common axis with No. 18 AWG, stranded (7x26) copper drain wire.
 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired 3 pair(s), No. 18 AWG, stranded (7x26) copper conductors.
 2. Plastic insulation.

3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 18 AWG, stranded (7x26) copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.7 KEYPAD CABLES

- A. Standard Cable: NFPA 70, Type CM.
 1. Paired 3 pair(s), No. 18 AWG, stranded (7x26) copper conductors.
 2. Polypropylene insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. PVC jacket.
 5. Pairs are cabled on common axis with No. 18 AWG, stranded (7x26) copper drain wire.
 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
 1. Paired 3 pair(s), No. 18 AWG, stranded (7x26) copper conductors.
 2. Plastic insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. Plastic jacket.
 5. Pairs are cabled on common axis with No. 18 AWG, stranded (7x26) copper drain wire.
 6. Flame Resistance: Comply with NFPA 262.

2.8 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CM.
 1. 18 AWG, 2 pair stranded (7 x 26) bare copper conductors.
 2. PVC insulation.
 3. Individually shielded.
 4. PVC overall jacket.
 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
 1. 18 AWG, 2 pair stranded (7 x 26) bare copper conductors.
 2. Fluorinated ethylene propylene insulation.
 3. Individually shielded.
 4. Fluorinated ethylene propylene jacket.
 5. Flame Resistance: NFPA 262, Flame Test.
 6. Jacket color: Gray
 7. Operating voltage: 300 V RMS

2.9 REQUEST FOR EXIT MOTION DETECTOR CABLE

- A. 18 AWG, 4 conductors, stranded bare copper conductors, unshielded with an overall jacket.
 1. 4 conductor, 18 AWG
 2. Stranded 7 x 26
 3. Polymer alloy insulation
 4. Flexible plenum jacket material
 5. Operating voltage: 300 V RMS
 6. Unshielded with overall jacket
 7. Flame resistance: NFPA262
 8. UL listed
 9. CMP rated for plenum

2.10 ELECTRIC LATCH/LOCK CABLE

- A. 18 AWG, 6 conductors, stranded bare copper conductors, unshielded with an overall jacket.
 - 1. 6 conductor, 18 AWG
 - 2. Stranded 7 x 26
 - 3. Polymer alloy insulation
 - 4. Flexible plenum jacket material
 - 5. Operating voltage: 300 V RMS
 - 6. Unshielded with overall jacket
 - 7. Flame resistance: NFPA262
 - 8. UL listed
 - 9. CMP rated for plenum

2.11 DOOR RELEASE CABLE

- A. 18 AWG, 4 conductors, stranded bare copper conductors, unshielded with an overall jacket.
 - 1. 4 conductor, 18 AWG
 - 2. Stranded 7 x 26
 - 3. Polymer alloy insulation
 - 4. Flexible plenum jacket material
 - 5. Operating voltage: 300 V RMS
 - 6. Unshielded with overall jacket
 - 7. Flame resistance: NFPA262
 - 8. UL listed
 - 9. CMP rated for plenum

2.12 LOCK DOWN CABLE

- A. 18 AWG, 4 conductors, stranded bare copper conductors, unshielded with an overall jacket.
 - 1. 4 conductor, 18 AWG
 - 2. Stranded 7 x 26
 - 3. Polymer alloy insulation
 - 4. Flexible plenum jacket material
 - 5. Operating voltage: 300 V RMS
 - 6. Unshielded with overall jacket
 - 7. Flame resistance: NFPA262
 - 8. UL listed
 - 9. CMP rated for plenum

2.13 LOW-VOLTAGE CONTROL CABLE

- A. Paired Lock Cable: NFPA 70, Type CMG.
 - 1. 1 pair, twisted, No. 16 AWG, stranded (19x29) copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.
 - 1. 1 pair, twisted, No. 16 AWG, stranded (19x29) copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with NFPA 262.

2.14 ACCESS CONTROLLER INPUT CABLE

- A. Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) copper conductors, polypropylene insulation, overall aluminum foil-polyester tape shield with No. 22 AWG, stranded (7x30) copper drain wire, 100 percent shield coverage, and PVC jacket.
 - 1. NFPA 70, Type CMR.
 - 2. Flame Resistance: UL 1666 Riser Flame Test.
- B. Plenum-Type, Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) copper conductors, fluorinated-ethylene-propylene insulation, aluminum foil-polyester tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.
 - 1. NFPA 70, Type CMP.
 - 2. Flame Resistance: NFPA 262 Flame Test.

2.15 AC TRANSFORMER CABLE

- A. Paired AC Transformer Cable: 1, 2, 3 or 4 pair, twisted, No. 18 AWG, stranded (7x26) copper conductors, PVC insulation, unshielded, and PVC jacket.
 - 1. NFPA 70, Type CMG.
- B. Plenum-Type, Paired AC Transformer Cable: 1,2,3 or 4 pair, twisted, No. 18 AWG, stranded (19x30) copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
 - 1. NFPA 70, Type CMP.
 - 2. Flame Resistance: NFPA 262 Flame Test.

2.16 FIRE ALARM WIRE AND CABLE

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than] No. 18 AWG or size as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.17 CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.

- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway; power-limited cable, concealed in building finishes; or power-limited tray cable, in cable tray complying with UL 83; unless indicated otherwise.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
- C. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- D. Pathway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard when entering room from overhead.
 - 4. Extend conduits 3 inches above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.
- F. Cables in walls shall be installed in conduits to above accessible ceilings.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Provide all cabling for the access control system.
- B. Provide all cabling for the CCTV camera system.
- C. Comply with NECA 1.
- D. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Chapter. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 9. Pulling Cable: Comply with BICSI ITSM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- E. UTP Cable Installation: Comply with Division 27 Section "Communications Structured Cabling."
- F. Optical Fiber Cable Installation: Comply with Division 27 Section "Communications Fiber Optical Backbone Cabling."
- G. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- H. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.
- I. Separation from EMI Sources:
1. Comply with BICSI TDM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.
- ### 3.3 CABLE APPLICATION
- A. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."

- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. RS-232 Cabling: Install at a maximum distance of 50 feet.
- D. RS-485 Cabling: Install at a maximum distance of 4000 feet.
- E. Card Readers:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 20 AWG wire if maximum distance is 500 feet.
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
 - 4. Install minimum No. 18 AWG shielded cable to readers that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed 500 feet.
- G. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of 25 feet.

3.4 CONNECTIONS

- A. Refer to Drawings.

3.5 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Firestopping."
- B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 27 Section "Identification for Communications Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test and inspect optical fiber cabling according to Division 27 Section "Communications Fiber Optical Backbone Cabling."
 - 2. Test and inspect UTP cabling according to Division 27 Section "Communications Structured Cabling."

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 280523

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SECTION 281300 PHYSICAL ACCESS SECURITY CONTROL AND DATABASE MANAGEMENT SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the Lenel S2 Security and Database Management System (SMS) consisting of computer hardware, software, and associated licensing and equipment for monitoring, recording, and managing Electronic Access Control System (EACS) and Integrated Systems (IS) data and functionality to match the existing Hammond Fire Department systems.
- B. The SMS includes the following sub-components:
 - 1. Operating Systems (OS) software and firmware
 - 2. Application Software
 - 3. Database Software
 - 4. Network connected Security Management Servers
 - 5. Network connected field level panels

1.02 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. Drawings and general provisions of the Contract, including:
 - 1. Drawings:
 - a. As shown on document bid set.
 - 2. Related Specification Sections:
 - a. Division 26
 - b. Division 27
 - c. Division 28

1.03 DEFINITIONS

- A. CPU: Central Processing Unit
- B. DVR: Digital Video Recorder
- C. FCC: Federal Communications Commission
- D. FIPS: Federal Information Processing Standard

- E. IP: Internet Protocol
- F. LAN: Local Area Network
- G. MJPEG: Motion JPEG
- H. NFPA: National Fire Protection Association
- I. NVR: Network Video Recorder
- J. OS: Operating System
- K. OVID: Open Video Integration Driver
- L. PDF: Portable Document Format
- M. PoE: Power over Ethernet
- N. PTZ: Pan-Tilt-Zoom
- O. RAID: Redundant Array of Independent Disks
- P. REX: Request to Exit
- Q. RU: Rack Unit
- R. SMS: Security Management System or Short Message Service (text messaging)
- S. SUSP: Software Upgrade and Support Plan
- T. TCP: Transmission control protocol - connects hosts on the Internet
- U. TIA: Telecommunications Industry Association
- V. TLS: Transport Layer Security
- W. UPS: Uninterruptible Power Supply
- X. UTP: Unshielded Twisted Pair
- Y. VMS: Video Management System
- Z. WAN: Wide Area Network
- AA. Wi-Fi: Wireless Network

1.04 PERFORMANCE REQUIREMENTS

- A. The SMS shall be certified to meet the following standards:
 - 1. System shall be RoHS (Restriction of Hazardous Substances) compliant and meet proposed amendments to the reduction of toxic substances in manufacturing as stated in the Environmental Design of Electrical Equipment Act (EDEE)

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application
3. Installation shall comply with NECA 1-2010 "Standard Practice of Good Workmanship in Electrical Construction"
4. Installation shall comply with NEC/NFPA 70E "Standard for Electrical Safety in the Workplace"
5. Electronic data exchange between Video Surveillance System and an Access Control System shall comply with SIA TVAC
6. Installation shall comply with FCC CFR 47 Part 15 Class A "Telecommunications, Radio Frequency, Digital Device Emission"
7. Installation shall comply with federal, state, and local codes and Authority Having Jurisdiction (AHJ)

1.05 ACTION SUBMITTALS

- A. Product Data: Provide details and technical specifications for each product indicated. Include physical dimensions, features, performance, electrical characteristics, ratings, software versions, and operating system details.
- B. Shop Drawings: Include system line diagrams, equipment locations, installation details, and system integration plans.
 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types, quantities, and sizes.
 3. Plans and Elevations: Dimensioned plans and elevations of equipment racks, enclosures, and conduit interconnections, including access and workspace requirements.
 4. Data Calculations: Provide data bandwidth and storage calculations, including data backup and archive configuration details meeting the minimum project requirements as described herein.
 5. Power and Heat Load Calculations: Provide power and heat load calculations for all hardware, including UPS capacity calculations.
 6. Wiring Diagrams: For power and signal wiring.
- C. Equipment and Software List: Include every piece of equipment and software by product/model name and/or number, manufacturer, serial number, revision number, location, and date of original installation. If factory and/or bench testing regimens are required by the project plan, add pretesting record of each piece of equipment and software, listing name of person testing, date of test, and adjustments made.

1.06 INFORMATIONAL SUBMITTALS

- A. CE and FCC Compliance Certificates:
- B. Field quality-control reports
- C. Current LenelS2 Integrator Certification Letter
- D. Current LenelS2 Training Certificates (listing expiration dates) for two (2) technicians from the supporting office
- E. Warranty: Software support and warranty information for all components, including Service Level Agreement (SLA) details, and duration of agreement from date of system acceptance by Owner

1.07 CONTRACTOR REQUIREMENTS

- A. The Contractor shall have a supporting office within fifty (50) miles of the project location
- B. Certifications: Two (2) technicians from the supporting office shall hold current certifications with LenelS2
- C. On-site maintenance and repair service shall be available locally and within four (4) hours of notification of condition
- D. On-site Contractor personnel shall hold all required local, state, and federal licenses
- E. On-site Contractor personnel shall hold current certifications with LenelS2
- F. The Contractor shall provide three (3) references for completed projects of similar scope

1.08 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For all components and software to include in emergency, operation, and maintenance manuals.
 - 1. Extra Materials:
 - a. Return all left-over (unused) product and materials to the Owner
 - 2. Applicable operating system, database, client, and application software on portable storage media
 - 3. Full System Backup as of closeout date on portable storage media
 - 4. Submit one (1) printed and one (1) electronic copy of project binder in final form. This copy shall contain as a minimum:
 - a. Table of Contents for each element
 - b. Contractor information - names phone numbers, and email for sales, technical support, and consumables reordering

- c. Lists of spare parts and replacement components recommended to be stored at the site for ready access
- d. Datasheets for all equipment
- e. Operation and maintenance manuals for all equipment
- f. Operation and maintenance procedures not covered in manufacture's manuals
- g. Training:
 - 1) Program Syllabus.
 - 2) Manual(s) and Material(s).

1.09 QUALITY ASSURANCE

- A. The installation shall comply with federal, state, and local codes and Authority Having Jurisdiction (AHJ).
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. All software and hardware shall be programmed and installed in accordance with manufacturer's specifications.
- D. All equipment shall be new, in current production, and the standard products of a manufacturer of ESS equipment.
- E. The manufacturer shall guarantee availability of parts, for a minimum of seven (7) years from date of shipment.
- F. On-site maintenance and repair service shall be available locally and within <four (4) hours> of notification of condition.
- G. The contractor shall review drawings and specifications.
- H. Software integration between all integrated systems shall be tested and certified for interoperability by the manufacturer of each system.
- I. Software integration between the SMS, VMS, and all other integrated system components shall be tested and certified for interoperability by the manufacturers of each system.

1.10 PERMITS

- A. All permits required for the specified performance and completion of the work shall be secured by the Contractor.

1.11 PROJECT CONDITIONS

- A. Environmental Conditions: System components shall withstand the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior Environmentally Controlled Space: Rated for continuous operation in ambient temperatures of 32° to 95° F (0° to 35° C) dry bulb and a relative humidity of 20 to 80 percent, noncondensing.

1.12 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to service, repair or replace system components as needed for proper system operation as specified herein.
- B. Warranty Period: a 2-year warranty on hardware and a 1-year warranty on labor and software from date of date of Owner Acceptance.

PART 2 - PRODUCTS

2.01 OPERATIONAL REQUIREMENTS

- A. The SMS shall be implemented through network appliance architecture with a three-tier modular hardware hierarchy and embedded three-tier software architecture.
 1. The network appliance shall be capable of running on an existing TCP/IP network and shall be accessible, configurable, and manageable from any network-connected PC with a browser.
 2. Browser access for configuration and administration of the system shall be possible from a PC on the same subnet, through routers and gateways from other subnets, and from the Internet. Control and management of the system shall therefore be geographically independent.
 3. Security of the data communicated over the network to and from the browser, Network Controller, and field panels shall be protected by TLS protocol encryption. The connection shall use TLSv1.3, GCM mode, and a 2048-bit RSA key.
 4. The top hardware tier shall be the Network Controller. Embedded on the Network Controller shall be an operating system, a web server, security application software, and the database of personnel and system activity. Converged Video Access systems shall also include a fully functional network video recorder.
 5. The middle hardware tier shall be the Network Node. The Network Node shall make and manage access control decisions with data provided by the Network Controller, and it shall manage the communication between the Network Controller and Application Blades connected to the system's inputs, outputs, and readers. This modular design shall make it possible, even during network downtime, for the system to continue to manage access control and store system activity logs. When network connectivity is re-established, the system activity logs shall be automatically re-integrated.
 6. The bottom hardware tier shall be the Application Blades. Four unique Application Blades shall be available:
 - a. Access Control Blade: shall support two readers, four supervised inputs, and four relay outputs.
 - b. Alarm Input Blade: shall support eight supervised inputs.

- c. Relay Output Blade: shall support eight relay outputs.
 - d. Temperature Blade: shall support eight analog temperature sensor inputs.
- B. The SMS shall integrate, within a browser interface, access control, alarm monitoring, video monitoring, and temperature monitoring applications. These applications shall be embedded in a three-tier software architecture.
 - 1. The database tier shall use PostgreSQL. PostgreSQL is a full featured, high performance database management system that supports ODBC. This shall provide a small footprint, low administration, and a high reliability relational database that is embedded without requiring the use of a separate PC server.
 - 2. The web server tier shall be based on an Apache® embedded web server. This shall provide a graphically rich security management application through a standard web browser.
 - 3. The security application software tier contains the business logic. This application shall also be embedded on the Network Controller and requires no additional memory or processing power.
 - 4. This three-tiered embedded software design runs within an embedded Linux Ubuntu 18 LTS operating system and shall require no client-side software other than a web browser.
- C. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.
- D. All LenelS2 systems and components shall have been thoroughly tested and proven in actual use.

2.02 FUNCTIONAL REQUIREMENTS

- A. The system shall support the Global(TM) product offering. Global is a global security operations center (GSOC) application enabling system operators and administrators to monitor and control multiple distributed NetBox installations simultaneously. The Network Controller can be configured to use Network Address Translation (NAT) to communicate with a Global system.
- B. The system shall support the High Availability (HA) Solution. The HA Solution includes an HA server pair consisting of two NetBox Enterprise 100 servers running Stratus Technologies everRun Express high availability virtualization software. The servers act as a platform for the LenelS2 software and operating system as a virtual machine on one server, which is continually backed up on the other server.
- C. Widget Desktop: The SMS shall provide a widget-based user interface that enables users to create custom monitoring layouts by selecting and arranging widgets on a desktop.
 - 1. Each widget shall provide easy access to a frequently used function—allowing users to, for example, view an Activity Log, a camera view, or real-time web content.
 - 2. System administrators can save custom layouts for subsequent call up by users, who can then arrange the widgets as desired on their desktops. The administrator shall determine which widgets are available in a layout and the extent to which users can customize the layout. Setup privileges shall enable administrators to switch from "Compose Mode" to "Monitoring Mode" from the desktop menu.

3. When composing layouts, system administrators shall have the ability to display a grid overlay on the Widget Desktop background. Whenever a widget is moved or resized, it will align with (or “snap to”) the nearest intersection of lines in the grid. If the grid is saved with the layout, it will appear in the background when users view the layout.
 4. The widgets that shall be available for layouts are: Activity Log, Alarm Workflow, Auto-Monitor, Camera View, Clock, Duty Log Entry, Elevator Status, Events, Explorer, Floorplans, Intrusion Panel, Passback Grace, Photo ID History, Portal Status, Portal Unlock, Statistics Block, Status, and Threat Level.
- D. The SMS shall provide the following Access Control capabilities:
1. Login throttling, which can be enabled for the system to limit the number of login attempts from the same IP address for a selectable duration.
 2. Integrated photo ID creation capability.
 3. Photo ID and video verification during access control monitoring.
 4. User interface secured access under encrypted password control.
 5. System-wide timed anti-passback function.
 6. Regional anti-passback with mustering and roll call functions.
 7. Region occupancy counting and control.
 8. “First-in-unlock” rule enforcement.
 9. Multiple access levels and cards per person.
 10. 128-bit card support for Wiegand card readers.
 11. Detailed time specifications.
 12. Simultaneous support for multiple card data formats.
 13. Elevator control with or without floor selection tracking.
 14. Access privileges variable by threat level.
 15. Scheduled portal unlocks by time and threat level.
 16. Card Format Decoder to quickly discover unknown card formats.
 17. Card enrollment by reader or keyboard.
 18. Compatibility with various input devices, including biometric readers.
 19. Activation/expiration date/time by person with one-minute resolution.
 20. Access level disable for immediate lockdown.
 21. Use of Threat Levels to alter security system behavior globally.

22. Duress PINs, which can be enabled for the system to allow a valid user to raise an alarm if compelled under duress to use his or her credentials (card and PIN) to allow access for another person.
23. Multiple holiday schedules.
24. Timed unlock schedules.
25. Scheduled actions for arming inputs, activating outputs, and locking and unlocking portals.
26. Optional two-man access restriction for portals, requiring two valid card reads from two separate cardholders within a specified amount of time for portal entry.
27. Card enrollment reader support.
28. Dual-reader portal support.
29. Wiegand reader support.
30. OSDP Reader support.
31. Magnetic-stripe reader support with cards using ABA Track 2 format for up to 200 bits.
32. Wiegand keypad PIN support for 4-digit or 6-digit PINs.
33. 8-bit and 4-bit burst keypad support for 4-digit or 6-digit PINs.
34. Integration with Allegion, ASSA ABLOY, and Mercury hardware.
35. Integration with supported alarm panels.
36. Support for up to 200 DMP and 255 Bosch intrusion panels with high-level TCP/IP integration.
37. Optional storage and recall of ID photos and personal/emergency data.
38. Unlimited person records.
39. Up to 150,000 credentials are stored locally at the Network Node. An unlimited number of credentials may be authenticated with the Network Controller, caching up to 150,000 of the most frequently used credentials on the Network Node. In an instance where the credential is not stored locally at the Network Node, the Network Node will attempt to confirm access by verifying the existence of the credential with the Network Controller.
40. Unlimited number of scheduled actions, with the Network Controller downloading up to 16 per Network Node per day of the soonest-to-activate actions applying to that Network Node, with any others that remain in the database as candidates for downloading later. Expired scheduled actions are removed automatically.
41. The system shall support the tracing of a person's activity in the current partition if the "Trace this person" check box is selected in the person record. When a system user opens the person record, a Trace Person Notice dialog box shall display one of the following: the default message, a custom message created for that person, or a custom default message created for the system.

42. Search for person records using a credential scan.

E. The SMS shall provide the following Monitoring capabilities:

1. The Monitoring Home page shall allow users to view a full system summary, including the Activity Log, Auto-Monitor, and links to frequent User Tasks.
2. Common alarm panel integration for disarm on access, and arm on egress.
3. Support for the direct viewing of IP cameras.
4. Integrated real-time IP-based NetVR and VRx video management systems, and compatible third-party NVR systems with stored video replay for events.
5. Provides alarms on video loss, video motion detection, and video restore events.
6. Virtual inputs for video fail, camera normal, video motion, and building occupancy limits exceeded.
7. Provides alarms on communication loss and temperature variation.
8. Support for the creation of custom sets of alarm event actions.
9. Provides the ability to record video and link to video for alarm events based on access control activity.
10. Available video control and playback through the SMS user interface.
11. Provides the ability to assign threat levels to various alarm events according to severity.
12. Provides the ability to select up to 20 levels of priority for event actions.
13. Provides the ability to enter a duty log comment into the Activity Log, or to append a unique or preset comment to a particular log entry while viewing the Activity Log.
14. Support for the display of Activity Log entries that include both the time the event occurred on the Network Node and the time it was reported to the Network Controller.
15. Support for electronic supervision of alarm inputs.
16. Support for the use of output relays for enabling circuits under alarm event control.
17. A monitoring desktop that integrates video, system Activity Logs, floorplans, ID photos, threat level control, and alarm notifications.
18. Support for the creation of unlimited customized monitoring layouts through the use of widgets, including layouts sized for the iPad or MacBook Air.
19. Graphic floorplans with active icons of security system resources.
20. System user permissions to grant whole or partial access to system resources, commands, and personal data.
21. Secure access to the user interface under encrypted password control.

22. Delivery of alerts via browsers, email, and text messages.
 23. Remote Logging of system messages to remote host.
 24. System health and maintenance:
 - a. Provides the ability to manage system health alerts generated by the SMS when it detects error conditions at applicable health monitoring points.
 - b. For a given system, the health monitoring points may include the system license, disks, RAID drives, FTP, NAS, Backup, Archive, Disk Usage, VMS, and DMP intrusion panels.
 - c. If a user configures notifications for a selected email group, group members shall receive a message whenever an error condition is detected at a health monitoring point. If the user has chosen to include a health summary, each notification shall include status information for all of the system's health monitoring points.
- F. The SMS shall provide the following Video Management capabilities:
1. Real-time video monitoring displays, including multiple cameras simultaneously.
 2. Pan, Tilt, and Zoom control of capable cameras.
 3. Playback of video and access control event-related video.
 4. Video switching and video widget pop-ups based on access activity or event activation.
 5. Integrated alarm inputs from the Video Management System (VMS).
 6. Digital playback of video events.
 7. Linking of video and events based on triggers provided by the SMS or VMS.
 8. Support for multiple third-party NVR systems.
 9. Multiple pre-programmed supported cameras.
 10. Recall of photo ID and real-time video feed for video verification and comparison of card holder.
 11. Monitoring and control through a web browser interface.
 12. System user permissions to grant whole or partial access to system cameras and video resources.
 13. Full integrated operation with Magic Monitor® for live, recorded, forensic and life safety notification over existing TV's and Monitors.
 14. Ability to use the SMS web interface to review the status of system and storage drives, and to adopt physical and virtual drives into NetVR or VRx so it can begin using them for video storage.

G. The SMS shall provide the following Security Database capabilities:

1. Maintain data of system activity, personnel access control information, system user passwords and custom user role permissions for whole or partial access to system resources and data.
2. Partitions: It shall be possible to partition the system to create independent, virtual security management systems for multiple populations.
3. Support for the sharing of user privileges across partitions in a system.
4. Support for the grouping of multiple access levels across partitions in a system.
5. Built-in Open Database Connectivity (ODBC) compliant database for personal data. The ODBC connection shall support SSL encrypted communication.
6. LDAP, LDAPS, and Microsoft Active Directory integration for single-user login authentication.
7. Microsoft Active Directory integration to allow the synchronization of cardholder data between Active Directory servers and the SMS.
8. Unlimited person records.
9. Network-secure API for external application integration.
10. Extensive and easy to use custom report generator.
11. User-defined data fields in personnel records.
12. Record recall by vehicle tag, name, or card.
13. An API for adding to, deleting from, and modifying the database.
14. Storage of system user passwords and permissions.
15. Storage and recall of ID photos and emergency personal information.
16. Pre-defined reports on system configuration, system activity history, and people.
17. A Used By feature for listing all correlations between specific card readers, keypads, inputs, and outputs, against groups, portals, elevators, access levels, access level groups, and other configured access control features. This feature may be useful for quickly determining I/O associations when editing and/or deleting system I/O points.
18. An Audit Trail report that shows changes made to the security database over a specified period of time.
 - a. For each transaction listed in the report results, information is available on when the transaction occurred, who made the changes, the fields that were modified, and the original and new values.
 - b. Search criteria can be applied to filter the report results, either by the person whose record was changed or by the area of the system configuration that was modified.

19. A Credential Audit report that shows all existing access cards by their current status settings and provides the ability to search for cards that have not been used for an operator-entered number of days. The report also shows for each card the name of the person to whom it was issued and the card number.
20. A Duty Log report shows duty log comments residing in the current security database, including archives.
 - a. For each duty log comment included in the report results, information is available on when the comment was entered, who entered it, the date and time of the logged event associated with the comment, the name of the logged event, and the specific comment text.
 - b. Search criteria can be applied to filter the report results, either by Operator (the user who entered the duty log comment) or by Event type.
21. Custom report writer interface that allows the interactive creation of custom reports. Reports may be saved for later reuse. No third-party software (such as Crystal Reports) shall be necessary.
22. Custom report scheduling and distribution of report via email.
23. Selectable custom report output formats, including PDF, CSV, and HTML (default).
24. Custom report repository location. Users shall be able to review, cancel and delete reports from this data storage location.
25. Seamless search capability for access history reports. The reporting function shall search the database and archive simultaneously for matching report parameters.
26. Column sorting. Custom reports output shall be user configurable to sort individual columns in both ascending and descending order.
27. Periodic backup to on-board flash ROM and optional Network Attached Storage (NAS), or including FTP / SFTP servers.
28. Periodic archive creation for historical custom reporting and improved on-board database performance.
29. Email and text messaging (SMS) alert notifications.
30. Custom Menu capabilities allowing a user to create a custom menu containing a specific set of options, which can be assigned to users and will then appear in their navigation palettes.

2.03 HARDWARE REQUIREMENTS

- A. The SMS shall employ a modular hardware concept that enables simple system expansion and utilizes a three-tiered hardware hierarchy:
 1. At the top tier is the Network controller, which shall contain the database engine, web server, application software, and configuration data. It is at this level that System Users, through a browser interface, shall interact with the SMS, set configurations, monitor activities, run reports, manage alarms, and manage cameras and video and storage.

2. At the second tier is the Network Node, an intelligent device with native TCP/IP support, which shall make and manage access control decisions.
 3. At the third tier are the application extension blades. Each of these blades shall connect to and manage a set of inputs, outputs, readers, or temperature monitoring points.
 4. The Network Controllers and Network Nodes shall run on existing building TCP/IP networks and shall be configurable for access from separate subnets, through gateways and routers and from the Internet.
 5. A MicroNode Plus(TM), which combines an Access Control blade and a Network Node, shall also be available.
- B. The Network Controller shall contain the operating system, database engine, web server, application software, and configuration data. The Network Controller shall be available in four configurations to support small to medium, large, and ultra-large systems. Those systems shall be identified as a solid-state NetBox Network Controller, a solid-state NetBox Extreme Network Controller, a NetBox Enterprise 50 Network Controller, and a NetBox Enterprise 100 Network Controller.
- C. The solid-state NetBox Network Controller shall contain a processor, flash memory, and a network switch. The Network Controller shall be supplied with 12V DC at a minimum of 5 amps. Internal battery backup shall supply sufficient power to provide for an orderly shutdown of the system in case of loss of external power. External battery backup shall be used to provide uninterrupted operation in the event of external power loss. The Network Controller is accompanied by a Network Node. The Network Node shall contain I²C for communication with the Application Blades and a network interface port. The solid-state Network Controller shall have the following capabilities:
- | | |
|--------------------------------|---|
| 1. OS | Linux Ubuntu 18 LTS |
| 2. Storage | 20GB MSATA(minimum) |
| 3. Processor | Intel N2800 1.86GHz 2 Cores 4 Threads |
| 4. Memory (RAM) | 8GB |
| 5. Ethernet Ports | 1 |
| 6. Certifications/Compliances | UL, CE, FCC Part 15, RoHS |
| 7. Warranty | 2 years hardware, 1 year software |
| 8. Dimensions (H, W, D) | 17in x 17.5in x 8.25in
(43.18cm x 44.45cm x 20.95cm) |
| 9. Weight | 10 lbs. (4.54 kg) (minimum configuration) |
| 10. Operation Temperature | 32° to 95° F (0° to 35° C) |
| 11. Storage Temperature | -4° to 158° F (-20° to 70° C) |
| 12. Relative Humidity | 5-90% |
| 13. MTBF | 213447 hours |
| 14. AC Input | 86-264 VAC 47-440 Hz 1.5A max @ 115VAC |
| 15. BTU/h | 256 |
| 16. Network Nodes / MicroNodes | 32 |
| 17. Access control portals | 32 |
| 18. Access cards | 20,000 |
| 19. Card formats | 64 per Network Node (32 active) |
| 20. Alarm input points | 500 |
| 21. Control point outputs | 500 |
| 22. Temperature monitor points | 500 |
| 23. Floors | 52 per Network Node |
| 24. Online event history log: | up to 10 million records |
| 25. Ethernet ports | 1 |

26.	Time specifications	512 per Network Node
27.	Time spec groups	512 per Network Node
28.	Time specs per group	8
29.	Threat Levels	8 per Network Node
30.	Threat Level Groups	32 per Network Node
31.	Holidays	30 per Network Node
32.	Access levels	512 per Network Node
33.	Access levels per person	32 per Network Node
34.	Unique user roles	Unlimited
35.	Credentials per person	No limit per Network Node
36.	Report Groups	50
37.	Camera Groups	50
38.	Concurrent system users	5

D. The LenelS2 application blades shall interface with the Network Controller through the Network Node. The application blades shall be blade-style circuit cards. There shall be four types of application blades:

1. LenelS2 access control blade - The access control blade shall receive power via the ribbon cable bus directly from the Network Node blade. The access control blade shall supply up to 500 mA of power to one reader or 250 mA of power to each of two readers. The new generation access control blade shall allow the user to select OSDP or Wiegand reader configurations. An OSDP configuration shall support data encryption between the OSDP readers and the blade.
 - a. Reader Connectors 2
 - b. Max Reader Cable Length 500 feet (152m) (18 AWG twisted, shielded)
 - c. Reader Power 500 mA
 - d. Input Connectors 4
 - e. Max Input Cable Length 2000 feet (610m) (22 AWG twisted, shielded)
 - f. Output Connectors 4
2. LenelS2 input blade - The input blade shall receive power via the ribbon cable bus directly from the Network Node blade. It shall support a wide variety of input supervision types including normally-open circuit and normally-closed circuits, and zero, one or two resistor configurations.
 - a. Input Connectors 8
 - b. Max Input Cable Length 2000 feet (610m) (22 AWG twisted, shielded)
 - c. Supervision Types 4 (open, closed, normal, alarm)
3. LenelS2 output blade - The output blade shall receive power via the ribbon cable bus directly from the Network Node blade. Both normally-open circuit and normally-closed circuit output devices shall be supported. The relay outputs shall support any output devices that operate on the following maximum electrical ratings: 30 Volts DC or AC, 2.5 Amps inductive or 5.0 Amps non-inductive.
 - a. Output Connectors 8
 - b. Contact Type Form C
 - c. Max Electrical Ratings 30 Volts DC, 2.5 Amps Inductive, 5.0 Amps non-inductive.
4. LenelS2 temperature blade - The temperature blade shall receive power via the ribbon cable bus directly from the Network Node blade.
 - a. Temperature Inputs 8

- b. Max Temperature Cable Length 1000 feet (305m) (18 AWG twisted, shielded)
- c. Temperature Range 32° to 158° F (0° to 70° C)

2.04 SOFTWARE REQUIREMENTS

A. Operating System and Application Software:

1. The embedded operating system for the SMS is Linux Ubuntu 18 LTS (long term support) as the operating platform. The operating system kernel shall be open-source and no operating system training or certification shall be necessary.
2. The SMS application software shall be embedded in the system. The database shall be an embedded PostgreSQL relational database requiring a small footprint and provides high reliability. The web server shall be based on an embedded Apache™ web server enabling users to access and operate the system using a standard web browser.
3. The SMS shall support the following web browsers:
 - a. Internet Explorer 11
 - b. Chrome 79
 - c. Firefox 72
 - d. Safari 8, 9

B. LenelS2 Software Licensing:

1. Software licensing shall be based upon the number of portals, cameras, and select features for one Network Controller. Software license upgrades shall be available if system portal and camera capacity must be increased. The LenelS2 user license shall be valid in perpetuity and shall include one year of software updates from the date of shipment from the factory.
2. Licensing shall be controlled by a Product Key and an Activation Key. The Product Key contains the licensed system features and limits. To upgrade your system license to enable more cameras or more portals you will need a new Product Key. The Activation Key contains the software support expiration date. The keys are locked to the system license number. The system license number shall be viewable on-screen on the About page

C. Software upgrades shall be possible from a browser on any network-connected PC by uploading a software update to the Network Controller. The Network Controller shall automatically upgrade all connected Network Nodes. No client software installation shall be necessary.

D. Online Help and Documentation - The SMS shall be provided with complete embedded documentation. The online documentation shall include:

1. Context-sensitive online Help - (The Help displayed is specifically relevant to the current screen.) The online Help system shall provide explanations and procedures for all monitoring, administrative, and system configuration and maintenance functions. The Help system shall have linked table of contents, a linked index, and frequently asked questions pages. Each topic shall also have links to related topics. Each Help topic shall be printable.

2. Technical Support Notes - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
 3. Installation Guides - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
 4. Video Integration Guides - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
 5. End-User Task Guide - This document shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
- E. Technical Support Collaboration - It shall be possible, by the use of a network Support Collaboration Tool, for a technical support specialist to connect to the SMS and assist on-site technicians from remote network-connected locations. It shall only be possible for an on-site system administrator or technician to initiate this connection. There shall be no way to initiate this connection from outside of the secure network.
- F. Language Support - The SMS shall be provided with multiple language support. The ability to switch from one language to another shall be accomplished through the user interface. Translation of the user interface, online help and documentation into other languages shall be available. The languages supported shall include:
1. English
 2. Spanish
- G. Date Formats - The SMS shall support global date formats as follows:
1. mm/dd/yyyy
 2. dd/mm/yyyy
 3. yyyy/mm/dd
- H. Floorplans - The SMS shall provide graphic floorplan capability including graphic display of links to other floorplans, alarms and system resources such as portals, IP video cameras, inputs, outputs, and temperature monitoring points.
1. The Network Administrator holding at least a Setup user role shall be able to graphically configure device icons onto the floorplan images, and to upload additional floorplan images. JPEG images shall be supported, and the maximum size for a floorplan image shall be 256K.
 2. It shall be possible to create floorplan groups for the purpose of assigning or withholding assignment of these groups to system user permissions known as custom user roles. If a floorplan group is assigned to a particular system user then the floorplans in that group shall be viewable by that system user.
- I. Personnel Data - The SMS shall maintain person data relating to access control, system user privileges, photo identification, system activity, and contact information.
1. All person data in the system shall be integrated onto one tabbed page for viewing, editing, and deletion by system users.

2. A system user holding at least an Administrator user role shall be able to create, modify, delete, and purge person records, including access levels and access level groups.
 3. A system user holding at least a Setup user role shall be able to configure the display of person records. For example, the user shall be able to hide various tabs, and configure the User-defined tab by changing the tab label and customizing any of the 20 data fields that appear on the tab. The user shall be able to enter text, numbers, Boolean expressions, or user-defined list information into these data fields. The user shall also be able to define UDF value lists, which can be displayed as pre-entered drop-down lists for user-defined data fields.
 4. A system user holding the full system setup user role, or a custom user role that includes the Purge Person permission, shall be able to configure the system to automatically purge all person records that have been deleted. This shall include person records deleted before the user set up the automatic purge configuration. The user must enter the number of days after a deletion a person record should be purged. Purging a person record shall permanently remove the record and all related data from the system.
 5. The Person page shall contain a Journal tab, allowing the operator to enter and save a journal entry associated with the person.
- J. Data Security:
1. Administrative access to the security management application and the personnel data shall be password protected and controlled by roles-based authorizations.
 2. In addition, it shall be possible to enable secure communications between the Network Controller and web browsers, and between the Network Controller and Network Nodes.
 3. Communication between the Network Controller and browsers shall be secured using TLS digital certificates. The available options are:
 - a. Generate a self-signed certificate that is signed with your web server's own private key. This certificate shall provide encryption but not authentication.
 - b. Upload a certificate that is signed by a certificate authority (CA) to the Network Controller. This certificate shall provide both encryption and authentication.
 - c. Upload your organization's own certificate and matching key to the Network Controller.
- K. On-board Data Management - Each night the SMS shall truncate a sufficient number of the oldest records held on-board to reduce the database to its set limit, if required. This shall create the needed storage space for additional system activity records. Truncation will be performed on a First-in, First-out (FIFO) basis.
- L. User Roles and Permissions - There shall be four pre-programmed levels of user roles, and custom user roles can be configured in the system with different permissions for each user:
1. Master Partition Monitor - These users may use the functions in the Monitor menu only within the Master (default) partition. Monitor functions shall include viewing the Activity Log, cameras, and floorplans.
 2. Master Partition Administrator - These users may use the functions of both the Administration and Monitor menus only within the Master (default) partition. Administrative

functions shall include adding and editing person information in the enrollment database, issuing and revoking cards, generating reports, and performing database backups.

3. Master Partition Setup - These users may use the functions of the Setup, Administration, and Monitor menus only within the Master (default) partition. Setup functions shall include defining access control, alarm event behavior, camera settings, floorplan images and configurations, holiday and time specifications. Setup functions shall also include: designation of network resources such as time and DNS servers, email and network storage settings; performance of system maintenance such as database backup and restore, software updates and file cleanups; designation of time zone, daily backup schedule and enrollment readers.
4. Full System Setup - These users may use the functions of all menus in all partitions.
5. Custom User Roles - In addition to the roles above the system shall also support the creation of detailed user permissions regarding which data operations, cameras, floorplans, elevators, events, access levels, access level groups, portals, reports, and personal data fields the system user may see, edit, delete, or control.

M. Alarm Events - The SMS shall manage alarm events.

1. It shall be possible to delay an input's change to the Alarm state by a specified number of seconds. The range of delay options shall be 0.5 seconds or from 1 to 120 seconds.
2. It shall be possible to associate specific actions with each alarm event. These actions may include, but are not limited to:
 - a. Lock and Unlock portals.
 - b. Activate and Deactivate relay outputs.
 - c. Arm and Disarm input groups.
 - d. Pulse outputs or output groups.
 - e. Arm and Disarm alarm panels.
 - f. Send emails and SMS messages.
 - g. Move cameras to preset positions.
 - h. Switch to a video monitor.
 - i. Record video.
 - j. Momentarily unlock portals.
 - k. Change the threat level for a location, and (optionally) for its sub-locations.
 - l. Make entries in the Activity Log.
 - m. Play a digital sound file; it shall be possible to specify that it play in a loop until cleared or acknowledged.
 - n. Display alarms in different colors.

- o. Set a priority for an alarm (one of 20 levels, with 1 being the highest).
 - p. Require a duty log entry.
 - q. Clear an alarm automatically or require an acknowledgement.
 - r. Push a Magic View to an Magic Monitor.
 - s. Push a Magic View to a group of Magic Monitors.
 - t. Push a NetVR/VRx camera stream to a Magic Monitor.
 - u. Push a NetVR camera stream to a group of Magic Monitors.
- 3. A system user holding at least a Setup user role shall be able to create, delete, and modify alarm system inputs, input groups, outputs, output groups, alarm panels, and events.
- 4. It shall be possible to trigger events based on system activity such as:
 - a. Failed login attempts.
 - b. Video motion detection.
 - c. Camera failure and camera restore events.
 - d. Valid or Invalid card reads.
 - e. Portals held or forced open.
 - f. Valid card reads with a specified access level.
 - g. Inputs entering an alarm state.
 - h. High and low temperature events.
 - i. Low batter voltage and low battery capacity events.
 - j. Alarm panel arming failures.
 - k. Alarm panel zone faults.
 - l. Tailgating and passback violations.
 - m. Occupancy limit exceeded
 - n. Region empty violations.
 - o. Network Node power failure, communication failure, timeout, and tamper events.
 - p. Active Directory synchronization failures.
- 5. It shall be possible to clone an event which creates an event with all attributes of the original, needing to change only the event's name and any attributes it will not have in common.

N. Activity Monitoring:

1. The SMS shall support a Monitoring Desktop that integrates video, system Activity Logs, floorplans, threat level control, ID photos, and alarm notifications.
2. Activity Log viewing includes one-click navigation to person records.
3. The system shall support a Widget Desktop that allows the creation of custom monitoring layouts. Within a custom layout, widgets display live video, system Activity Logs, alarm notifications, ID photos, floorplans, duty log entries, portal status displays, and intrusion panels.
4. The system shall support specific alarm events in the Events and Alarm Workflow widgets in one of the following three modes:
 - a. *Activations do not display alarms* – No alarm events shall be displayed in either widget when such events are configured in this mode. All settings shall be disabled in the Acknowledgements section of the page.
 - b. *Multiple activations display a single alarm* – Alarm events shall appear in both widgets each time the alarm input is triggered. Each subsequent trigger of the same input shall display a new alarm event which shall replace the previous one.
 - c. *Multiple activations display multiple alarms* – Alarm events shall appear in the Events widget as described in item b above. The Alarm Workflow widget shall simultaneously display a separate alarm event for each alarm trigger.
5. Many widgets support multiple partition viewing and filtering. For example, the Activity Log widget can display data from multiple partitions and data filtered by event type or reader group, and/or based on the text content of the event. Additionally, the system shall support the use of category filters, including Access Control, Alarms and Events, Threat Levels, System Admin, Devices, Network Nodes, Access Granted, and Access Denied.
6. It shall also be possible to view cameras, Activity Logs, and floorplans on separate monitoring pages within the application.
7. The system shall support tracing a person's activity in the current partition if the "Trace this person" check box is selected in the person record.
 - a. The traced activity is displayed in bold in the color selected for "Trace person log color" on the Network Controller page.
 - b. In addition, if an event is selected for "Trace person event" on the Network Controller page, the event is triggered each time a traced person makes an access attempt. These event activations can be reported using a Trace people filter in a custom history report.
 - c. When a user opens a person record in which "Trace this person" is enabled, a dialog box shall indicate that the person's activity is being traced.
8. The Activity Log shall be capable of displaying additional cardholder information, including "Hot Stamp", "Encoded Number", and "Company ID".
9. The system shall include a Photo Display Widget, which allows operators to display a current ID photo based on the most recent access request.

10. It shall be possible for a system user to place restrictions on the retention and tracking of access activity by setting options on the Network Controller page.
 - a. The user can set an option to show Access Granted events in the Activity Log only when both a credential and PIN are used for access.
 - b. The user can set an option to have the system retain Access Granted and Access Denied events only for a specific number of days. Once an Access activity record has been stored for the specified number of days, it shall be purged from the database. Access activity records shall not be included in archives.
- O. Network-based Cameras and Video Surveillance - The system shall provide live IP video surveillance capability. The number of supported cameras shall be limited only by license. The system's video capabilities shall include video monitor switching based on access activity. The system shall provide monitoring, configuration, and administration of IP video. Cameras can be separately monitored or monitored in groups.
 1. Presets - The system shall support the creation, deletion, and editing of camera preset positions in the system. It shall also be possible to save changes in preset positions directly to a camera.
 2. Views - The system shall support the creation, deletion, and editing of multiple camera views, specifically Quad views (four cameras), and NetVR/VRx 2x2 and 1+7 views. The application shall provide a drop-down pick list for selecting current views or naming of new views.
- P. Access Control:
 1. The SMS shall be able to make access control decisions, define a variety of access levels and time specifications, write system activity into a log file, maintain a personnel enrollment database, receive signals from input devices such as door switch monitors, card readers and motion detectors, energize devices such as door locks and alarms via outputs.
 2. Time Specifications: Each time specification must be assigned a unique alphanumeric name of up to 64 characters. The definition of a time specification shall require the assignment of both a start time and an end time.
 - a. Each day of the week shall be individually assignable for inclusion in time specifications.
 - b. Up to eight holiday groups per partition shall be assignable for inclusion in time specifications. If no holidays are assigned to a time specification then no holiday access shall be allowed. It shall be possible for users to change the default holiday group names (hol1 through hol8) to more meaningful names.
 - c. Time specifications shall be assignable to access levels, output groups, portal groups, input groups, and alarm events.
 - d. Time specifications shall function appropriately per Network Node for the time zone specified for that Network Node.
 3. Card Formats - The system shall support the use of readers that use the Wiegand Reader Interface. The system shall support but not require the use of the card facility code. The system shall also support the use of the Magnetic Stripe ABA track 2 card data formats.

- a. It shall be possible to create new card formats, designate start bits and bit lengths for facility codes and card ID numbers, and designate parity bits. The system shall support up to 64 different card formats, and 32 formats can be enabled at a time. With compatible Mercury panels the system shall allow for up to 16 card formats to be designated as Mercury-supported. These Mercury-supported formats will be enabled on Mercury panels.
 - b. It shall be possible to reverse the read order of the bits in the facility code and/or card ID portions of a card format.
 - c. It shall be possible to view and change the default parity bit definitions for a card format.
 - d. A card formats shall be disabled by default. Once enabled, the format appears in the card format dropdown within the credential section of a person record.
 - e. The system shall support the use of a concatenated version of the FIPS 201 format (Federal Information Processing Standard Publication 201)
 - f. FIPS 201 128-bit format. This system-owned credential format is based on Federal Information Processing Standard (FIPS) 201. It can be enabled and disabled, but it cannot be modified. The credential number is a Federal Agency Smart Credential-Number (FASC-N) containing 32 characters, encoded as binary-coded decimal (BCD) digits. When issuing a credential using this format, a user can either enroll the credential via an enrollment reader or use a dialog box to enter a value for each of the fields that make up the 32 BCD string
 - g. Administrators shall be able to specify a specific number of days of non-use that will be allowed before unused cards will be disabled. Administrators shall be able to exempt individual users from this non-use rule.
 - h. The system shall support the Southwest Texas Regional Advisory Council (STRAC) UUID format of 128 bits displayed as 32 hexadecimal characters.
4. Mobile Security User Settings – When the system is registered with Cumulus, a security administrator shall be able to enable and configure system-wide settings for Mobile Security User. These include settings for escalation time, virtual photo ID, self mustering, call security, and crowdsource media.
 - a. A system administrator shall be able to use the Mobile Apps tab in a person record to enable Mobile Security User for a person, assign the person to people groups which define a notification process for mobile apps users, and enable the Threat Level Module for the person.
5. The system shall support the provisioning and management of Blue Diamond mobile credentials within the NetBox user interface, as well as the registration and de-registration of BlueDiamond Mobile readers.
6. The system shall support the provisioning, issuance, and management of HID mobile credentials within the NetBox user interface.
7. People groups – Security administrators shall be able to apply access level approval or notification workflows to a group of person records.

8. Access Levels - The system shall be capable of storing unlimited access levels in each partition.
 - a. Each access level must be assigned a unique alphanumeric name of up to 64 characters.
 - b. The definition of an access level shall require the assignment of a reader or reader group, and a time specification.
 - c. It shall be possible to also assign an elevator floor group to an access level.
 - d. It shall be possible to create a temporary access level by assigning an activation date and/or expiration date for any of a person's assigned access levels. It shall also be possible to have the system automatically remove a temporary access level once it has expired.
9. Access Level Groups – The system shall support the creation of access level groups, which will allow users to assign multiple access levels at once. Users with at least a Setup user role can create single-partition access level groups that can be viewed and assigned within the partition in which they were created. Users with the Full System Setup role can also create multi-partition access level groups, which can be viewed and assigned across partitions, and can contain access levels from multiple partitions, depending on the user's permissions.
10. First-in Unlock Rule: The system shall support the use of a First-in unlock rule. It shall be possible to use this rule to control the unlock behavior of portal groups with assigned unlock time specs.
 - a. The First-in unlock rule shall require a card read of a specified access level. The portals in the group shall unlock only when the rule is satisfied and the unlock time spec is valid.
 - b. There can be up to 64 First-in unlock rules in the system at a time.
11. Double Card Presentation - The system shall support the use of a Double Card Presentation mode. This mode shall allow the presentation of a card twice in quick succession at a designated reader. Such a "double read" shall change the locked portal to an unlocked state until a subsequent relock event or user-designated timeout occurs. The double card presentation mode shall be enabled on an individual portal basis and shall also require a designation on the access level assigned to the cardholder. The mode shall adhere to time spec and threat level restrictions.
12. Keypad timed unlock - It shall be possible to enable a timed unlock feature for a portal that has a combination reader/keypad device. Once this feature is enabled, any cardholder with valid access to the portal shall be able to specify how long the portal will remain unlocked.
 - a. A cardholder presents his or her card and then enters the associated PIN, followed by the number sign (#) and the number of minutes (1-99) the portal should remain unlocked.
 - b. The portal will remain unlocked for the specified number of minutes; unless it is closed before the timer expires. If the portal remains open after the timer has expired, a [Door Held Open] alarm will be activated.

- c. If reader/keypad devices are located on both sides of the portal, cardholders will be able to use either device to initiate a timed unlock.
- 13. Keypad Commands - For Network Node connected access control keypads and combination card reader/keypads, users having the authorized access levels shall be capable of executing keypad initiated commands based on pre-defined two-digit number codes.
 - a. Keypad commands shall be defined by mapping one or more two-digit codes to events defined in the system using the "Setup: Alarms: Keypad Commands" page.
 - b. Keypad commands shall be assigned to specific keypads using the "Setup: Access Control: Readers/Keypads" page.
 - c. Keypad commands shall be assigned to specific access levels using the "Setup: Access Control: Access Levels" page.
- 14. Holidays - The system shall support up to 30 holidays Network Node. Each holiday must be assigned a unique alphanumeric name of up to 64 characters. The definition of a holiday shall require a start date and an end date. Holidays shall have the ability to span several days using only one holiday slot. Holiday definitions shall support the designation of a start time and an end time. If no start time is designated then the system shall default to 00:00 (start-of-day). If no end time is designated then the system shall default to 24:00 (end-of-day). Holidays shall require the use of 24-hour time format, e.g. 17:00 is 5:00PM.
- 15. Portals - A portal is a configurable object which can contain a reader or two readers, with or without keypads; a door status monitor (DSM); a request to exit (REX) device; and a lock. A system user with at least the Setup role shall be able to view current portal definitions, change portal definitions, delete portals, and create new portals. Creating a portal defines the access and alarm behavior of the access point. This can include:
 - a. Card readers and keypads.
 - b. Output for locking.
 - c. Input for monitoring the door switch.
 - d. Input for a Request-to-Exit function.
 - e. Local alarm outputs and system alarm events.
- 16. With compatible Mercury panels, the system shall support Facility Code Mode for reader/keypads, with the following available options.
 - a. None (the default): The facility code is treated as part of the overall encoded credential number. A card matching only the facility code will not be granted access.
 - b. Configuration: Facility-code only checking is turned on only while the complete set of credentials is being downloaded to the Mercury panel. Once the credential download is complete, the behavior is the same as for the "None" setting.
 - c. Offline: Facility-code only checking is turned on only when the SIO is disconnected from its Mercury panel (via the RS-485 link). When the SIO is connected to the panel, the behavior is the same as for the "None" setting.

- d. Configuration and Offline: Facility-code only checking is turned on both during the credential download and when the SIO is disconnected from its Mercury panel. At all other times, the behavior is the same as for the "None" setting.
 - e. Permanent: Facility-code only checking is always turned on.
17. Anti-passback - The system shall support both regional and timed anti-passback access control. For anti-passback functions, it shall be possible to configure regions, assign readers to those regions, and specify events for response to tailgate, passback, and occupancy limit violations. It shall also be possible to designate parent regions for hierarchical anti-passback.
- a. Grace: It shall be possible for a system Monitor or Administrator to Grace Card holders from passback and tailgate violations.
 - b. It shall also be possible to set a specific time for all cardholders to be graced daily.
 - c. The system shall be able to automatically place the cardholder in a predefined region upon the selection of the grace option.
18. Mustering - To aid in evacuation management it shall be possible to designate a region or regions for mustering. It shall be possible to quickly get an occupancy count and occupant list for any region.
19. Scheduled Actions - It shall be possible to specify system actions to occur at scheduled times. When scheduling an action, it shall be possible to specify whether the time specifications for the scheduled action will be based on the time zone set for the local Network Node or the time zone set for the Network Controller. Scheduled actions can include:
- a. Arming and disarming inputs and input groups.
 - b. Activating and deactivating outputs and output groups.
 - c. Locking and unlocking portals and portal groups.
 - d. Locking and unlocking elevator floors and floor groups.
20. Floor plans - The system shall support displaying of active graphic floorplans and configuring each floorplan with icons representing system resources: cameras, portals, temperature points, and alarms. A network administrator holding at least a Setup user role shall be able to upload floorplan images and graphically configure device icons onto the floorplan images. Viewing floorplans will require the Adobe Flash Player plug-in for the browser.
- a. It shall be possible to create floorplan groups for assigning or withholding assignment of these groups to system user permissions known as custom user roles. If a floorplan group is assigned to a system user then the floorplans in that group shall be viewable by that system user.

Q. Reports:

- 1. The SMS shall support a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system.

2. It shall also be possible to produce reports directly from the Network Controller based on data in archive files on FTP or SFTP servers, network attached storage, or the built-in hard drive.
3. The SMS shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters can be inserted into reports to prompt for data input at report runtime. Report results can be printed, output to a PDF file or put into a spreadsheet.
4. It shall also be possible to group reports for assignment to custom user roles. Any reports not grouped and assigned to a custom user role shall not be viewable by that system user.
5. The system shall be capable of sorting users by various criteria, including email address, and allow for email groups to be selected for auto-distribution.
6. Report generation shall not affect the real-time operation of the system.
7. The specific reports provided shall include the following:
 - a. Configuration Reports
 - 1) As Built - A graphical report that displays an image of each Application Blade in a Network Node and the specific resources (inputs, outputs, readers, etc.) configured for that blade. The network settings for the Network Node shall also be included. This report shall display an image of each Mercury panel being used and specific resources configured on those panels.
 - 2) Cameras - Displays all camera configuration information including control address, IP port, and camera type.
 - 3) Camera Presets - Displays configured presets for each camera in the system.
 - 4) Elevators - Displays elevator configuration information including Network Node, reader, floor to output mappings, floor select, and duress/emergency inputs.
 - 5) ENGAGE Locks – Lists all Allegion ENGAGE devices in the system. For each device, the report shall include the device ID, name, ENGAGE Gateway, status, battery voltage, signal quality, firmware version, MAC address, and WiFi version.
 - 6) Floor Groups - Displays all configured floor groups for use in elevator control.
 - 7) Holidays -Displays holiday specification information.
 - 8) Portals - Displays portal definition information including reader, DSM input, REX input, alarm outputs, and events.
 - 9) Portal Groups - Displays a list of all defined portal groups.
 - 10) Reader Groups - Displays defined groups of readers.
 - 11) Remote Locks - Available if the Remote Locks feature is licensed for the system. Displays the following information for each remote lock: name, IP address, synchronization status, serial number, last completed update time, firmware version, battery voltage, assigned remote lock profile, and number of stored cardholders. The report can be sorted by any of the columns.
 - 12) Resources - Displays all configured system resources including readers, inputs, outputs, elevators, and temperature points.
 - 13) Threat Level Groups - Displays all configured threat level groups and the threat levels assigned to them.
 - 14) Threat Levels - Displays all configured threat levels including the description and color assignment.

- 15) Time Specs - Displays all configured time specs currently in the system. Time specs, which define allowed access times, are used as part of access level definitions.
- b. History Reports
 - 1) Access History - Displays access history based on an entered query. The system user can specify the query using either the keyboard or point-and-click selection. Access history reports shall include the ability to include elevator access requests.
 - 2) Access Level Approval Status – For systems with Mobile Settings enabled, lists all access level approval requests whose status changed at least once during the system's specified approval escalation time period as they moved through the approval process.
 - 3) Alarm Resolution – Provides a report that tracks alarm duration. This is the period between the activation of an alarm and its resolution. Alarms are individual activations of events defined in the system. For an alarm to be resolved, it must be acknowledged (if acknowledgement is required according to the associated event definition) and its underlying cause must be cleared.
 - 4) Custom History Report - Provides the ability to create custom reports of historical data. A graphic interface provides the user with the ability to interactively create and save reports for later use. Parameters can be inserted into reports to prompt for data input at report runtime. Custom report output shall be user selectable for HTML, PDF or CSV format. Custom report configuration shall include page size, orientation, and column width and shall automatically notify the user if the selected configuration exceeds the selected page size.
 - 5) General Event History - Displays time, type of activity, and activity details for a variety of event types. The system user can select the specific event types for the report.
 - 6) Portal Access Count - Display how many times users have used a portal.
 - 7) Audit Trail - Displays an audit trail of system changes and the name of the system user that made the changes. It shall be possible to specify the dates and times covered in the report.
 - 8) Duty Log - Displays duty log comments residing in the current security database, including archives. For each duty log comment, the report shows the date and time the comment was entered, the person who entered the comment, the date and time of the logged event associated with the comment, and the Activity Log message followed by the specific comment text.
- R. Administration - The SMS shall provide for the performance of system administration tasks from any network-connected computer with a browser. Most of the administrative, maintenance, and configuration utilities and functions shall require a SMS user with at least a Setup user role. Information from the network administrator shall, in many cases, also be required. These administrative tasks shall include but not be limited to:
 1. Generating reports:
 - a. The system shall support a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system.
 - b. Alternatively, the system shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters can be inserted into reports to prompt for data

input at report runtime. Report results can be printed, output to a pdf file or put into a spreadsheet.

- c. It shall also be possible to group reports for assignment to custom user roles. Any reports not grouped and assigned to a custom user role shall not be viewable by that system user.
- d. A system user holding All Administration permissions, or permissions to view and edit specific types of reports, shall be able to view and create reports.

2. Database backups:

- a. The system shall create database, or full system data backups, each night at 00:15 hours. These backups shall be stored in ROM and written to the drive on the disk-based controller.
- b. It shall also be possible for system users to create such database backups at any time. Any database backups onboard the Network Controller may also be downloaded to off controller storage by the system user at any time.
- c. Backups shall also be written to network attached storage (NAS), or to an FTP or SFTP server if such storage has been configured in the system.
- d. A user with at least a Setup user role shall have the ability to schedule a time for the daily transfer of backups to NAS. The user can specify that the transfer will occur after the daily backup or at a specific time of day.

3. System restore:

- a. The system shall be able to restore its database, or the full system data, from a backup. Restoration of the system shall only be possible from a backup copy onboard the Network Controller. It shall, therefore, be possible to upload a copy of a database backup from any network attached storage.
- b. It shall be possible to review backups by date and description and select the desired backup for upload to the Network Controller or restoration as the current system database.

4. Software updates:

- a. Software updates, upgrades and patches shall be provided from time to time. The system shall be able to update its software from these .upg files. Update of the application software shall only be possible from an update file onboard the Network Controller. It shall, therefore, be possible to upload a copy of the software update from any network attached storage or from any PC drive or desktop.
- b. Software updates may involve the Network Controller only or may include updates for the Network Node(s) also. The monitoring of the security system may be unavailable for several minutes during this process.

5. File upload - The system shall support uploads of files for use in and with the system. Supported files include:

- a. Floorplans in .jpg format

- b. Badge layouts
 - c. ID photos in .jpg format
 - d. Database backups
 - e. Software license files
 - f. Software updates
 - g. Threat level icons in .jpg format
 - h. Sound files (.wav) for use in event alerts
6. Setting system time, time zones, and time servers:
- a. The SMS shall support the setting of time zones by selection of a drop-down pick list. Time zones shall be separately settable for the Network Controller and for each M1-3200 Network Node, MicroNode Plus, or Mercury panel in the system. An extensive list of world-wide time zones shall be provided. Adjustments for daylight saving time (summer time) shall be automatic.
 - b. The SMS shall support the use of network time servers. Up to three time servers can be designated. Use of a network time server ensures that the Network Controller and its Network Nodes are regularly synchronized with the exact time used by all other network resources.
 - c. It shall also be possible to manually set the system date and time.
7. Changing passwords:
- a. Person data maintained in the system may also contain a user name and password for logging on to the security application website as a system user. The system shall support the changing of administrator passwords. It shall be required to enter the password twice for verification purposes.
 - b. Administrators shall be able to specify a minimum number of characters that users must include in their login passwords.
 - c. Administrators shall be able to specify that users' login passwords must contain a combination of letters, numbers, and special characters.
 - d. Administrators shall be able to set a password expiration period in months (from 1 month to 12 months) for all passwords in the current partition. Whenever a user changes his or her password, it will remain in effect for the selected number of months.
 - e. It shall also be possible to integrate an LDAP or SLDAP server for single-user logon authentication. This will reference the LDAP-stored password for use by the system.
8. Issuing and revoking cards (credentials):
- a. Access cards shall be assignable by the system user either by entering card data directly into the person record or by use of an enrollment reader. Access levels shall be assignable through the user interface by selection from the list.

- b. Access cards shall be revocable at any time. A system user holding at least an Administrator user role may perform this action. Revoked cards shall stop functioning immediately.
- c. A system user holding at least the Administrator role may also disable an access card by changing its Active status to Clear, Damaged, Disabled, Expired, Forgotten, Lost, Missing Active, Missing Disabled, Not Returned, Not Used Not Validated, Returned, Stolen, Suspended or Temporary Expired. The card will not function with any of these status settings (unless the setting has been customized, as described below). Running a Credential Audit report shall allow existing cards to be viewed by their status settings.
- d. A system user holding at least the Administrator role may customize any of the following access card status settings: Clear, Damaged, Forgotten, Lost, Not Returned, Not Validated, Returned, Stolen or Suspended. The user can change the name and/or description of the status setting, and can specify that a card to which the setting is applied will continue to function.
- e. A maximum number of active cards per person can be enabled for the system. Once a person has reached the system limit, a new card can be added for that person only if one of his or her active cards is revoked or disabled.
- f. When "Enable credential profiles" is selected on the Network Controller page, it shall be possible to assign credential profiles to individual credentials to determine the number of days of non-use before they expire.
- g. It shall be possible to set expiration dates for individual credentials in a person record. When a Network Controller encounters an expired person record during its nightly system check, it shall modify that person record from "Active" to "Expired". Similarly, if an expired person record is set to "Temporary", it shall be changed to "Temporary Expired".
 - 1) To reactivate "Expired" and "Temporary Expired" credentials, a system user with appropriate user role permissions may edit the person record in the User Interface, and modify the expiration date to a future date/time. Once the record is saved, the person record status will be changed to "Active" or "Temporary".
- h. It shall be possible to specify that any credential not used within a specific number of days from the date it was issued will be disabled automatically.
- i. To ensure that all new and modified credentials have expiration dates, a user with Setup privileges can enable a credential expiration requirement option for the system. When this option is enabled, users will be prevented from saving new and modified credentials that do not have expiration dates. The API shall enforce this by requiring that a valid expiration date be passed when a command is issued to add or modify a credential.
- j. The "First Name", "Middle Initial", and "Last Name" fields of each Person Record shall allow for up to 50 characters each.
- k. The system shall provide for a workflow to be configured to facilitate processing of lost and/or forgotten credentials.

- I. The system shall track credential status information and make it available for use in creating up-to-the-minute credential status reports.
9. Enrolling new people:
 - a. All person data entered into the system shall be held in the system database and shall be available only to system users holding at least an Administrator user role.
 - b. Person data can be added, deleted, and edited by users holding at least an Administrator user role.
 - c. The system shall support person record templates.
 - 1) Each template defines values for specific fields, such as a default set of access levels.
 - 2) These values will be filled in automatically in any person record created from the template.
 - 3) When adding a person to the system, a user shall be able to use one of the available templates in the active partition to create the person record, or create it without a template.
 - 4) Person Record Templates shall be available for use in custom People report definitions and in person search criteria.
10. Creating Photo IDs - The system shall include an integrated photo ID function. It shall be possible:
 - a. To design badge layouts.
 - b. To upload badge layouts for badge printing.
 - c. To capture ID photo images, print badges, and delete uploaded badge layouts.
 - d. For the system user to manage all photos ID functions entirely from within the browser.
 - e. To track the number of times a badge has been printed.
 - f. To print multiple badges at once using the Badge Print Workflow.
 - g. To enroll a person's card number manually or through a reader and save the new credential from the Badge Print Workflow.
 - h. The system shall be capable of automatically generating auto-incremental encoded credential numbers. Each new encoded credential number shall be increased by one over the next highest number in the system.
11. Configuring network resources:
 - a. Cumulus registration – The system shall support the registration of an SMS with Cumulus to support cloud-based monitoring and administration of the system from a single management dashboard.
 - b. Microsoft Active Directory Data Synchronization – It shall be possible to configure an Active Directory (AD) server for data synchronization:

- 1) Each NetBox shall support up to 10 AD server connections.
 - 2) A user with the Full System Setup role shall have the ability to create up to 10 configurations for synchronizing data, with the same AD server or with different AD servers.
 - 3) Each configuration shall allow the synchronization of: (1) person attribute values stored on the AD server with values displayed in person records on the NetBox, and (2) security group assignments on the AD server with access level assignments on the NetBox.
- c. Microsoft Active Directory User Authentication – It shall be possible to configure an Active Directory (AD) server for user authentication:
- 1) The configuration shall provide single user-login capability.
 - 2) Password rules and authentication will be governed by the AD server.
- d. Domain Name Servers (DNS) - The system shall support setting IP addresses for up to two domain name servers.
- e. Email settings - The system shall support the use of email notifications of alarm events.
- 1) The system user must setup the email server IP address or DNS name and the email address of the Network Controller.
 - 2) A network administrator must setup the network mail server to relay email for the IP address of the Network Controller.
 - 3) When setting up an email relay, users shall be able to select a port number other than 25 to indicate that the system should attempt to use encrypted SSL connections for the outgoing messages. If an encrypted connection is not available, then the system will fall back to port 25 for an unencrypted connection.
- f. File Transfer Protocol (FTP) - The system shall support the use of an FTP or SFTP Server for backups. Once configured, backups are automatically saved to the FTP server on a daily basis.
- g. Time sever – It shall be possible for a system user to set up a primary Network Time Protocol (NTP) server and, optionally, secondary and tertiary NTP servers. The Network Controller's use of an NTP server will ensure the system will be synchronized regularly with the exact time used by all other network resources.
- h. Remote logging – It shall be possible for a system user to set up remote logging. This will ensure that messages generated by the SMS will be forwarded to a remote host running the Rsyslog daemon.
- i. A system user holding at least a Setup user role shall be able to configure network resources. Configuring an Active Directory server for data synchronization requires the Full System Setup user role.

12. Data Operations:

- a. View – Users having the “Data Operations: View” user role permission shall be able to view the results of data operations. Depending on which other user permission roles assigned to them, they may also be able to add person records (including access level, credential, and user defined person record information) to the SMS, and modify and delete existing person records.
- b. Import File – Shall enable the user to manually upload (import) tab-separated or comma-separated (CSV) text files.
- c. Export File – Shall enable the user to manually download (export) CSV text files.
- d. Automatic Import – Shall enable the system to process an Import File at scheduled intervals from a pre-configured NAS location.
- e. Automatic Backups – Shall support the use of network attached storage (NAS) devices for automatic backup of Data Operations Import files to a network storage location.
- f. Person Record Management – Data Operations shall provide the user interface to import person record CSV data to the NetBox SMS. Data Operations shall also be the interface for exporting the complete set of current access level and credential configuration of existing person records from an NetBox SMS to an external target system.

2.05 MAGIC MONITOR(R) INTEGRATION

- A. The Magic Monitor Network Security Management System shall provide a single client management application for the security system.
- B. Magic Monitor shall integrate with NetBox SMS systems.
- C. Magic Monitor software shall be available to be installed as a native client.
 - 1. Supported Operating Systems
 - a. Windows 10
 - b. mac OS Catalina 10.15
 - c. mac OS Mojave 10.14
- D. The Magic Monitor appliance shall be available as a single monitor/TV appliance or a multi-monitor solution.
- E. The Magic Monitor solution shall provide the ability to operate in a secure access mode that requires the application to use existing credentials from the NetBox, NetVR, or VRx and shall not require duplication of users
 - 1. Login credentials shall be able to be managed as a single credential over the video, access-control and Magic Monitor client operations.
 - 2. Magic Monitor software shall provide a standalone mode with no requirement to authenticate with the NetBox and shall provide the ability to add network video recorders and access controllers with local credentials.

3. Security of the data communicated over the network to and from the Magic Monitor software shall be protected by encryption (SSL 128-bit) or authentication (TLS).
 4. Magic Monitor shall provide the ability to be set as an active client for video, access control and event management or as a standalone remote managed screen for video and public safety notifications.
- F. Magic Monitor shall provide the ability to search for person records in SMS systems, and to view, edit, and add person records, based on the user's permissions on these systems.
- G. Magic Monitor shall provide live real-time monitoring of access-control activity data, and video verification in real time over local and wide area networks.
- H. Magic Monitor shall provide the ability to view recent activity at a portal defined on an SMS, and to momentarily unlock a portal, based on the user's permissions on the SMS.
- I. Magic Monitor shall provide the ability to show video based on access control activity, live or recorded, and the option to view image from the card holder database based on the access control activity.
- J. Magic Monitor shall support simultaneous access to video, data, alarms and events from multiple servers.
- K. Magic Monitor shall support ability to span client into multiple direct attached monitors.
- L. The Magic Monitor client shall show live operation video, access control data, pop up events and push notifications, and life safety or any other digital signage graphics.
- M. Magic Monitor shall allow for the creation of custom layouts, including up to 400 cells.
- N. Magic Monitor shall be able to manage multi-media content:
1. Video Streams
 2. Access Control Activity
 3. Cardholder Images
 4. Images to be used in digital signage [.jpg and .png]
 5. Video Clips [MP4 and MOV]
 6. Date and Time
 7. Weather
 8. Traffic
 9. Information from private and public RSS feed
 10. Twitter® feeds
 11. Pandora® Radio
 12. YouTube TV

13. Web content

14. Text

2.06 VIDEO MANAGEMENT SYSTEM INTEGRATION

1. General: The SMS shall support the integration of certain Network Video Recorders (NVR). This integration shall allow the viewing of live streaming video in the browser interface and recorded video playback. Viewing live streaming video shall require the Java™ 2 Runtime Environment version 1.4.2 or version 5.0.
2. Events in the alarm subsystem can initiate video recording. Video motion detection and camera up/camera down messages from the VMS can initiate alarms.
3. It shall be possible to monitor NVR cameras in the same views as direct IP cameras. VMS events shall be logged in the system Activity Log. It shall be possible to view recorded video of events from the Activity Log.
4. It shall be possible to view live cameras through floor plans, on the camera view pages, and on the Monitoring and Widget Desktops.
5. It shall be possible to pull up recorded video through reports.

B. NetVR/VRx Appliances (NetVR and NetBox VR / VRx and NetBox VRx):

1. NetVR/VRx appliances must integrate with LenelS2 systems access control, event monitoring, and video management into a single user interface for real-time video monitoring and recorded video playback.
2. NetBox VR/NetBox VRx shall be either a fully self-contained video management appliance, or a one-box unit with both an access control system and video management appliance; also containing a database, an operating system and application software, as well as raw video storage.
3. Multiple NetVR/VRx appliances can be connected to Network Controllers as follows:
 - a. Up to 4 subordinate NetVR/VRx appliances supporting up to 256 cameras, with one NetBox system
4. NetVR/VRx appliances shall use browser-based functionality with the use of an installed Magic Video Player
5. NetVR/VRx appliances shall natively support up to 128 cameras
6. NetVR/VRx appliances shall support video surveillance features, including:
 - a. Real-time surveillance video integrated on the home page, the Monitoring Desktop, and the Widget Desktop
 - b. Viewer-adjustable single-camera and multi-camera views (2x2 or 1+7) and presets
 - c. The ability to call up cameras through events and through floor plans

- d. The ability to configure a camera's settings, including the camera name, overlay, preset positions, image settings, connection, and video stream
 - e. The ability to schedule continuous and motion-activated recording for a camera
 - f. The ability to browse video from anywhere that has permitted access to the network and has the Magic Video Player installed
 - g. The ability to organize surveillance tools using favorite cameras, camera categories, and camera sort order.
 - h. VRx provides the ability to manage and display crowdsourced video. Video footage submitted through Magic Monitor can be stored on the VRx server and made available in Magic Monitor Forensics.
 - 7. Network Address Translation (NAT): SMS system users shall be able to configure NAT settings for an NetVR/VRx that is behind a NAT device. NAT allows multiple devices on a private network to be mapped to a single IP address.
 - 8. Disk Management: SMS system users shall be able to view storage drives that have been installed in an NetVR/VRx appliance, and adopt drives into NetVR/VRx so it can begin using them for video storage.
- C. Third-party Video Integration Functionality:
- 1. Third-party NVR integration shall be performed by using the LenelS2 Open Video Interface Document (OVID)
 - 2. A TCP/IP connection shall be established between the SMS and the third-party NVR.
 - 3. The Integration shall support:
 - a. Trigger video recordings
 - b. Trigger preset commands
 - c. PTZ control
 - d. Recalling recorded video
 - e. Motion events
 - f. Video loss events
 - g. Video restore events
 - 4. Integrated NVR Systems:
 - a. Exacq – exacqVision – 9.8
 - b. Milestone XProtect Systems – Professional+ (2019-R3), Professional (2017-R2, 2018-R3, 2019-R2), Expert (2017-R2, 2018-R3, 2019-R2, 2019-R3), and Corporate (2017-R1, 2018-R3, 2019-R3)
 - c. OnSSI – Ocularis 5.3

- d. Salient Systems - CompleteView NVR 3.5.2
 - e. Video Insight - Enterprise Video Management Software 4.3
 - f. Avigilon - Avigilon Control Center (ACC) 6
5. Open Video Interface Driver (OVID) API:
- a. This specification defines an API to implement the integration of video surveillance systems with the SMS.
 - b. The OVID API shall allow users to monitor and control one or more video servers along with their associated video cameras, to augment the physical security devices (door locks, card readers, etc.) controlled by the SMS.
 - c. The integrated system shall be controlled through a web browser user interface which presents an integrated view of both the SMS and the video surveillance system.

2.07 MERCURY AND MERCURY POWERED HARDWARE INTEGRATION

- A. The SMS shall support the integration of access control hardware from Mercury Security Corp.

1. Supported Mercury EP-Series and LP-Series Panels:
- a. EP2500: Intelligent Controller: 32MB RAM, Ethernet
 - b. EP1502: Intelligent Dual Reader Controller: 16MB RAM, Ethernet, 2 readers) 8 inputs, 4 relays
 - c. EP1501: Intelligent Single Door Controller: PoE, single door, 2 readers, 2 inputs, 2 outputs
 - d. LP2500 Master Intelligent Controller (no onboard I/O): Ethernet.
 - e. LP1502: Intelligent Reader Controller (2 readers, 8 inputs, 4 outputs)
 - f. LP1501: Intelligent Controller with PoE and Edge-capability (2 readers, 2 inputs, 2 outputs)
 - g. A security administrator shall now be able to compare the current firmware version for a Mercury panel with the recommended firmware version; and if the panel's firmware is out of date, update the panel to the recommended version.
2. Supported Mercury Interface Boards (SIOs):
- a. MR-50 Reader Interface Module (Series 2 and 3): 1 reader (magnetic stripe or Wiegand), 2 inputs, 2 relays
 - b. MR-52 Reader Interface Module (Series 2 and 3): 2 readers (magnetic stripe or Wiegand), 8 inputs, 6 relays
 - c. MR-16in Input Monitor Module (Series 2 and 3): 16 inputs (zones), 2 relays

- d. MR-16out: Relay Output Control Module (Series 2 and 3): 16 relays
3. Supported Mercury MS Bridge Devices: The Mercury MS Bridge hardware platform uses legacy Software House enclosures retrofitted with Mercury MS and MR devices to replace existing Software House devices. The following Mercury hardware components shall work with the Network Controller:
- a. MS-ICS - intelligent control device for the replacement of the Software House Pro Series General Controller Module (GCM)
 - b. Supported Mercury Interface Boards (SIOs):
 - 1) MR-50 Reader Interface Module (Series 2 and 3): 1 reader (magnetic stripe or Wiegand), 2 inputs, 2 relays
 - 2) MR-52 Reader Interface Module (Series 2 and 3): 2 readers (magnetic stripe or Wiegand), 8 inputs, 6 relays
 - 3) MR-16IN Input Monitor Module (Series 2 and 3): 16 inputs (zones), 2 relays
 - 4) MR-16OUT: Relay Output Control Module (Series 2 and 3): 16 relays
 - 5) MS-ACS - 8-reader interface board for the replacement of the Software House Pro Series ACM
 - 6) MS-I8S - 8-input interface board for the replacement of the Software House Pro Series I8
 - 7) MS-R8S - 8-output interface board for the replacement of the Software House Pro Series R8
4. Supported Mercury M5 Bridge Devices: The Mercury M5 Bridge hardware platform uses legacy Mercury Casi Micro/5 enclosures retrofitted with Mercury M5 and MR devices to replace existing Casi devices. The following Mercury hardware components shall work with the Network Controller:
- a. M5-IC - intelligent control device for the replacement of the Casi PX, PXN, and PXNplus CPU controllers
 - b. Supported Mercury Interface Boards (SIOs):
 - 1) MR-50 Reader Interface Module (Series 2 and 3): 1 reader (magnetic stripe or Wiegand), 2 inputs, 2 relays
 - 2) MR-52 Reader Interface Module (Series 2 and 3): 2 readers (magnetic stripe or Wiegand), 8 inputs, 6 relays
 - 3) MR-16IN Input Monitor Module (Series 2 and 3): 16 inputs (zones), 2 relays
 - 4) MR-16OUT: Relay Output Control Module (Series 2 and 3): 16 relays
 - 5) M5-2K - multi-device interface panel for the replacement of the Casi M2000 reader controller

- 6) M5-2RP - multi-device interface panel for the replacement of the Casi 2RP reader control device
 - 7) M5-2SRP - multi-device interface panel for the replacement of the Casi 2SRP reader control device
 - 8) M5-8RP - multi-device interface panel for the replacement of the Casi 8RP reader control device
 - 9) M5-16DO - multi-device interface panel for the replacement of the Casi 16DO output control device
 - 10) M5-16DOR - multi-device interface panel for the replacement of the Casi 16DOR input control device
 - 11) M5-20IN - multi-device interface panel for the replacement of the Casi 20DI input control device
 - 12) MUX8 – multi-device interface panel for the replacement of the Casi M Series 8RP to a single communications port
 - 13) CASI F2F readers and keypads shall be supported for Mercury M5 Bridge 2RP, 2SRP, and 8RP panels
5. Supported Schlage Devices:
- a. Mercury-connected Schlage AD-400 wireless locks and WRI400 wireless access point modules via PIM-400 module.
 - b. Mercury-connected Schlage AD-300 Wired locks.
6. Supported Honeywell PW-Series Devices:
- a. Mercury-powered PW-Series devices controlled and connected to intelligent control module PW6K11C.
7. Mercury support for OSDP readers: When configuring readers for Mercury SIOs, users can enable the Open Supervised Device Protocol (OSDP). For readers that support AES 128-bit encryption, users shall be able to enable encryption as well. OSDP shall allow for tamper and disconnect actions, which can trigger events.
8. Mercury support for TLS encryption: When setting connection options for a Mercury panel's communication channels, users can select a TLS Secure option, which replaces the AES encryption option. The TLS Secure option shall enable reliable communications between the Network Controller and the Mercury panel through the use of the Transport Layer Security (TLS) protocol.
9. Mercury support for alternate readers: When configuring a reader, a user shall be able to specify that it will be used only as an alternate reader for an elevator on a Mercury panel. Although access to the elevator will be associated with the elevator's primary reader, cardholders will be able to request access at either of the elevator's readers.
10. Mercury support for cipher mode: User shall be able to define cipher mode credential formats and cipher mode reader/keypad devices. A person to whom a cipher code has

been issued shall be able to either enter the code or present a valid credential to access portals for which cipher mode reader/keypad devices are defined.

2.08 ALLEGION ENGAGE REMOTE DEVICE INTEGRATION

- A. The NetBox, NetBox Extreme, NetBox Enterprise 50, and NetBox Enterprise 100 Security Management Systems shall support the integration of the following Allegion ENGAGE devices:
 - a. Schlage NDE Series (cylindrical) and LE Series (mortise) Wireless locks – used for access control in commercial, institutional, and multi-family facilities.
 - b. Schlage BE Series (deadbolt only) and FE Series (lever and deadbolt) Control locks – used for access control in residential properties.
 - c. Von Duprin RM/RU (Remote Monitor/Remote Undog) exit devices – used for mass access control, and do not have physical readers or user databases.
- B. The SMS shall support the integration of ASSA ABLOY Wi-Fi enabled locks (models v.S2, p.S2, and IN120) and PoE locks (models v.S1, p.S1, and IN220).
 - 1. The system shall support more than 500 remote locks; each Network Controller configuration shall be rated for the number of locks it can support.
 - 2. Once a remote lock is installed and registered with the Network Controller, it appears in the security application as a “remote lock” node, which can be enabled and configured to work with the Network Controller.
 - 3. When a remote lock connects to the Network Controller, it shall report its power type, which is encoded in its serial number.
 - a. A lock reporting having PoE or direct hardwired power shall be treated as an online lock and assigned the Default (Online) lock profile.
 - b. A lock reporting having only batteries as a power source (such as a Wi-Fi lock) shall be treated as an offline lock and is assigned the Default (Offline) lock profile.
 - c. The offline remote lock shall update the Network Controller with the current voltage level of its battery upon each connection.
 - d. Clearing the “Online” check box on the Advanced tab of the Network Nodes page will change an online lock communication status to offline.
 - e. The default lock profile automatically assigned to the lock the first time it connects to the system shall be editable.
 - 4. It shall be possible to set configuration options for a remote lock to change its call-in and unlock behaviors.
 - 5. It shall be possible to configure the reader and portal that were automatically created for a remote lock.
 - 6. It shall be possible to view cached information for a remote lock, for troubleshooting purposes.

7. It shall be possible to specify special-use formats for access cards to be used with remote locks.
8. The remote lock shall be able to send high priority events to the Network Controller.
9. It shall be possible to schedule an automatic unlock period for remote-lock portals. The start of this period can be triggered by time or by an initial valid card read.
10. It shall be possible to select a check box when creating a magnetic stripe ABA Track 2 card format to ensure that the format will be recognized by remote locks with magnetic stripe card readers.
11. It shall be possible to create remote lock profiles to assist in the configuration and management of large numbers of remote locks. A lock profile is a defined set of attributes that affect lock behaviors. Assigning a profile to a lock gives it the attributes defined in the profile. Any subsequent changes made to the profile are applied to the lock automatically.
12. Locks shall support PIN-only credentials.
13. It shall be possible to specify a voltage level below which an offline lock will go into power saving mode. If a Low Battery event is enabled for the lock, the event will be triggered. Once the battery is replaced, the lock will leave power saving mode only when the voltage level reaches 1.5 Volts higher than its current Low Voltage setting.
14. It shall be possible for a remote lock to check for permissions with the host (controller) for a person that is not yet stored in the lock.
15. Online locks shall have the same capabilities as offline locks with the following additional capabilities:
 - a. Online locks can be assigned to locations; changes to a location's threat level can cause the locks in that location to enter and exit panic mode.
 - b. Online locks shall have momentary unlock capability while in panic mode (by means of an event action or button on the portal status page).
 - c. Online locks shall be capable of persistent unlock or lock mode (by means of an event action or button).
 - d. Online locks can be added and managed in floorplans.
 - e. Online locks can be unlocked momentarily via event actions or from the Portal Status page, the Widget Desktop, the Monitoring Desktop, or a floorplan.
 - f. Online locks shall be capable of performing scheduled locks or unlocks via, event actions, or from buttons on the Portal Status page, the Widget Desktop, the Monitoring Desktop, or a floorplan.
 - g. Online locks shall be capable of being switched to a locked or unlocked state, and be disabled or enabled using buttons on the Portal Status page.
 - h. Online locks shall be capable of being enabled and disabled via buttons on the Portal Status page.
 - i. Activity associated with an online lock can be viewed in real time in the Activity Log.

- j. It shall be possible to enable Double Card Presentation mode for an IN120 or IN220 lock. This mode shall allow the presentation of a card twice in quick succession to change the lock from the locked to an unlocked state until a subsequent relock event or user-designated timeout occurs.

2.09 CUMULUS(TM) REMOTE MONITOR AND ADMINISTRATOR

- A. The system shall support cloud-based monitoring and administration of LenelS2 access control and video systems from a single management dashboard.
- B. Cumulus shall support NetBox, NetVR, VRx, Global, and Magic Monitor.
- C. Cumulus shall support remote monitoring of the following:
 - 1. The last communication with Cumulus
 - 2. Status of the CPU
 - 3. Memory and network bandwidth usage
- D. Cumulus shall support the managing of system licenses, including:
 - 1. OS version
 - 2. LenelS2 software version
 - 3. SUSP expiration date
 - 4. Detailed license information.

2.10 CARD READER PEDESTAL

- A. Provide dual height card reader pedestal for cars and trucks.
- B. Must be ADA compliance.
- C. First card reader to be mounted at 42 "AFF.
- D. Second card reader to be mounted at 72 " AFF.
- E. Provide Bolts kit as needed.
- F. Unit shall be mounted on 12" by 12" by 24" concrete pad.
- G. Provide accessories like 'Hood, Housing, Buffer Plate, Neck extensions as needed.
- H. B.O.D.: Pedestal PRO : 72-DSP-3-12-12.finish as selected by owner/architect.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine cable pathways including conduit, raceways, cable trays, and other pathway elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine rough-in for control cable and conduit systems to controllers, card readers, and other system components to verify conduit and back-box locations prior to installation of system devices
- C. Examine available network capacity and support infrastructure. Consult with network administrator for compliance with network standards and capacity
- D. Examine install location for compliance with space allocations, installation tolerance, hazards to safe system operation, and other conditions affecting installation
- E. Examine roughing-in for LAN, WAN, and IP network before device installation

3.02 PREPARATION

- A. Comply with SIA CP-01 Control Panel Standard.
- B. Comply with ANSI/TIA-606-B Labelling Standard.
- C. Prepare detailed project planning forms for programming and configuration of the SMS. Fill in all data available from project plans and specifications and publish as project planning documents for review and approval.
- D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final programming and configuration documents. Use final documents to program and configure software.

3.03 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction".
- B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- C. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 performance of completed and linked signal paths, end to end.
- D. Junction boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with tamper resistant fasteners and/or tamper detection switches. In addition, hinged enclosure doors shall be equipped with locking hardware. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

- E. Install end-of-line resistors at the field device location and not at the controller or panel location.
- F. Card Readers and Keypads and Peripheral Devices:
 - 1. Install number of conductor pairs recommended by device manufacturer for the functions specified.
 - 2. Follow device manufacturer's installation requirements for maximum cable distances and sizes.

3.04 IDENTIFICATION

- A. Label, in plain English, each end of each cable, field panel, patch panel, network switch, or cabinet
 - 1. Each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the device as shown
- B. At completion, cable and asset management documentation shall reflect as-built conditions

3.05 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved.
- B. Assign the software license(s) to Owner.
- C. All default password shall be changed to those selected by the owner
 - 1. The contractor shall retain no records of passwords for the project

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Factory Commissioning: Onsite visit by the Manufacturer's in-house personnel to inspect, test, and assess system programming, functionality, and performance.
- D. Tests and Inspections:
 - 1. Inspection: Confirm that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Configure and pretest system components, wiring, and functions to confirm that they comply with specified requirements.
 - 3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements.

4. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least <14 days>. Provide a minimum of 10 days' notice of test schedule.
 5. Operational Tests: Perform operational system tests to confirm that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- E. The system is considered defective and the project incomplete if it does not pass tests and inspections
- F. Prepare test and inspection reports.

3.07 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
- B. Provide onsite visit by Manufacturer's in-house personnel to train Owner's operations personnel.
- C. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
- D. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.08 ADJUSTMENTS

- A. Occupancy Adjustments: When requested within 30 days of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project for this purpose. Tasks shall include, but are not limited to, the following:
 1. Check cable connections
 2. Confirm system configuration and adjust settings needed
 3. Recommend changes to the system to improve Owner's use
 4. Provide a written report of adjustments and recommendations

3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the system equipment.
- B. Develop and provide separate training modules for the following:
 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
 2. Operators who prepare and input credentials, monitor the SMS, and to enroll personnel.
 3. Security personnel.

4. Hardware maintenance personnel.
5. Corporate management.

3.10 MAINTENANCE

- A. The Contractor shall offer a Software Upgrade and Support Agreement (SUSP)
 1. The Contactor shall offer the SUSP in 3 year increments.
 2. As part of the agreement, normal business hours (9:00 AM – 6:00 PM), manufacture phone support shall be available.
 3. The option of 24/7 telephone support shall be offered.
 4. As part of the agreement, access to software patches and software upgrades shall be available.

END OF SECTION 281300

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SECTION 28 31 00 - ADDRESSABLE FIRE DETECTION AND ALARM

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The system and all associated components shall be in accordance with the current edition enforced of the following:
 - 1. Indiana Building Code
 - 2. NFPA 70, National Electrical Code
 - 3. NFPA 72, National Fire Alarm and Signaling Code
 - 4. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilation Systems.
 - 5. NFPA 101, Life Safety Code
 - 6. Local Jurisdiction Adopted Codes and Standards
 - 7. ADA Accessibility Guidelines.
- C. Related Sections:
 - 1. Section 280523 – Conductors and Cables for Electronic Safety and Security
 - 2. Division 28 Security
 - 3. Electrical General Provisions: Section 26 05 01

1.02 WARRANTY

- A. For warranty information see Section 26 05 01, Electrical General Provisions.

1.03 SCOPE OF WORK

- A. The work described by this section includes the furnishing of all materials, equipment, labor, service and the performing of all operations necessary for the installation of the addressable fire detection system, complete and in operating condition as indicated on tile drawings and/or described herein.

1.04 SUBMITTALS

- A. Submit shop drawings on all fire alarm system components as well as complete field wiring diagrams and floor plans in accordance with Specification Section 26 05 01, Electrical General Provisions.

1.05 SYSTEM DESCRIPTION

- A. System shall consist of a microprocessor based fire alarm control panel, addressable alarm initiating devices (manual stations, automatic smoke detectors, duct smoke detectors and thermodetectors, alarm signaling devices, annunciators, programmable output relays in control panel and digital communicator for contacting a central supervising location.

- B. System shall be closed circuit, electronically operated, with short and open wiring faults, causing audible and visual trouble indication at the control panel. The initiating devices shall be wired in a loop configuration to allow each device or master device to be assigned an individual address.
- C. Actuation devices shall be displayed at the control panel according to the following identification system: Any detection device shall carry its own address which shall be displayed on a digital display by number. The zone/loop and the group (i.e. area, device type, etc. as programmed) to which it belongs shall be displayed by an LED.
- D. An adequate number of control relays shall be provided to interface to temperature control equipment, elevator equipment, air handling equipment or other controls to provide auxiliary operations. It shall be possible to operate these relays from different sections of the system as follows: Outputs and/or relays shall be available that are sector specific (i.e. zone/loop) such as FIRE, TROUBLE, SUPERVISORY.
- E. The fire alarm system shall be provided with remote annunciator panels. Data shall be multi-plexed from the control panel to each annunciator to reduce wiring requirements. Coordinate final location with Owner's Representative and local fire department

1.06 SCOPE AND RELATED DOCUMENTS

- A. The work covered by this section of the specifications includes the furnishings, equipment, materials, and performance of all operations associated with the installation of an addressable microprocessed fire alarm system as shown on the drawings and as herein specified.
- B. The complete installation shall conform to the applicable sections of NFPA 72A, 72B, 72C, 72D Local Code Requirements and National Electrical Code with particular attention to Article 7-0.

1.07 QUALITY ASSURANCE

- A. 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 Underwriter's Laboratories Inc., (UL), and shall bear the UL label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.
- B. All control equipment must have transient protection to comply with UL896 requirements.
- C. In addition to the UL-UOJZ requirements mentioned above, the system controls shall be UL listed for Power Limited Applications and all circuits must be marked in accordance with NEC article 760-23.

1.08 SEQUENCE OF OPERATION

- A. Upon activation of an alarm initiating device, the following shall occur:
 - 1. Audio/visual alarm shall occur throughout the building.
 - 2. The alarm shall be annunciated by floor and device type on the building fire alarm control panel.
 - 3. The alarm shall be annunciated at the remote annunciator.
 - 4. The supervising location shall be contacted.

5. The air handling equipment serving the area in alarm shall shut down.
 6. Contact closures will interface to the temperature control system for the following alarms:
 - a. Fire Alarm
 - b. Fire Alarm System Trouble
 - c. Sprinkler Flow Alarm
- B. Upon activation of sprinkler supervisory switch, or a system trouble, the following shall occur:
1. The fire alarm control panel shall show system trouble.
 2. The fire alarm remote annunciator shall show system trouble.

1.09

CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
 2. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Provide "Fire Alarm System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 4. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with an indication of origination and termination points.
 5. Riser diagram.
 6. Device addresses for all initiating and notification devices.
 7. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
 8. Record copy of site-specific software.
 9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 1. Equipment tested.
 2. Frequency of testing of installed components.
 3. Frequency of inspection of installed components.
 4. Requirements and recommendations related to results of maintenance.
 5. Manufacturer's user training manuals.
 10. Manufacturer's required maintenance related to system warranty requirements.
 11. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- B. Software and Firmware Operational Documentation:
2. Software operating and upgrade manuals.
 3. Program Software Backup: On magnetic media or compact disk, complete with data files.
 4. Device address list.
 5. Printout of software application and workstation graphic screens.

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one (3) unit.
2. Addressable Input and Output Modules: Quantity equal to 10 percent of amount installed, but no fewer than three (3) of each unit.
3. Smoke Detectors, Fire Detectors, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than six (6) unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than six (6) units of each type.
5. Keys and Tools: One extra set for access to locked or tamper-proof components.
6. Audible and Visual Notification Appliances: Six (6) of each type installed.
7. Fuses: Two of each type installed in the system. Provide a box or cabinet with compartments marked with fuse types and sizes.
8. Provide wall mount cabinet with locking door to house spare devices

PART 2: PRODUCTS

2.01 APPROVED MANUFACTURERS:

- A. Simplex/JCI
- B. Notifier.
- C. Honeywell.
- D. EST.
- E. Siemens.

2.02 ADDRESSABLE BASES OR DETECTORS

- A. If required, addressable devices shall be provided for interfacing with base-compatible photo electronic and thermal-type detectors.
- B. The addressable device shall contain an addressable element which is monitored by a serial polling operation.
- C. The device's addressable element shall be encapsulated to ensure protection against environmental contaminants.
- D. The addressable device shall incorporate an integral pulsing alarm LED for quick recognition of the alarming device. The base shall have the capability of supporting a remote pulsing LED.
- E. Manual Pull Station
 1. Addressable Pull Stations (Manual Fire Alarm Boxes): Addressable pull stations shall contain electronics that communicate the station=s status (alarm, normal) to the control panel over two wires which also provide power to the pull station. The address shall be set on each station. The stations shall be manufactured from high impact red Lexan. Lettering shall be raised and painted white. The station shall mechanically latch upon operation and remain so until manually reset. Pull stations shall be single action.
 2. All pull stations shall have 2 inch white label with red lettering stating the digital address of the device. Mount label at top of pull station.

2.03 PHOTOELECTRONIC SMOKE/HEAT DETECTORS

The smoke detector shall be of the solid state photoelectronic type and shall operate on the light scattering, photodiode principle. The detector shall be factory set to detect smoke at a nominal 1.5% light obscuration per foot regardless of the rate of combustion. To minimize nuisance alarms, detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. All smoke detectors shall be equipped with self-compensating circuitry to provide maximum stability against effects of aging, dust and film accumulation.

The detector light source shall be an LED. The detector shall be equipped with a pulsed LED power supervisory indicator. The detector shall be designed to latch into alarm following a 6 to 10 second signal processing delay verifying the continued presence of smoke within the sensing chamber. An alarm condition shall be indicated by a steady red glow from the LED indicator. Smoke detectors shall have an integral fixed temperature heat detector rated at 135°F as indicated. Heat detector shall operate the alarm circuit and illuminate the smoke detector "Alarm" indicator lamp. A calibrated test feature shall be provided capable of simulating a maximum acceptable amount of smoke for alarm. The test feature shall provide individual local testing of the detector. For ease of maintenance and installation, detectors shall be designed for twist-lock mounting to a separate base assembly having screw terminals for external wire connections.

2.04 AIR DUCT DETECTORS

The duct smoke detector shall be of the solid state photoelectronic type and shall operate on the light scattering, photodiode principle. The detector shall be factory set to detect smoke at a nominal 1.5% light obscuration per foot regardless of the rate of combustion. To minimize nuisance alarms, detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. All smoke detectors shall be equipped with self-compensating circuitry to provide maximum stability against effects of aging, dust and film accumulation. The detector light source shall be an LED. The detector shall be equipped with a pulsed LED power supervisory indicator. The detector shall be designed to latch into alarm following a 6 to 10 second signal processing delay verifying the continued presence of smoke within the sensing chamber. An alarm condition shall be indicated by a steady red glow from the LED indicator. Air duct detector will be installed in ventilating duct as indicated in the manufacturer's instructions. Air sampling tubes shall conform to dimensions of air duct construction and shall be constructed of 1/2" EMT tubing. Provide a remote alarm lamp as indicated on the drawings. Detectors shall be installed for supply ducts at furnaces F-1, F-2, F-3, F-4 F-5 and F-6 and air handling AHU-1.

2.05 THERMAL DETECTORS

- A. The addressable thermal detectors shall be of the rate compensated for fixed temperature type (135°F) and shall be listed by Underwriters Laboratories, Inc.
- B. The addressable thermal detectors shall be individually annunciated on the control panel. The addressable thermal detectors shall contain an integral alarm lamp.

2.06 SPRINKLER SYSTEM INITIATING DEVICES

- A. Sprinkler system initiating devices are to be furnished and installed by the fire protection system piping trades in accordance with Division 23 of the specifications. Sprinkler system initiating devices include, but are not limited to PIV, OS&Y, and butterfly valve tamper switches, flow switches, air pressure monitoring switches and fire pump supervisory switches.
- B. Sprinkler system initiating devices shall be connected to compatible addressable interface devices that are connected to the fire alarm system.

2.07 ADDRESSABLE AUXILIARY INTERFACE

- A. The addressable auxiliary interface device shall provide for monitoring and interfacing normally open, latching alarm contacts or normally closed latching trouble contacts to the addressable system, via a separate Class B circuit.
- B. The auxiliary interface device shall contain an addressable element which is monitored by a serial polling operation.
- C. The auxiliary interface device's addressable element shall be encapsulated to ensure protection against environmental contaminants.
- D. The addressable auxiliary interface device shall be capable of occupying the same initiating circuit along with other addressable devices.

2.08 ADDRESSABLE CONTROL INTERFACE

- A. The control interface shall contain an addressable element which is monitored by a serial polling operation.
- B. The control interface's addressable element shall be encapsulated to ensure protection against environmental contaminants.
- C. The addressable control interface shall be capable of occupying the same initiating circuit along with other addressable devices.

2.09 ADDRESSABLE MANUAL ALARM STATION

- A. The body of the addressable manual alarm station shall be hinged to a backplate assembly to which it is locked by a head screw. Resetting the station after operation shall require opening the front cover for access to the alarm switch.
- B. Single action non-coded addressable manual alarm station shall be fitted with a pull lever which, when operated, locks in position after activating an alarm initiating contact.
- C. The non-coded, addressable manual alarm station shall be adaptable for surface or semi-flush installation.
- D. The non-coded, addressable manual alarm station shall be capable of occupying the same initiating circuit along with other addressable devices.
- E. The non-coded, manual alarm station's addressable element shall be

encapsulated to ensure protection against environmental contaminants.

2.10 ADDRESSABLE FIRE ALARM CONTROL PANEL

A. General

1. The term "control panel" is used as a general definition, encompassing the following types of devices and operating modes:
 - a. Fire alarm initiating circuits
 - b. Fire alarm indicating circuits
 - c. Status monitoring circuits
 - d. Auxiliary control circuits
 - e. Interface logic for all of the above
2. The control unit shall basically consist of the following elements:
 - a. Display and operating terminal(s)
 - b. Plug-in control modules
 - c. Main and standby power supplies
 - d. Connection terminals
3. The control units shall be of modular design by means of plug-in cards allowing later expansion and exact tailoring of detection zones and control outputs to the building's (object's) requirements.
4. The control units shall be microprocessor based and controlled by a program contained in non-volatile memory (ROM or EPROM). Field programmable information may be stored in RAM.

B. Basic Performance Data

1. All detection and signaling circuits shall be monitored against open/short circuits and ground faults. Should a malfunction occur in any circuit, a trouble condition shall be indicated while all other circuits continue operating normally.
2. Detection and signaling circuits shall be Class B, two wire.
3. Maximum number of addressable devices per zone/loop shall be 50.

C. Addressable Detector Line Circuits

1. The control unit shall be capable of processing and evaluating incoming signals from addressable devices such as automatic detectors, manual pull stations and contact device points.
2. The operating power for the addressable detection devices shall be supplied through the addressable line/circuit.
3. Each line/circuit shall function independently in order to maintain full autonomous operation.
4. The base electronics shall be fixed and all assignments of zones shall be field programmable via system keypad.
5. Should a detection device respond with either an alarm or trouble condition, it shall be possible to determine the exact device address (location) at the control unit.
6. Control logic data shall be field programmable. Modifications/revisions shall not require factory reprogramming.

D. Alarm Test Mode

1. It shall be possible to switch each floor of the fire alarm system selectively to a detector only test mode.
2. The control unit shall automatically issue a reset command to the detector after ten seconds.
3. The above described method shall allow a single person to perform detector testing without having to travel to another location for detector reset action.
4. When a zone is in the test mode, all remote signaling and control outputs of the zones to be tested shall automatically be inhibited. The test alarm shall only trigger the internal silent alarm indicator of the control unit and provide a printout of each alarm. If, however, two zones in the test mode alarm simultaneously or if a manual station is activated, a normal alarm sequence shall be started.
5. The fire alarm control panel shall be U.L. listed to test addressable devices relative to function, sensitivity and calibration.

E. Basic Operation of Control Unit

1. Clear distinction shall be provided between unacknowledged and acknowledged alarm status.
2. Terminal(s) shall be equipped with an alarm acknowledge button, which shall silence the audible alarm.
3. Subsequent alarms shall actuate the audible alarm devices.
4. Terminal(s) shall be equipped with an alarm reset button which sets the control unit into normal (quiescent) condition.
5. A locked enclosure shall be provided.
6. Actuation of a control unit trouble circuit shall provide both visual and audible annunciation. Silencing the trouble audible shall not extinguish the visual indicators.
7. Subsequent trouble conditions shall reactivate the audible/ visual trouble indicators.
8. All trouble LEDs shall be non-resettable except by an actual clearing of the trouble condition at which time trouble indicators shall clear automatically with no requirement for reset of the control unit.
9. There shall be a clear distinction between the audible alarm and trouble signals:
 - a. Alarm: continuous sounding
 - b. Trouble: intermittent sounding
10. The control unit shall provide multiple access levels to prohibit unauthorized operator access.

F. Evacuation: The building's audible signals shall sound continuously throughout the entire facility.

G. Fire Information: The system shall automatically transmit fire alarm and trouble status as indicated below:

1. Fire Alarm Condition: Provide dry contact closure to initiate an autodialer to connect Owner directed security number.
2. Trouble Condition: Provide a dry contact closure and appropriate interface with Building Management System.

- H. Indicating Circuits
 - 1. The control unit shall be capable of monitoring and activating 24 Vdc indicating circuits.
 - 2. Indicating circuits shall be Class B, two wire.
- I. Power Supply Unit
 - 1. The control unit shall contain the power supply for the entire fire detection system.
 - 2. The control unit shall derive its primary operating power from a 120 Vac, single phase, 60 Hz supply. There shall also be:
 - a. A 24v battery standby power source capable of operating the entire system for a period of twenty four hours in supervisory mode and then being capable of operating the alarm devices for a minimum of five minutes.
 - b. Batteries shall be sealed type using lead acid or gel-gel.
 - 3. The power supply unit shall contain suitable overvoltage protection to prevent any malfunction or damage which might occur from line power surges (lightning).
 - 4. Upon loss of main power, the power supply unit shall automatically revert to battery power and the system shall remain fully operational.

2.11 REMOTE ANNUNCIATOR

- A. The annunciator shall be indicated by floor location and type of initiating device, i.e. first floor, manual pull station.
- B. The annunciator shall be of the backlighted type or it may use LEDs.
- C. The annunciator shall completely interface with the fire alarm system and be UL listed as a part of the fire alarm system.
- D. The annunciator shall be connected to the fire alarm standby power system or shall be provided with a separate standby power system.

2.12 REMOTE STATION-DIGITAL ALARM COMMUNICATING TRANSMITTER

- A. The programmable digital communicator transmitter shall transmit fire alarm activity to a central supervising location.
- B. The communicator shall be UL 864 listed as conforming to the requirements of NFPA 72 for Central Station connections and shall be UL listed as compatible with the connected fire alarm control panel.
- C. 24 VDC operating voltage and battery backup shall be provided by the fire alarm control panel.
- D. The communicator transmitter shall have the capability of supervising two separate paths of communication and sending an alarm signal on one or both without the need of any additional equipment. If communication service is interrupted on either service for more than 90 seconds, the communicator transmitter shall be capable of reporting the loss of either service without regard to which failed. If both services fail, a local panel mounted trouble alert shall sound.

- E. The communicator shall be capable of being programmed to send a test signal to the central supervising location once every 24 hours at any user selected time.
- F. Signals to the central supervising location shall indicate which of the communicator transmitter initiating device circuits are in alarm and which are in trouble. Restoration to normal status shall also be transmitted with specific description messages. The communicator shall be capable of transmitting to Silent Knight, Radionics, or ADEMCO receiving stations.

2.13 COMBINATION AUDIO/VISUAL SIGNALING DEVICES

- A. Horn (Audio Portion): The horn shall be capable of providing a minimum audio output of 94 dB at a distance of 10 feet. Horn circuit shall be supervised.
- B. Strobe (Visual Portion):
 - 1. The lamp shall be a xenon strobe type or equivalent.
 - 2. The color shall be clear or nominal white and "fire" shall be imprinted on lens in red letter.
 - 3. The maximum pulse duration shall be two-tenths of one second (0.2 sec) with a maximum duty cycle of 40 percent. (The pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.)
 - 4. The intensity shall be a minimum of 75 candela.
 - 5. The flash rate shall be a minimum of 1 Hz and a maximum of 3 Hz.
 - 6. The appliance shall be placed 80 inches above the highest floor level within the space of 6 inches below the ceiling whichever is lower.
 - 7. In general, no place in any room or space required to have a visual signal appliance shall be more than 50 feet from the signal (in the horizontal plane). In large rooms and spaces exceeding 100 feet across, without obstructions 6 feet above the finish floor, such as auditoriums, devices may be placed around the perimeter, spaced a maximum 100 feet apart.
 - 8. No place in common corridors or hallways in which visual alarm signaling appliances are required shall be more than 50 feet from the signal.

2.14 SPARE PARTS

- A. Furnish to the Owner spare smoke detectors, heat detectors, fusible elements for heat detectors, visual, horns/light equal to 3% of each type used on the Project, except the minimum number shall be three of each type.

PART 3: EXECUTION

3.01 GENERAL

- A. All wiring in areas exposed to view shall be in EMT conduit. Wiring in concealed areas may utilize plenum rated cable. Wiring shall run concealed in walls or above ceilings and shall be in strict accordance with the manufacturer's wiring diagrams and when complete, shall test free from opens, shorts and grounds and be in proper operating condition.

- B. All of the actual wiring is not shown as this may vary between acceptable suppliers. It shall be the responsibility of the Contractor to obtain this information from the acceptable suppliers and include cost of same in his bid.
- C. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be permitted in fire alarm conduits. Wiring splices are to be avoided wherever possible, but if needed they must be made only in junction boxes and shall be crimp connected. Transposing or changing color coding of wires not permitted. Wire nut-type connections are not acceptable. All conductors in conduit containing more than one wire shall be labeled on each end with "E-Z markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc. shall be clearly labeled on all equipment panels. All wiring shall be checked and tested to ensure that there are no grounds, opens or shorts.
- D. Contractor shall show evidence of having successfully completed at least three similar projects. Installation shall be performed by or under the supervision of factory authorized distributor.
- E. Preparatory work required to accommodate installation (i.e. conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required) shall be furnished and installed under this contract
- F. It shall be the responsibility of Division 26 contractor to wire and connect the waterflow and the valve supervisory switches as required by the Fire Marshal and by the existing conditions.

3.02

TEST AND REPORTS

- A. A person or company who has written authorization from the manufacturer to act as an agent for the manufacturer shall make these tests. He need not necessarily be a person from the factory; he can be a dealer who has a letter from the manufacturer stating that he is qualified and has the proper instruments to make such tests. Perform all tests in the presence of the Owner or a person whom the Owner has elected to represent him. The Contractor shall perform all electrical and mechanical tests required by the equipment manufacturer's form.
- B. This must be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable. All test and report costs shall be in the Contract price. A checkout report shall be prepared by the installation technician and submitted in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
 - 1. A complete list of equipment installed and wired.
 - 2. Indication that all equipment is properly installed and functions and conforms with these specifications.
 - 3. Test area and duct mounted smoke detectors with smoke or freon or test instrument. All detectors to be measured in place with the HVAC system operating.
 - 4. Test the system in five random zones by causing shorts, grounds and open circuits to ascertain the proper function of the supervisory system and trouble light(s).
 - 5. Serial numbers, locations by zone and model number for each installed

- detector.
 - 6. Voltage (sensitivity) settings for each ionization and photoelectric smoke detector.
 - 7. Technicians' name, certificate number and date.
 - 8. All installed devices to be tested per function.
- C. At the time of the test provide the Owner or his representative with an oral explanation of the operation of the system. After completion of all the tests and adjustments listed above, the Contractor shall submit the following information to the Owner with a copy to the Engineer.
- 1. 'Record' conduit layout diagrams including wire color code and/or tag number.
 - 2. Complete 'record' wiring diagrams.
 - 3. Detailed catalog data on all installed system components.
 - 4. Copy of the Test Report.
 - 5. A cover letter for the above-mentioned tests, certifying the entire fire alarm system parts, application and installation meets or exceeds the recommendations of the manufacturer.

3.03 HARDWARE/SOFTWARE AVAILABILITY

- A. The manufacturer shall guarantee hardware availability, including mechanical components, over a period of ten (10) years.
- B. The manufacturer shall guarantee software (program packages) availability, including updated versions (compatible), over a period of ten (10) years.
- C. All equipment required to update field programmability or equipment shall be supplied under the specification.

3.04 GUARANTEE

- A. Contractor shall guarantee all labor, material, equipment and wiring to be free of mechanical and electrical defects for a period of two (2) years from date of completion of the installation. Manufacturer shall furnish, gratis to Owner, a two-year contract effective from the date of acceptance for maintenance and inspection service of manufacturer's equipment. There shall be a minimum of four (4) inspections during contract years. Test and record all devices per manufacturer's requirements or every 6 months whichever is least. This contract for preventative maintenance will be made renewable to Owner after gratis years for standard fee.
- B. Contractor shall maintain adequate supply of spare parts and full time service facility with factory trained service technicians and shall guarantee that replacement parts will be available 24 hours after notification.
- C. Upon completion of installation and after satisfactory testing of system by Contractor in presence of equipment supplier, Contractor shall test the system in presence of Engineer and Owner's Representative.

3.05 FIRE ALARM CONDUIT

- A. Interior concealed dry spaces
 - 1. EMT
 - 2. Where otherwise directed on drawings, or with Engineers approval, plenum rated, MC type cable specifically manufactured for use with Fire Alarm Systems shall be used in interior concealed dry spaces above accessible corridor ceilings (MC-FPLP). The jacket shall have red coloring.
- B. Interior exposed, or in moist locations RGS or IMC shall be used.
- C. Bay area RGS or IMC conduit.

END OF SECTION

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