Project Manual: Volume 2
Divisions 21-33

INTERIOR AND EXTERIOR RENOVATIONS – RE-BID

OWNER:

New Castle-Henry County Public Library
376 S 15th Street
New Castle, Indiana 47362

Architect:

LWC Inc.
712 East Main Street
Richmond, Indiana 47374
(765) 966-3546 Fax (765) 962-9195

DATE: August 8, 2023

SPECIFICATION

For

INTERIOR AND EXTERIOR RENOVATIONS OF NEW CASTLE – HENRY COUNTY PUBLIC LIBRARY

SPECIFICATION SECTIONS			
	RE-BID SET	PERMIT SET	CONSTRUCTION SET
DIVISION 0 SECTIONS – BIDDING AND CONTRACT REQUIREMENTS			
000210 – Invitation to Bid - REBID	X	X	
000211 – Instructions to Bidders - REBID	X	X	
000900 – Geotech Report	X	X	
001020 – Supplemental Instructions to Bidders	X	X	
001030 – Form of Proposal - REBID	X	X	
001030A – Form 96 Revised 2013 - Indiana	X	X	
001031 – A101 – 2017 Standard Form of Agreement	X	X	
001031A – A101 – 2017 Exhibit A Insurance and Bonds	X	X	
001050 – A310 – 2010 Bid Bond	X	X	
001060 – A312 – 2010 Payment Bond	X	X	
001070 – A312 – 2010 Performance Bond	X	X	
001071 – A201 – 2017 General Conditions	X	X	
001072 – Modifications to General Conditions	X	X	
001090 – Affidavit of Employment Eligibility Verification	X	X	
DIVISION 1 SECTIONS – GENERAL CONDITIONS			
011000 – Summary of Work - REBID	X	X	
012200 – Unit Prices	X	X	
012300 - Alternates	X	X	
012500 – Substitution Procedures	X	X	
012600 – Contract Modification Procedures	X	X	
012900 – Payment Procedures	X	X	
013100 – Project Management and Coordination	X	X	
013200 – Construction Progress Documentation	X	X	
013300 – Submittal Procedures - Shop Drawings, Product Data and Samples	X	X	
013310 – Agreement and Waivers	X	X	
014000 – Quality Control Services	X	X	
014200 - References	X	X	
015000 – Temporary Facilities and Controls	X	X	
016000 – Product Requirements	X	X	
017300 - Execution	X	X	
017329 – Cutting and Patching	X	X	
017700 – Closeout Procedures	X	X	
017823 – Operation and Maintenance Data	X	X	
017839 – Project Record Documents	X	X	
017900 – Demonstration and Training	X	X	
DIVISION 2 SECTIONS – EXISTING CONDITIONS			
020100 – Maintenance of Existing Conditions	X	X	

024113 – Selective Site Demolition	**X**	**X**	
024119 – Selective Demolition	**X**	**X**	
DIVISION 3 SECTIONS - CONCRETE			
031000 – Concrete Formwork	**X**	**X**	
032000 – Concrete Reinforcement	**X**	**X**	
033000 – Cast in Place Concrete	**X**	**X**	
DIVISION 4 SECTIONS - MASONRY			
NOT USED			
DIVISION 5 SECTIONS - METALS			
055000 – Metal Fabrications	**X**	**X**	
055213 – Pipe and Tube Railings - REBID	**X**	**X**	
DIVISION 6 SECTIONS			
061053 – Miscellaneous Rough Carpentry	**X**	X	
064023 – Interior Architectural Woodwork	**X**	**X**	
DIVISION 7 SECTIONS			
071413 – Fluid Applied Waterproofing	**X**	**X**	
072100 – Thermal Insulation	**X**	**X**	
072414 – EIFS Recoat Systems	**X**	**X**	
078413 – Penetration Firestopping	**X**	**X**	
078446 – Fire-Resistive Joint Systems	**X**	**X**	
079200 – Joint Sealants			
DIVISION 8 SECTIONS			
081113 – Hollow Metal Doors and Frames	**X**	**X**	
081416 – Flush Wood Doors	**X**	**X**	
083113 – Access Doors and Frames	**X**	**X**	
084113.01 – Flush Aluminum Doors and Frames	**X**	**X**	
087100 – Door Hardware - REBID	**X**	**X**	
088000 – Glazing	**X**	**X**	
DIVISION 9 SECTIONS			
092216 – Non-Structural Metal Framing	**X**	**X**	
092900 – Gypsum Board	**X**	**X**	
093000 - Tiling	**X**	**X**	
095113 – Acoustical Panel Ceilings	**X**	**X**	
095223 – Custom Linear Metal Ceiling System - REBID	**X**	**X**	
095423 – Linear Metal Ceilings - REBID	**X**	**X**	
096513 – Resilient Base and Accessories	**X**	**X**	
096623 – Resinous Matrix Terrazzo Flooring	**X**	**X**	
096813 – Tile Carpeting	**X**	**X**	
098400 – Custom Felt Fabrications (Turf Design)	**X**	**X**	
098413 – Sound-Absorptive Acoustical System	**X**	**X**	
099100 – Interior Painting	**X**	**X**	
DIVISION 10 SECTIONS			
101426 – Post and Panel – Pylon Signage	X	X	
102113.14 – Stainless Steel Toilet Partitions	**X**	**X**	

102600 – Wall and Door Protection	X	X	
102800 – Toilet, Bath and Laundry Accessories	X	X	
104413 – Fire Protection Cabinets	X	X	
DIVISION 11 SECTIONS			
115213 – Projection Screens	X	X	
DIVISION 12 SECTIONS			
122413 – Roller Window Shades	X	X	
124813 – Entrance Floor Mats	X	X	
DIVISION 14 SECTIONS			
144200 – Wheelchair Lifts	X	X	
DIVISION 20 SECTIONS			
NOT USED			
DIVISION 21 SECTIONS			
210501 – Basic Fire Suppression Requirements	X	X	
210502 – Agreement and Waiver for the Use of Electronic Files	X	X	
210502A – Electronic Files – Heapy Release form to Contractors	X	X	
210504 – Basic Fire Suppression Materials and Methods	X	X	
210505 – Firestopping	X	X	
210507 – Piping Materials and Methods for Fire Suppression	X	X	
210509 – Excavation, Backfill and Surface Restoration	X	X	
210529 – Hangers and Supports for Fire Suppression Piping	X	X	
210553 – Identification for Fire Suppression Piping and Equipment	X	X	
DIVISION 22 SECTIONS			
220501 – Basic Plumbing Requirements	X	X	
220502 – Agreement and Waiver for the Use of Electronic files	X	X	
220502A – Electronic Files – Heapy Release Form to Contractors	X	X	
220504 – Basic Plumbing Materials and Methods	X	X	
220505 – Firestopping	X	X	
220507 – Piping Materials and Methods	X	X	
220509 – Excavation, Backfill and Surface Restoration	X	X	
220523 – General Duty Valves for Plumbing Piping	X	X	
220529 – Hangers and Supports for Plumbing Piping	X	X	
220553 – Identification of Plumbing Piping and Equipment	X	X	
220719 – Plumbing Piping Insulation	X	X	
221116 – Interior Domestic Water Piping	X	X	
221119 – Interior Domestic Water Piping Specialties	X	X	
221316 – Interior Drainage and Vent Systems	X	X	
221319 – Drainage System Specialties	X	X	
221329 – Plumbing Pumps - Drainage	X	X	
224200 – Plumbing Fixtures	X	X	
DIVISION 23 SECTIONS			
230501 – Basic HVAC Requirements	X	X	
230502 – Agreement and Waiver for the Use of Electronic files	X	X	

230502A – Electronic Files – Heapy Release Form to Contractors	**X**	**X**	
230504 – Basic HVAC Materials and Methods	**X**	**X**	
230505 – Firestopping	**X**	**X**	
230507 – Piping Materials and Methods	**X**	**X**	
230513 – Electrical Requirements for HVAC Equipment	**X**	**X**	
230514 – Adjustable Frequency Motor Controller	**X**	**X**	
230519 – Gauges and Make Up Meters	**X**	**X**	
230523 – General Duty Valves for HVAC Piping	**X**	**X**	
230529 – Hangers and Supports for HVAC Equipment	**X**	**X**	
230530 – Bases and Supports for HVAC Equipment	**X**	**X**	
230531 – HVAC Equipment Drives	X	X	
230549 – Vibration Control for HVAC	**X**	**X**	
230550 – Flexible HVAC Pipe Connectors	**X**	**X**	
230553 – Identification of HVAC Piping and Equipment	**X**	**X**	
230593 – Testing, Adjusting and Balancing for HVAC	**X**	**X**	
230713 – Duct Insulation	**X**	**X**	
230716 – HVAC Equipment Insulation	**X**	**X**	
230719 – HVAC Pipe Insulation	**X**	**X**	
230923 – Building Automation System for HVAC	**X**	**X**	
230925 – Instrumentation and Control Devices for HVAC	**X**	**X**	
230947 – Control Power and Wiring for HVAC	**X**	**X**	
232113 – Hydronic Piping	**X**	**X**	
232117 – Glycol Solution Systems	**X**	**X**	
232123 – Hydronic Pumps	X	X	
233113 – HVAC Ductwork	**X**	**X**	
233300 – Air Duct Accessories	**X**	**X**	
233700 – Air Outlets and Inlets	**X**	**X**	
236420 – Scroll Water Chillers – Air Cooled	**X**	**X**	
237323 – Custom Air Handling Units	X	X	
238128 – DX Mini Split Systems	X	X	
238219 – Fan-Coil Units	X	X	
DIVISION 26 SECTIONS			
260501 – Basic Electrical Requirements	**X**	**X**	
260502 – Agreement and Waiver for Use of Electronic Files	**X**	**X**	
260502A – Electronic Files – Heapy Release Form to Contractors	**X**	**X**	
260504 – Basic Electrical Materials and Methods	**X**	**X**	
260505 – Firestopping	**X**	**X**	
260509 – Excavation, Backfill and Surface Restoration	**X**	**X**	
260519 – Low-Voltage Electrical Power Conductors - Copper	**X**	**X**	
260520 – Low-Voltage Electrical Power Conductors – Metal Clad MC Cable	**X**	**X**	
260526 – Grounding and Bonding for Electrical Systems	**X**	**X**	
260533 – Raceways and Boxes for Electrical Systems	**X**	**X**	
260543 – Manholes, Handholes, Underground Ducts and Raceways for Electrical	**X**	**X**	
260553 – Identification for Electrical Systems	**X**	**X**	
260923 – Lighting Control Devices	**X**	**X**	
260926 – Lighting Control Panelboards	**X**	**X**	
262213 – Distribution Transformers	**X**	**X**	
262416 – Panelboards	**X**	**X**	
262417 – Panelboards with Surge Protective Devices	**X**	**X**	
262716 – Electrical Cabinets and Enclosures	**X**	**X**	
262719 – Single Channel Aluminum Multi-Outlet Assembly	**X**	**X**	

262726 – Wiring Devices and Coverplates	X	X	
262813 – Fuses	X	X	
262816 – Disconnect Switches	X	X	
262913 – Motor Controllers	X	X	
264313 – Surge Protection Devices for Low-Voltage Electrical Power Circuits	X	X	
265113 – Interior Luminaires and Drivers	X	X	
265200 – Exit and Emergency Lighting	X	X	
265600 – Exterior Lighting	X	X	
DIVISION 27 SECTIONS			
270501 – Basic Communications Requirements	X	X	
270502 – Agreement and Waiver for Use of Electronic Files	X	X	
270502A – Electronic Files – Heapy Release Form to Contractors	X	X	
270504 – Basic Communications Materials and Methods	X	X	
270505 – Firestopping	X	X	
270526 – Grounding and Bonding for Communications Systems	X	X	
270528 – Communications Systems Pathways and Support Equipment	X	X	
270553 – Identification for Communications Systems	X	X	
274119 – Video display Equipment	X	X	
275125 – Building Paging / Intercom System	X	X	
275128 – Auditorium sound Reinforcement System	X	X	
DIVISION 28 SECTIONS			
283100 – Extension of Existing Fire Detection and Alarm (Addressable)	X	X	
DIVISION 31 SECTIONS			
312000 - Earthwork	X	X	
312323 – Flowable Fill	X	X	
312500 – Erosion Control	X	X	
313116 – Termite Control	X	X	
DIVISION 32 SECTIONS			
321216 – Asphalt Paving	X	X	
321300 – Site Concrete	X	X	
323300 – Site Furnishings	X	X	
328000 - Irrigation	X	X	
329000 – Planting	X	X	
329219 – Seeding	X	X	
DIVISION 33 SECTIONS			
330500 – Common Work Results for Utilities	X	X	
334000 – Storm Drainage	X	X	

END OF INDEX

DIVISION 21

FIRE SUPPRESSION

21 05 01 BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, and Supplementary Conditions, including Divisions 00 and 01, apply to work specified in this Division.

B. The scope of the Division 21 work includes furnishing, installing, testing and warranty of all work and complete Fire Suppression systems as shown on the FS series drawings, and as specified in Division 21 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors to the Prime Contractor, assignments of work by division are not intended to restrict the Prime Contractor in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in Division 21. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Each bidder shall inspect the project site and the premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install piping and equipment.

D. The Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of equipment, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings and necessary drains required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect.

1.5 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 21 Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.6 Coordination Drawings

A. The Division 23 Contractor shall prepare and be responsible for 0.25inch scale electronic coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format with the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 23 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings and that specified ceiling heights are maintained.

1.7 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.8 Record Drawings

A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work, and within 90 days of system acceptance, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.9 Operating and Maintenance Manuals

A. Assemble three copies of operating and maintenance manuals for the Fire Suppression work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

C. Pipe pressure test reports shall also be included.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.10 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect the work and develop their own punch list to confirm that it is complete and finished. Then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect and Engineer for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.11 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense

to the Owner. Use of equipment for temporary system use is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and/or labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.

C. This provision shall not be construed to include maintenance items such as re-tightening or repacking glands, greasing, oiling and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 - General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

A. All equipment and appliances shall be listed and labeled in accordance with the Building and Fire Codes. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance.

2.3 Reference Standards

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

2.4 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and

standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

D. If extensive changes in pipe or equipment layout, or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included.

2.5 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, pump curves, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer’s attention in a separate clearly stated notification at the time of submittal for the Engineer’s review.

C. Shop drawings of the following Fire Suppression equipment and materials shall be submitted:

1. Pipe, fittings and joining methods.
2. Firestopping systems for pipe penetrations.
3. Pipe hangers.
4. Valves.
5. Sprinklers and accessories.
6. Wet pipe components.
7. Sprinkler system installation drawings per NFPA 13, calculations and water supply flow curve.

PART 3 - EXECUTION

3.1 Pipe Testing

A. Pipe testing for fire suppression piping shall be as described below and in Section 21 13 13 Fire Suppression Sprinkler System.

B. Ensure that air is vented from piping when piping is hydrostatically tested.

C. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

D. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

3.2 Pipe Cleaning

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

B. Refer to appropriate Sections for cleaning of other piping for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each piping system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

C. Test relief valves, air vents and regulating valves to ensure proper operation.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

END OF SECTION

21 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. **Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form.** Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project's name and address, the Architect's, Engineer's and any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the

Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

21 05 02A
ELECTRONIC FILES HEAPY RELEASE FORM TO CONTRACTORS

Project: New Castle – Henry County Public Library – Interior & Exterior Renovations
376 S 15th St
New Castle, IN 47362

Owner: Henry County Public Library

Heapy Engineering Project Number: 2022-07145

Heapy Engineering Project Manager: Mat Root

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Name of authorized Recipient Representative: _____

Title of authorized Recipient Representative: _____

E-mail address of authorized Recipient Representative: _____

Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____

_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ Heapy FTP ☐ User's FTP site

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 2022 DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG

Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 21 Electronic .DWG Files:

First Drawing: $50.00 $50.00

Additional Drawings $15.00 each _____ x $15.00 = $ _____

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _____ x $ 5.00 = $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____
All files will be bound together.
Available electronic Revit file format:
☐ 2022 .RVT

Cost of Preparation of Division 21 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

21 05 04 BASIC FIRE SUPPRESSION MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Construction Water

A. Refer to Division 01 - General Requirements, for information regarding construction water.

B. Each Contractor requiring water for construction purposes shall connect to wall hydrants or other connection points within the existing building.

1.2 Continuity of Services

A. Work shall be so planned and executed as to provide reasonably continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done during normal working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without markup.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devices and equipment requiring service or adjustment.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with tamperproof screws. Locks in “secured” areas of the building shall have tamperproof screws. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.
2. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls, Milcor Style “ATR” or equal.
3. Standard flush type for drywall ceilings and walls, Milcor Style “ATR” or equal.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18 inches x 18 inches unless larger panels are shown or required. Panels shall be equal to Chicago Metallic Model CRG.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Fire Suppression work shall be performed by Contractors that are fully certified by the State or Authority Having Jurisdiction.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect. All piping shall be elevated from grade for on-site storage, and all open ends shall be covered.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange for the provision of openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work. Any damage caused to the building shall be repaired or rectified.

C. Where pipes are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching and refinishing of same shall be provided. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls, etc. are to be cut for presence of existing utilities.

D. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system brace floor or alter location of new work to maintain existing system.

E. All new and existing sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

F. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and

integrity of the patched and refinished areas must meet the approval of the Architect / Construction Manager. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

G. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

3.4 Removals, Alterations and Reuse

A. Refer to the project documents for the scope of remodeling in the existing building.

B. Cooperate with the General Contractor regarding all removal and remodeling work. Unless otherwise noted, remove all existing work which is associated with Division 21 and which will be superfluous when the new work is installed and made operational.

C. Extraneous piping which is or becomes accessible shall be removed and stubs shall be capped at the first active pipe encountered. Piping that is and remains inaccessible shall be disconnected from active systems and abandoned. Ends of abandoned pipe shall be capped so as to be concealed by finished surfaces. Upon completion of the work no abandoned pipe, valve or stub shall extend thru finished floors, walls or ceilings.

D. When it is necessary to reroute a section of active piping the rerouted section shall be installed before removing the existing in order to minimize system down time.

E. Materials and equipment which are removed shall not be reused within the scope of this project unless specifically noted to be relocated or reused. Turn over to the Owner and place where directed on the premises all removed material and equipment so designated by the Owner. All material and equipment not claimed by the Owner shall become the property of the Contractor responsible for removal and shall be removed from the premises.

F. Remove, store and reinstall lay-in ceiling tile and grid as needed to perform work in areas where such removal and re-installation is not to be done by the General Contractor. Damaged tile and/or grid shall be replaced with new matching tile and/or grid.

G. In areas of minor work where the space is not completely vacated, temporarily move portable equipment and furnishings within the space as required to complete the work. Coordinate this activity with the Owner. Protect the Owner's property by providing dust covers and temporary plastic film barriers to contain dust. Remove barriers and return equipment and furniture upon completion of the work.

H. Refinish any surface disturbed under this work to match existing, except where refinishing of that surface is included under the General Contract.

3.5 Painting

A. In addition to any painting specified for various individual items of equipment, provide the following painting:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.

3. Equipment and materials, except sprinklers, which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up. Sprinklers and sprinkler assemblies shall be replaced with new.
4. Apply Z.R.C. Galvilite cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

B. Paint, surface preparation and application shall conform to the paint manufacturer's instructions. All rust must be removed before application of paint.

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

3.6 Access Panels

A. Install access panels. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall. Provide appropriate framing with drywall beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

END OF SECTION

21 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and pipe layouts.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the IBC and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of UL firestopping assemblies and installation instructions. Submittals shall include all information required in the IBC.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

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

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 21 05 07 Piping Materials and Methods for Fire Suppression for pipe sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION

21 05 07 PIPING MATERIALS AND METHOD FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 Piping materials and methods for piping common to Division 21 – Fire Suppression shall be as specified herein and as shown on the drawings.

1.2 Included in this section are:

A. Pipe, fittings and joining methods.

B. Unions and flanges.

C. Dielectric connectors.

D. Pipe sleeves, openings, curbing and escutcheons.

E. Installation methods of piping.

1.3 Refer to other Sections in Division 21 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.4 Refer to Section 21 05 05 Firestopping for firestopping requirements.

1.5 Pipe threads shall be cut to ASME B1.20.1, Pipe Threads, General Purpose.

1.6 Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to this trade in new walls, partitions, floors and roof slabs, same as for new piping.

1.7 Sleeves are not required:

A. In stud and gypsum board or plaster walls and partitions which are not fire rated.

B. For above grade uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.

C. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.

D. In large floor openings for multiple pipe risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after pipes are set.

1.8 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 For detail of pipe and fitting products see Section 21 13 12 Fire Suppression Piping.

2.2 Forged welding outlets equal to Anvil/Merit “Weld-Miser Tee-let” may be used where branch is two sizes smaller than the main. Outlets shall be rated for minimum 300 psi working pressure, UL Listed and FM Global Approved, and have threaded or grooved end appropriate for application. Non-listed nipples and fishmouthed connections are not acceptable.

2.3 Unions and flanges shall be:

A. Unions on steel pipe 2 inches and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

B. Flanges on steel pipe with welded or screwed joints, 2.5 inches and larger. Gaskets shall be 0.0625 inches thickness, ASME B16.21, full face compressed sheet suitable for temperature and pressure ranges of the application.

C. Mechanical joints associated with grooved end pipe are acceptable in lieu of unions and flanges.

2.4 A dielectric connector shall be incorporated at each connection between ferrous and non-ferrous piping. Connectors shall be:

A. Dielectric coupling with non-conductive polymer liner, Victaulic Style 47, Gruvlok "Di-Lok" and Lochinvar Corp. "V-Line" Dielectric fitting on service pressures less than 300 psi.

2.5 Pipe sleeves shall be:

A. Schedule 40 black steel pipe, ASTM A53, Type E, Grade A or 18 gauge galvanized steel in poured concrete floors, walls and roof decks.

B. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

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

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Piping shall be installed consistent with good piping practice, run concealed wherever possible and located as to be protected from damage by freezing. Coordinate with other trades to attain a workmanlike installation.

3.3 Piping shall be supported as specified in Section 21 05 29 Hangers and Supports for Fire Suppression Piping. Piping with mechanical joints for grooved end steel pipe shall be supported in accordance with the manufacturer's recommendations. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before the system is accepted.

3.4 Close open ends of piping during installation to keep interior of the pipe clean.

3.5 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the N.E.C.

3.6 Unions and flanges shall be installed at pipe connections to equipment and as required for erection purposes.

3.7 Pipe sleeves shall be placed, and shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect / Engineer.

3.8 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.9 Refer to 21 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.10 In lieu of firestopping and where permitted by the IBC, uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar) in compliance with ASTM E119 test requirements.

3.11 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe shall be closed with sealant or caulking to retard the passage of noise or smoke. Sealant or caulking shall be applied per the manufacturer’s requirements, including opening width limitations, backing materials, sealant or caulking thickness, etc. Sealants and caulking shall be compatible with the materials they are in contact with, and sealants and caulking in direct contact with copper piping shall be silicon-based to minimize the potential for corrosion.

END OF SECTION

21 05 09 EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 Excavate for associated incidental work. Backfill to finish grade or to levels consistent with site work activity. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition or as is consistent with site activity. All work shall comply with requirements set forth in Division 31 – Earthwork and Division 32 – Exterior Improvements.

1.2 Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.

1.3 Contact the Oil and Gas Producers Underground Protection Service (1-800-925-0988) sufficiently in advance of the start of any excavation so that notification can be made to member utility departments and utility companies (water, sewer, gas, petroleum, electric, telephone, cable, etc.) having underground utilities in or near the project area. Also contact those companies to verify that utility lines have been located and duly marked and identified.

1.4 Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by this Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 Refer to Division 31 - Earthwork for bedding and backfill materials specifications.

PART 3 - EXECUTION

3.1 Trenches for interior piping shall be over excavated and the pipe shall be laid on 6 inches minimum depth sand bed.

3.2 Backfilling and compaction of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with approved backfill materials to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand.

3.3 Backfill shall be mechanically compacted in layers not over 6 inches deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of. Refer to Division 31 - Earthwork for compaction requirements.

3.4 Concrete floor slabs, paving, sidewalks, curbs, sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced by this Contractor equal to original conditions.

3.5 Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadway shall be included so that no additional cost will accrue to the Owner.

3.6 Maintain in place adequate barricades, guards, planking, plating, signage, warning lights, etc., at and around excavations.

3.7 All exterior underground piping shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6 inches wide with black letters identifying the piping service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18 inches above and on the centerline of the pipe.

END OF SECTION

21 05 29 HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 All interior piping shall be supported from the building structure.

1.2 All products and assemblies installed within a plenum shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other approved equal manufacturers are B-line, Erico, Mason, PHD and TOLCO.

2.2 Hangers and supports for horizontal piping shall be UL listed and/or FM Global approved, and equal to:

A. General service – clevis type Anvil Fig. 260.

B. Pear shaped band hangers with adjustable swivel ring, lock nut and rod attachment - Anvil Fig. 69.

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis, trapeze and swivel ring type hanger.

Pipe Sizes	Min. Rod Dia.
4” and smaller	0.375"

2.4 Hanger rod attachment devices for attachment to the structure shall be:

A. Pre-set concrete inserts.

B. After-set steel expansion type concrete inserts.

C. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

D. Channel support systems equal to Unistrut or Hilti.

E. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.5 Base mounted pipe supports shall be factory or shop prime coat painted or hot-dipped galvanized, equal to Anvil catalog numbers as follows:

A. Adjustable pipe saddle support with cast iron saddle, locknut nipple and cast iron reducer. Fig. 264. Provide pipe stanchion and base plate.

B. Adjustable pipe saddle support with cast iron saddle, steel yoke and nuts, steel locknut nipple and cast iron reducer – Fig. 265. Provide pipe stanchion and base plate.

2.6 Pipe riser supports shall be as follows:

A. Riser clamps on piping – Anvil Fig. 261 except, epoxy coated on copper tubing.

2.7 Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension.

PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as specified herein and, in addition, spacing and hanging methods in conformance with NFPA Standards when more stringent.

A. Steel pipe (vertical) – at the base, at each floor level, and 15 ft. maximum spacing.

B. Steel pipe (horizontal) – 12 ft. intervals for piping 1.25 inch size and smaller, 15 ft. spacing for piping 1.5 inches and larger pipe.

3.2 In piping systems with rolled or cut groove end pipe and mechanical joint couplings, pipe hangers shall be provided on horizontal piping at normal specified intervals and, in addition, so that no pipe shall be left unsupported between any two couplings nor left unsupported whenever a change in direction takes place. Vertical piping shall be supported at normal specified intervals or every other pipe length, whichever is more frequent. The base of the riser or base fitting shall be supported.

3.3 Attachment of pipe hangers to the structure shall be with:

A. Pre-set concrete inserts in concrete construction of 4 inch minimum depth.

B. After-set concrete inserts, in 4 inch minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

C. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment. Attachment to the bar type joists shall be at joist panel points only.

D. In fabricated steel joist construction (bare joists) attachment of hanger rods shall be through the gap of the joist cord angles so that loads are concentrically applied to the steel joist in accordance with the rules of the Steel Joist Institute and the Structural Engineer. Connections made to the outer edge of one cord angle shall be limited to loads approved by the Structural Engineer.

E. Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.

F. Unistrut type channel support system may be utilized where a number of pipes are run parallel or to span below other utilities and equipment. Channel shall be pre-set or attached to the structure with inserts or clamps.

G. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

H. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer

to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

3.4 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.5 Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within the pipe chase. Ensure that adequate support is still maintained.

3.6 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.7 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

A. MSS SP-58 on Materials, Design and Manufacturer

B. MSS SP-69 on Selection and Application

C. MSS SP-89 on Fabrication and Installation Practices

END OF SECTION

21 05 53 IDENTIFICATION OF FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 Identification of fire suppression equipment shall consist of equipment labeling, pipe marking and valve tagging as specified hereinafter.

1.2 Each item of major equipment shall be labeled. This shall include valves and other similar equipment.

1.3 Pipe markings shall be applied to all piping.

1.4 Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8.50 inch x 11 inch paper, tabulating valve number, piping system, system abbreviation, location of valve (room or area) and service (e.g. - South wing Zone 1).

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

1.6 Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.7 The door (interior and/or exterior) to the sprinkler system riser / dry valve room shall be labeled as directed by the local fire department.

1.8 Coordinate pipe markings and valve tags to ensure similar markings.

PART 2 - PRODUCTS

2.1 Equipment labeling shall be either, or a mix, of the following:

A. Permanently attached engraved brass or plastic laminated signs with 1 inch high lettering. Signs on exterior equipment shall be brass.

B. Stencil painted identification, 2 inch high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 Sprinkler system riser room /dry valve room door labeling shall be 3 inch high red letters, or as approved by the local fire department.

2.3 Pipe markings shall be:

A. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color coded pipe markers extending fully around the pipe or pressure-sensitive vinyl markers similar to the above.

B. On piping 6 inches and greater diameter, full band as specified above or strip-type markers fastened to the pipe with laminated or bonded application or by color-coded plastic tape not less than 1.50 inches wide, full circle at both ends of the marker.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.4 Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with "F" (for fire suppression) and the designated number.

2.5 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in Division 21 identification work, with corresponding designations shown, specified or scheduled on drawings.

3.3 The Division 21, 22 and 23 labeling, marking and tagging shall be coordinated and consistent systems of identification.

3.4 Equipment labeling shall consist of unit designation as shown on the drawings.

3.5 Pipe markers shall be placed:

A. At each piece of equipment.

B. At 25 ft. centers in mechanical rooms and concealed spaces.

C. At 50 ft. centers in other exposed locations.

D. On mains at each branch take-off.

E. At least once in each room.

3.6 Refer to appropriate sections of this specification for installation of underground line marker tape.

3.7 Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above. Copies of one set of schedules shall be laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION

DIVISION 22

PLUMBING

22 05 01 BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, Supplementary Conditions including Divisions 00 and 01, apply to work specified in this Division.

B. The scope of the Division 22 work includes furnishing, installing, testing and warranty of all work and complete Plumbing systems as shown on the P series drawings, and as specified in Division 22 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors to the Prime Contractor, assignments of work by division are not intended to restrict the Prime Contractor in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in Division 22. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Each bidder shall inspect the project site and the premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect and Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install piping and equipment.

D. The Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of equipment, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary drains and minor valves, traps and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect.

1.5 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 22 Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.6 Coordination Drawings

A. The Division 23 Contractor shall prepare and be responsible for 0.25 inch scale electronic coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format with the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 23 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings and that specified ceiling heights are maintained.

1.7 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.8 Record Drawings

A. Maintain a separate set of prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work and within 90 days of system acceptance, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.9 Operating and Maintenance Manuals

A. Assemble three copies each of operating and maintenance manuals for the Plumbing work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

C. Pipe pressure test reports, domestic water disinfection certificate of completion and bacteriological analysis results shall also be included.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.10 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect the work and develop their own punch list to confirm that it is complete and finished. Then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect and Engineer for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.11 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during this warranty period shall be made good without expense to the Owner. Use of equipment for temporary system use is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and/or labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.

C. This provision shall not be construed to include maintenance items such as re-tightening or repacking glands, greasing, oiling, belt tightening and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

All equipment and appliances shall be listed and labeled in accordance with the Plumbing Code. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance

2.3 Reference Standards

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

2.4 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

D. If extensive changes in pipe or equipment layout, or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.5 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer’s attention in a separate clearly stated notification at the time of submittal for the Engineer’s review.

C. Shop drawings of the following Plumbing equipment and materials shall be submitted:

1. Pipe, fittings and joining methods for the various systems.
2. Pipe hangers and supports.
3. Valves.
4. Pipe insulation.
5. Drainage structures and accessories.
6. Supply system specialties.
7. Drainage system specialties.
8. Plumbing fixtures and trim.
9. Sewage ejectors, basin and controls.
10. Sump pumps, basin and controls.

PART 3 - EXECUTION

3.1 Pipe Testing

A. All piping provided in this work shall be pressure tested, as specified below.

B. Pipe testing for Plumbing piping shall be:

1. Domestic cold and hot water piping - hydrostatic at 125 psig or 1.50 times the maximum operation pressure of the system, whichever is higher, for 6 hours at the low point of the system.
2. Soil, waste and vent piping and storm piping - rough test and final test, in conformance to Plumbing Code requirements.
3. Interior natural gas piping - 25 psi compressed air for 4 hours.
4. Other piping - refer to appropriate Sections.

C. Testing shall be performed prior to application of insulation. Ensure that air is vented from piping when piping is hydrostatically tested.

D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

F. Where a new pipe connects to an existing pipe, provide the following to facilitate testing, cleaning, draining and eventual shutoff service:

1. A shutoff valve in the new pipe near the point of connection.
2. A valved stub with brass plug downstream of the valve for testing of the new pipe extension. Close valve, remove handle after testing is complete. Wire handle to valve body.

3.2 Pipe Cleaning

A. Before placing each water piping system in operation, the piping system shall be thoroughly flushed out with clean water. Remove, clean and replace all strainer screens once flushing is complete. On domestic water systems, remove, clean and replace all fixture mounted strainer screens and faucet aerators after fixtures are set and connected piping is flushed thru the fixtures.

B. Refer to appropriate Sections for cleaning of other piping for normal operation.

3.3 Disinfection of Piping

A. All new and existing domestic water systems including any existing domestic water piping and equipment out of service for more than 14 days shall be disinfected by a company or personnel regularly engaged in the performance of this service.

B. Keep new systems isolated from the existing systems until after disinfection is completed and proven acceptable by bacteriological test results. Provide a service cock at the point of connection for injection of the disinfecting agent. If it is necessary to use a potable water supply in the performance of the disinfection procedures, provide temporary reduced pressure zone back flow prevention until disinfection and analysis results are complete.

C. Thoroughly flush the system, as previously described, prior to disinfection. Disinfection shall be performed in accordance with the Local Authorities prescribed method, or when a Local

Authority prescribed method is not available, in accordance with the locally adopted Plumbing Code or AWWA C651 or AWWA C652 Standards. Disinfection shall be by means of a chlorine solution injected into the water system near the source. Each outlet shall be tested to prove presence of minimum chlorine concentration. Document that adequate levels of chlorine are present in all parts of the system. Following the appropriate retention period, flush out the system with clean water until the residual free chlorine content is equal to the level of the incoming water, but not greater than 1.5 parts per million or until approved by the Health Department.

D. Perform a bacteriological analysis of the potable water system in compliance with Health Department requirements. One test sample shall be collected from the end of the main and one from each branch. Provide certification stating the name of the lab performing the testing, the job name, the date of the sample and results of the testing.

E. Contractor shall inform the Owner in advance of disinfection procedures so that the Owner might have a representative witness the procedure. Certified laboratory information and bacteriological analysis reports shall be included in the Operations and Maintenance Manuals.

3.4 Operation and Adjustment of Equipment

A. As each piping system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing water systems, tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

C. Test relief valves, air vents and regulating valves to ensure proper operation.

3.5 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

D. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

END OF SECTION

22 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. **Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form.** Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project's name and address, the Architect's, Engineer's and any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the

Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

22 05 02A
ELECTRONIC FILES HEAPY RELEASE FORM TO CONTRACTORS

Project: New Castle – Henry County Public Library – Interior & Exterior Renovations
376 S 15th St
New Castle, IN 47362

Owner: Henry County Public Library

Heapy Engineering Project Number: 2022-07145

Heapy Engineering Project Manager: Mat Root

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Name of authorized Recipient Representative: _____

Title of authorized Recipient Representative: _____

E-mail address of authorized Recipient Representative: _____

Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____

_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ Heapy FTP ☐ User's FTP site

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 2022 DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG
Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 22 Electronic .DWG Files:

First Drawing: $50.00 $50.00

Additional Drawings $15.00 each _____ x $15.00 = $ _____

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _____ x $ 5.00 = $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____
All files will be bound together.
Available electronic Revit file format:
☐ 2022 .RVT

Cost of Preparation of Division 22 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

22 05 04 BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Construction Water

A. Refer to Division 01 - General Requirements, for information regarding construction water.

B. Each Contractor requiring water for construction purposes shall connect to wall hydrants or other connection points within the existing building.

1.2 All piping, fittings, valves, solders, fluxes, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

1.3 Continuity of Services

A. Work shall be so planned and executed as to provide reasonably continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done during normal working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without mark-up.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devise and equipment requiring service or adjustment. Refer to Section 22 13 19 Drainage System Specialties for access plates associated with cleanouts.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with tamperproof screws. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.
2. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls, Milcor Style “ATR” or equal.
3. Standard flush type for drywall ceilings and walls, Milcor Style “M” or equal.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18 inches x 18 inches unless larger panels are shown or required. Panels shall be equal to Chicago Metallic Model CRG.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Plumbing work shall be performed by licensed Plumbing Contractors in accordance with requirements of the jurisdiction.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect. All piping and tubing shall be elevated from grade for on-site storage, and all open ends shall be covered. Plastic piping shall be protected from direct and indirect sunlight.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange for the provision of openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work. Any damage caused to the building shall be repaired or rectified.

C. Where pipes are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching and refinishing of same shall be provided. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls, etc. are to be cut for presence of existing utilities.

D. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system, brace floor or alter location of new work to maintain existing system.

E. All new and existing sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

F. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect / Construction Manager. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

G. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

3.4 Removals, Alterations and Reuse

A. Refer to the project documents for the scope of remodeling in the existing building.

B. Cooperate with the General Contractor regarding all removal and remodeling work. Unless otherwise noted, remove all existing work which is associated with Division 22 and which will be superfluous when the new work is installed and made operational.

C. Extraneous piping which is or becomes accessible shall be removed and stubs shall be capped at the first active pipe encountered. Piping that is and remains inaccessible shall be disconnected from active systems and abandoned. Ends of abandoned pipe shall be capped so as to be concealed by finished surfaces. Upon completion of the work no abandoned pipe, valve or stub shall extend thru finished floors, walls or ceilings.

D. When it is necessary to reroute a section of active piping the rerouted section shall be installed before removing the existing in order to minimize system down time. Rerouted sections shall be insulated as required for new work. Patch insulation on existing piping which has been damaged or removed in this work.

E. Materials and equipment which are removed shall not be reused within the scope of this project unless specifically noted to be relocated or reused. Turn over to the Owner and place where directed on the premises all removed material and equipment so designated by the Owner. All material and equipment not claimed by the Owner shall become the property of the Contractor responsible for removal and shall be removed from the premises.

F. Remove, store and reinstall lay-in ceiling tile and grid as needed to perform work in areas where such removal and re-installation is not to be done by the General Contractor. Damaged tile and/or grid shall be replaced with new matching tile and/or grid.

G. In areas of minor work where the space is not completely vacated, temporarily move portable equipment and furnishings within the space as required to complete the work. Coordinate this activity with the Owner. Protect the Owner's property by providing dust covers and temporary plastic film barriers to contain dust. Remove barriers and return equipment and furniture upon completion of the work.

H. Refinish any surface disturbed under this work to match existing, except where refinishing of that surface is included under the General Contract.

3.5 Painting

A. In addition to any painting specified for various individual items of equipment, provide the following painting:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

B. Paint, surface preparation and application shall conform to the paint manufacturer’s instructions. All rust must be removed before application of paint.

C. Provide finish painting only where specifically instructed. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.6 Access Panels

A. Install access panels. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall. Provide appropriate framing with drywall beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

3.7 Miscellaneous Equipment Connections

A. Certain categories of fixtures and equipment require piping connections..

B. Make all final connections to these fixtures and equipment, as indicated and in accordance with the manufacturer's recommendations. All piping connections shall be valved and final connections made with unions, unless otherwise directed by equipment installation requirements.

C. Fixtures and equipment, unless otherwise noted, will be furnished complete with the basic plumbing supply and waste trim. The trim will generally be furnished "loose" and shall be installed under this work. Countertop sinks furnished "loose" shall also be installed.

D. Provide supplies, supply stops, traps, shut-off valves, fixture drains, continuous wastes and indirect wastes. Provide a water-hammer arrestor on the system side of each automatic (quick-closing) valve on water supply lines. Items not specifically described elsewhere in these specifications shall be of the same manufacturer as similar items specified in conjunction with the plumbing fixtures.

E. Supply piping and devices connecting to equipment, where exposed to view in the finished space, shall be chrome plated and insulation shall be omitted.

F. Roughing-in drawings shall be obtained for the various fixtures and items of equipment as the time approaches when such information is required; allow a reasonable period, from the time of notice, to obtain this information.

G. Connections to equipment shall be in accordance with manufacturers installation guidelines. Provide any additional accessories recommended by the manufacturer such as gauges, shut-off valves, unions at connection points, etc.

END OF SECTION

22 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and pipe layouts.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the IBC and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of UL firestopping assemblies and installation instructions. Submittals shall include all information required in the IBC.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

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

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 22 05 07 Piping Materials and Methods for Plumbing for pipe sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION

22 05 07 PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Piping materials and methods for piping common to Division 22 – Plumbing shall be as specified herein and as shown on the drawings.

1.2 All piping, fittings, valves, solders, fluxes, seals and appurtenances in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

1.3 Included in this section are:

A. Pipe, fittings and joining methods.

B. Unions and flanges.

C. Dielectric connectors.

D. Pipe sleeves, openings, curbing and escutcheons.

E. Installation methods of piping.

1.4 Refer to other Sections in Division 22 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.5 Refer to Section 22 05 05 Firestopping for firestopping requirements.

1.6 Pipe threads shall meet B1.20.1 for factory threaded pipe and pipe fittings.

1.7 Brazing procedures shall be per ANSI / AWS B2.2 with flux per AWS A5.31, Types FB3-A or FB3-C and filler metals per AWS A5.8, Types BCuP-3, 4 or 5 or Types BAg-1, 5 or 7. Types BAg-1, 5 or 7 shall be used with dissimilar metals.

1.8 Soldering procedures per ASTM B828 with flux per ASTM B813 and solder per ASTM B32.

1.9 Solvent cement joints for PVC per ASTM D-2855, primer per ASTM F656.

1.10 All pressure piping systems shall conform to applicable requirements of the Code.

1.11 Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to this trade in new walls, partitions, floors and roof slabs, same as for new piping.

1.12 Pipe sleeves shall be provided where below grade pipes penetrate foundation walls. Relieving arches shall be provided for all below grade pipes passing below structural footings.

1.13 Sleeves are not required:

A. In floor slabs on grade.

B. In stud and gypsum board or plaster walls and partitions which are not fire rated.

C. For above grade uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.

1.14 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 Copper tubing, conforming to ASTM B88, Standard Specification for Seamless Copper Water Tube and Fittings and Joints, shall be:

A. Type C1
Pipe - Type "L" seamless hard drawn copper tubing.
Fittings – ASME B16.22 wrought copper or cast bronze, solder ends.
Joints - soldered with lead-free tin alloy, 95-5 tin-antimony or silver-bearing tin in accordance with methods of ASTM B828 and equal to Harris "Stay-Brite", "Stay-Brite 8" or "Bridgit".

B. Type C3
Pipe - Type "K" soft copper tubing.
Fittings – ASME B16.22 wrought copper, solder ends.
Joints - brazed with 15 percent silver brazing alloy equal to Harris "Stay-Silv 15" or Harris "Dynaflow". Brazing filler shall meet AWS A5.8.

C. Type C6
Pipe - Type "L", 0.5 inches thru 4 inches seamless hard drawn copper tubing.
Fittings – copper or cast bronze press fittings conforming to ASME B16.51 and ASME B16.22, EPDM O-ring seal. O-ring seal and/or seal cup design must not allow the fitting joints to pass a pressure test prior to being pressed.
Joints – 200 psi, 250 degrees F rated compression joint using fitting manufacturer approved electro-hydraulic crimping tool. Compression crimp shall be applied on upstream and downstream side of EPDM seal bead.

2.2 Unions and flanges shall be:

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

B. Unions on steel pipe 2 inches and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

C. Flanges on steel pipe with welded or screwed joints, 2.50 inches and larger. Gaskets shall be 0.0625 inch thickness, ASME B16.21, full face compressed sheet suitable for temperature and pressure ranges of the application.

2.3 A dielectric connector shall be incorporated at each connection between ferrous and non-ferrous piping. Connectors shall be:

A. Dielectric coupling with non-conductive polymer liner, Victaulic Style 47, Gruvlok “Di-Lok” and Lochinvar Corp. “V-Line” Dielectric fitting on services 200 degrees and less, and pressures less than 300 psi.

B. Dielectric flange kits with non-metallic bolt hole grommets and gasket by Watts, Drake Specialties, Corrosion Control Products Company or Advance Products and Systems.

2.4 Pipe sleeves shall be:

A. Schedule 40 black steel pipe, ASTM A53, Type E, Grade A or 18 gauge galvanized steel in poured concrete floors, walls and roof decks.

B. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

C. Smith 1720, or equal, riser sleeve with clamping ring and auxiliary pipe sleeve extending 4 inches above finished floor or 8 inches above finished roof. Waterproofing membrane for roof and floor construction shall be secured by the clamping ring. These are to be used in areas having special membrane waterproofing in or on the floor slab and at roof decks.

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

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Press connections: Copper press fittings shall be made in accordance with the manufacturers 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 ensure the tubing if fully engaged (inserted) in the fitting. The joints shall be made using a calibrated tool approved by the manufacturer.

3.3 Piping shall be pitched for drainage. The low points shall be fitted with a 0.75 inch drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1.25 inches and smaller where a drain valve is not shown, a drain plug is acceptable.

3.4 Piping shall be installed consistent with good piping practice, run concealed wherever possible and located as to be protected from damage by freezing. Coordinate with other trades to attain a workmanlike installation.

3.5 Piping shall be supported as specified in Section 22 05 29 Hangers and Supports for Plumbing Piping. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.

3.6 Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering.

3.7 Close open ends of piping during installation to keep interior of the pipe clean.

3.8 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the NEC.

3.9 Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection purposes. A union shall be installed at each threaded shut-off valve on the side of the valve for which shut-off service is intended.

3.10 Pipe sleeves shall be placed, and structural footing relieving arch requirements shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Structural Engineer.

3.11 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water, refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.12 Refer to 22 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.13 In lieu of firestopping and where permitted by the IBC, uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar) in compliance with ASTM E 119 test requirements.

3.14 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with sealant or caulking to retard the passage of noise or smoke. Sealant or caulking shall be applied per the manufacturer’s requirements, including opening width limitations, backing materials, sealant or caulking thickness, etc. Sealants and caulking shall be compatible with the materials they are in contact with, and sealants and caulking in direct contact with copper piping shall be silicon-based to minimize the potential for corrosion.

END OF SECTION

22 05 09 EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 Excavate for all in-grade underfloor piping, underground exterior piping and associated incidental work. Backfill to finish grade or to levels consistent with site work activity. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition or as is consistent with site activity. Cut existing floor slabs and replace slabs in conformance to 22 05 04 Basic Plumbing Materials and Methods. All work shall comply with requirements set forth in Division 31 – Earthwork and Division 32 – Exterior Improvements.

1.2 Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.

1.3 Contact the Oil and Gas Producers Underground Protection Service (1-800-925-0988 or 811) sufficiently in advance of the start of any excavation so that notification can be made to member utility departments and utility companies (water, sewer, gas, petroleum, electric, telephone, cable, etc.) having underground utilities in or near the project area. Also contact those companies to verify that utility lines have been located and duly marked and identified.

1.4 Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by this Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 Refer to Division 31 Earthwork for bedding and backfill materials specifications.

PART 3 - EXECUTION

3.1 Trenches for interior and exterior piping shall be over excavated and the pipe shall be laid on 6 inches minimum depth sand bed.

3.2 Backfilling and compaction of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with approved backfill materials, to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand.

3.3 Backfill shall be mechanically compacted in layers not over 6 inches deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of. Refer to Division 31 Earthwork for compaction requirements.

3.4 Concrete floor slabs, paving, sidewalks, curbs, sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced by this Contractor equal to original conditions. Refer to Division 32 for Exterior Improvement requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.

3.5 Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadway shall be included so that no additional cost will accrue to the Owner.

3.6 Maintain in place adequate barricades, guards, planking, plating, signage, warning lights, etc., at and around excavations.

3.7 All exterior underground piping shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6 inches wide with black letters identifying the piping service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18 inches above and on the centerline of the pipe.

END OF SECTION

22 05 23 GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 Refer to Section 22 11 16 Interior Domestic Water Piping and Section 22 11 19 Interior Domestic Water Piping Specialties for selection of valves for the various services. Valves peculiar to individual systems are referenced or specified in Sections related to those systems.

1.2 Valves and materials shall comply with applicable standards and specification of ANSI, ASTM, ASME and MSS. Working pressure and temperature ratings of each valve shall exceed those imposed by the service in which it is applied. Valves shall be manufactured in the U.S.A.

A. ASTM B584 and ASTM B61 Copper Alloy Sand Casting for General Applications.

B. ASME B16.10, MSS SP-67 Butterfly Valves.

C. MSS SP-70 Cast Iron Gate Valves, Flanged or Threaded Ends.

D. MSS SP-80 Bronze Gate, Globe and Check Valves.

E. MSS SP-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

F. ASME B16.34, MSS SP-110 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

G. Bronze (brass) valves installed in drinking water systems made with copper silicon alloy shall contain less than 22 percent zinc, and made with copper bismuth alloy less than 4 percent zinc. Bronze (brass) valves installed in non-drinking water systems shall contain less than 15 percent zinc.

1.3 All piping, fittings, valves, solders, fluxes, seals, fixtures, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Valves installed in potable and drinking water systems shall be:

A. Ball Valves – NIBCO, Apollo, Milwaukee, Watts, Legend, Crane, Marwin

1. Type B1. 2 inches and smaller. 2 piece, non-repairable
NIBCO T 585-80-LF, 150 s.w.p., 600 w.o.g., two piece bronze body, ASTM B584 screwed ends, full port, bronze ball and stem, packing nut with adjustable stem packing, TFE seat and seal, handle.

2. Type B4. 2.50 inches and larger.
Watts G-4000-FDA or American 3700, 200 c.w.p., two-piece fused epoxy coated cast iron body (inside and out), flanged ends, stainless steel or PFA fused cast iron ball and stainless steel stem, full port, PTFE seat and seal, handle.

B. Check Valves – NIBCO, Milwaukee, Stockham, Watts, Legend, Crane

1. Type C1. 2 inches and smaller Swing check

NIBCO T 413-Y-LF, 125 s.w.p., 200 w.o.g., bronze body (ASTM B584), screwed ends, renewable bronze swing disc with TFE seat ring.

2. Type C2. 2.50 inches and larger. Swing check
Val-Matic Series 7800 or approved equal, 250 c.w.p., ductile iron body, NSF/ANSI 372 interior and exterior fused bonded epoxy coating, flanged ends, renewable iron swing disc and aluminum bronze seat.

3. Type C3. 2 inches and smaller. In-line spring
NIBCO T 480-Y-LF, 250 w.o.g., in line spring actuated center guided silent check, inline lift type, bronze body, screwed ends, TFE disc and seat ring.

4. Type C4. 2.50 inches and larger. In-line spring
Val-Matic Series 1400 A or approved equal, 200 c.w.p., in line spring actuated center guided silent check, wafer style, iron body for installation between flanges, NSF/ANSI 372 interior and exterior fused bonded epoxy coating, bronze seat and disc.

2.2 Sweat end valves of equal construction and features are acceptable in lieu of those specified with screwed ends.

2.3 Ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation. On cold service piping, the extended shaft neck design shall permit operation of the valve without breaking the vapor seal.

PART 3 - EXECUTION

3.1 Drain valves shall be the same as for shutoff service. Provide a 0.75 inch hose thread adapter on the outlet of each drain valve that is not piped to a drainage point.

3.2 Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing.

3.3 Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.

3.4 Packing glands shall be tightened before placing the valves in service.

END OF SECTION

22 05 29 HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 All interior and exterior piping shall be supported from the building structure.

1.2 All products and assemblies installed with-in a plenum shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other approved equal manufacturers are B-line, Erico, Mason, PHD and TOLCO.

2.2 Hangers and supports for horizontal piping shall be equal to:

A. General service - clevis type Anvil Fig. 260.

B. Uninsulated copper tubing - copper plated clevis type - Anvil Fig. CT-65 (or plastic coated clevis).

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis and trapeze type hanger.

Pipe Sizes	Min. Rod Dia.
2” and smaller	0.375"
2.5” to 3"	0.50"
4” to 5"	0.625"
6” to 8”	0.75”

2.4 Where the length of the hanger rod between the top of the hanger and the attachment device is 3 inches or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel.

2.5 Hanger rod attachment devices for attachment to the structure shall be:

A. Pre-set concrete inserts.

B. After-set steel expansion type concrete inserts.

C. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

D. Channel support systems equal to Unistrut or Hilti.

E. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.6 Base mounted pipe supports shall be factory or shop prime coat painted, or hot-dipped galvanized, equal to Anvil catalog numbers as follows:

A. Adjustable pipe saddle support with cast iron saddle, locknut nipple and cast iron reducer – Fig. 264. Provide pipe stanchion and base plate.

B. Adjustable pipe saddle support with cast iron saddle, steel, yoke and nuts, steel locknut nipple and cast iron reducer – Fig. 265. Provide pipe stanchion and base plate.

2.7 Pipe riser supports shall be as follows:

A. Riser clamps on cold service piping (cold water, chilled water, etc.) - insulated pipe riser clamp assembly, Pipe Shields, Inc. E1000, with polyisocyanurate insulation, galvanized steel jacket, top thrust plates and riser clamps.

B. Riser clamps on piping other than cold service - Anvil Fig. 261 except, on copper tubing, CT-121 (copper plated) or CT-121C (plastic coated).

2.8 Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension. Piping 1" and smaller and specified to be insulated with elastomeric type insulation may utilize Anvil's 25/50 flame/smoke rated Klo-Shure strut-mounted TPO plastic insulation couplings with steel strut clamp. Insulation wall thickness shall be 0.75" thickness. Transition to required service insulation thickness within 2" of either side of coupling.

2.9 Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, provide sheet metal shields and insulation inserts as specified in 22 07 19 Plumbing Piping Insulation.

2.10 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.11 Coordinate the items above during the bidding period and determine, consistent with industry practice, the selection, furnishing and installation of the needed components.

PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as follows; unless otherwise shown on drawings:

A. Steel pipe (vertical) - at the base, at each floor level, and 15 ft. maximum spacing.

B. Steel pipe (horizontal) - 7 ft. intervals for piping 1.5 inches size and smaller, 10 ft. spacing for piping 2 inches thru 6 inches, 12 ft. spacing for larger pipe.

C. Copper tubing (vertical) - at the base, at each floor level; and 10 ft. maximum spacing.

D. Copper tubing (horizontal) - 6 ft. spacing for tubing 1.25 inches size and smaller, 8 ft. spacing for 1.50 inches thru 2.5 inches sizes, 10 ft. spacing for tubing 3 inches size and larger.

E. Cast iron pipe (vertical) - at the base and at each floor (15 ft. maximum spacing).

F. Cast iron pipe (horizontal) - at each fitting and at each joint on straight lengths, 10 ft. maximum spacing.

3.2 Attachment of pipe hangers to the structure shall be with:

A. Pre-set concrete inserts in concrete construction of 4 inches minimum depth.

B. After-set concrete inserts, in 4 inches minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

C. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment. Attachment to bar type joists shall be at joist panel points only.

D. In fabricated steel joist construction (bar joists) attachment of hanger rods shall be through the gap of the joist chord angles so that loads are concentrically applied to the steel joist in accordance with the rules of the Steel Joist Institute and the Structural Engineer. Connections made to the outer edge of one chord angle shall be limited to loads approved by the structural engineer.

E. Unistrut type channel support system may be utilized where a number of pipes are run parallel or to span below other utilities and equipment. Channel shall be pre-set or attached to the structure with inserts or clamps.

F. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

G. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

3.3 Pate style support curbs shall be attached to the roof deck and flashed into the roofing system.

3.4 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.5 Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within the pipe chase. Ensure that adequate support is still maintained.

3.6 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.7 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

A. MSS SP-58 on Materials, Design and Manufacturer

B. MSS SP-69 on Selection and Application

C. MSS SP-89 on Fabrication and Installation Practices

END OF SECTION

22 05 53 IDENTIFICATION OF PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 Identification of plumbing equipment shall consist of equipment labeling, pipe marking and valve tagging as specified hereinafter.

1.2 Each item of major equipment shall be labeled. This shall include pumps and other similar equipment.

1.3 Pipe markings shall be applied to all piping.

1.4 Underground exterior piping shall be identified with a continuous plastic line marker tape as described in the service piping sections and this section.

1.5 Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8.50 inches x 11 inches paper, tabulating valve number, piping system, system abbreviation, location of valve (room or area) and service (e.g. - south wing cold water).

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

1.7 Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.8 Coordinate pipe markings and valve tags to ensure similar markings.

PART 2 - PRODUCTS

2.1 Equipment labeling shall be either, or a mix, of the following:

A. Permanently attached engraved brass or plastic laminated signs with 1 inch high lettering. Signs on exterior equipment shall be brass.

B. Stencil painted identification, 2 inch high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 Pipe markings shall be:

A. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl markers similar to the above.

B. On piping and insulation 6 inches and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1.50 inches wide, full circle at both ends of the marker.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.3 Underground line marker tape shall be permanent bright-colored, plastic with continuous identification lettering. Tape over service lines that cannot be detected by a metal detector shall be multi-ply with an aluminum foil core.

2.4 Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with "P" (for plumbing) and the designated number.

2.5 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after insulation and painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in Division 22 identification work, with corresponding designations shown, specified or scheduled on drawings.

3.3 The Division 21, 22 and 23 labeling, marking and tagging shall be coordinated and consistent systems of identification.

3.4 Equipment labeling shall consist of unit designation as shown on the drawings.

3.5 Pipe markers shall be placed:

A. At each piece of equipment.

B. At 25 ft. centers in mechanical rooms and concealed spaces.

C. At 50 ft. centers in exposed finished area locations.

D. On mains at each branch take-off.

E. At least once in each room.

3.6 Refer to appropriate sections of this specification for installation of underground line marker tape.

3.7 Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above. Copies of one set of schedules shall be laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION

22 07 19 PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 Piping systems shall be insulated as described below. Pipe, fittings, unions, flanges, valves, devices, specialties and related items in the piping systems shall be insulated unless otherwise noted, with access maintained to P/T test ports, strainer caps, air vents and similar accessories thru the use of removable and reusable caps, plugs and fittings.

1.2 Composite insulation assemblies shall not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 243 listed in lieu of UL 723 or ASTM E84.

1.3 Insulation thicknesses are based on ASHRAE 90.1 and an average thermal conductivity of 0.22 to 0.28 BTU-in./hr. ft.2 - degrees F at 100 degrees F (0.21 to 0.27 BTU-in/hr ft^2 – degrees F at 75 degrees F). Thickness of insulation with lower conductivity may be reduced proportionately except that minimum thickness shall be 0.50 inch.

1.4 The following plumbing piping shall be covered with insulation of thickness listed, in compliance with ASHRAE 90.1, latest publication:

Pipe System	0.75” and smaller	1.0” to 1.25”	1.50” to 3”	4” to 6”	8” and larger
Domestic cold and non-potable water	0.50”	0.50”	1”	1”	1”
Domestic hot water (≤140°F)	1”	1”	1.50”	1.50”	1.50”
Storm drainage (1)	-----	-----	1”	1”	1”
Condensate drainage (2)	0.50”	0.50”	0.50”	0.50”	0.50”

Notes:

1. Storm and secondary (emergency) roof drainage systems - interior horizontal above ground piping including underside of roof drain sumps and outlet piping.

2. Condensate - from all ice machine bin drains and cooling coil drain pans - floor drain sump, trap and horizontal above ground piping to vertical stack or to downstream horizontal piping main. Coordinate with HVAC.

1.5 Insulation on plumbing systems is to be omitted on the following:

A. Unions in domestic hot water piping systems.

B. Exposed plumbing fixture supplies and supply stops except where required to meet ADA requirements.

C. Vertical interior storm drainage piping (downspout), except the first vertical section at the outlet of the roof drain sump and as noted above.

D. Condensate drains other than as noted above.

1.6 Protective metal/PVC jacketing shall be provided on insulation.

1.7 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.8 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Fiberglass insulation shall be manufactured by Johns Manville, Owens-Corning, Knauf or Manson. Closed-cell elastomeric insulation shall be manufactured by Armacell, K-Flex USA "Insul-Tube" or Aeroflex USA "Aerocel-SSPT". Refer to paragraphs below for manufactures of specific restricted use insulations.

2.2 Fiberglass pipe insulation shall be factory molded tubular fiberglass with "all service" jacket having an integral vapor barrier. Longitudinal joints of the jacket shall be overlapping with factory applied adhesive. In lieu of the factory adhesive, staples on 6 inch centers may be used with vapor barrier mastic applied to seal both the joint and stable holes. Butt joints shall be sealed with 3 inches wide ASJ pressure sensitive tape. Insulation shall be GreenGuard certified for low formaldehyde and VOC emissions.

2.3 Closed-cell elastomeric insulation shall be tubular or sheet form, flexible pipe insulation. Polyolefin insulation is not acceptable. Insulation shall be manufactured without the use of CFC's, HCFC's or HFC's. It should meet ASTM C534 and also be formaldehyde free, low VOC and resistant to mold and mildew. Pre-slit longitudinally with pressure sensitive adhesive tape closure system on tubular systems up to 4 inches IPS pipe size, field-split adhesive-seal on tubular systems for 6 inches IPS pipe size and self-adhering sheet insulation for pipe sizes larger than 6 IPS. Joints which do not have factory-applied sealant shall be sealed with 2 inches wide elastomeric thermal insulation tape or low VOC vapor sealing adhesive, complying with the specifications of the insulation manufacturer. Installation shall be in accordance with the manufacturer's published installation instructions.

For indoor systems, use shall be restricted to those systems requiring 1.5 inch thickness or less (due to 25/50 ASTM E84 requirements).

Unless jacketed, for insulation located outside, field paint with minimum (2) coats of an appropriate paint as recommended by the insulation manufacturer to prevent solar ultra-violet deterioration.

2.4 Cellular glass insulation shall be molded pipe insulation equal to Pittsburgh Corning "Foamglas One". Fittings shall be insulated with machined segments of pipe insulation or block or board stock. Joints shall be sealed with vapor sealing adhesive, per manufacturer's instructions. For direct-buried systems, jacketing shall be 70 mil self-sealing modified bituminous membrane "Pittwrap SS". For exterior above grade systems, jacketing shall be PittCoat 300, protected with an external metal jacket.

2.5 Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with:

A. For fiberglass insulation systems:

1. Factory molded fitting insulation cover with PVC one-piece fitting cover;
2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover;
3. Fiberglass blanket insulation, compressed, held in place and covered with PVC one-piece fitting cover; or
4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.

B. For closed-cell elastomeric insulation systems:

1. Miter cutting of tubular insulation using special tools and mitering devices; or
2. Oversized pipe insulation and insulation donuts, overlapped and shaped to conform to the fitting, valve or device.

C. For cellular glass insulation systems:

1. Machined or factory fabricated segments.
2. Hand carved, subject to approval by the engineer.

2.6 Hangers on insulated horizontal piping are to be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:

A. Pipe 2 inches and smaller - Anvil Fig. 168 18 ga. sheet metal rib-lock shield with belled ends, 12 inches long.

B. Pipe 2.50 inches and larger.
Pipe service temperatures 210 degrees F and below: 360 degrees insulated saddles equal to Buckaroos Tru-Balance with phenolic foam insulation, integral zero-perm vapor barrier and sheetmetal rib-lock shield with belled ends. For piping systems specified to be insulated with elastomeric type insulation, utilize Armafex IPH 25/50 flame/smoke rated insulation pipe hangers with polyurethane inserts and 30 MIL aluminum jacket, insulation wall thickness shall be minimum 1". If required service insulation is specified to be greater than 1", transition to required thickness within 2" of either side of IPH.

2.7 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.8 Protective jacketing on fiberglass insulation for both pipe and fittings shall be 0.016 inch aluminum with special Z-joint closure and factory supplied snap-straps.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

1. Due to condensation issues, fiberglass insulation shall not be installed until building is covered and conditioned.

C. Ensure that pressure testing of piping and fittings has been completed prior to installation.

3.3 Installation

A. Installation shall be done by tradesman specializing in insulation work in strict accordance with manufacturers' recommendations. Installers shall be factory trained and certified for the insulation systems being installed. Submit credentials upon request.

B. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices.

C. Install insulation on piping subsequent to acceptance tests.

D. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal, including over staples.

E. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic, except in cellular glass systems. PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.

F. Vapor barrier shall be continuous on insulation of all cold services, including horizontal storm and overflow drains. Vapor barrier type mastic shall be used where needed to maintain a vapor seal. Overlap and seal all longitudinal joints of fiberglass insulation jacket. Staples and adhesive may be used as stated above. Tape and seal cross joints.

G. Insulation on cold service piping shall be run thru floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to the 22 05 07 Piping Materials and Methods for special considerations which must be given at fire rated wall and floor penetrations. Refer to Section 22 05 23 General Duty Valves for Plumbing Piping for valves requiring extended shaft necks. Coordinate the furnishing, installation and detailed requirements of these. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.

H. The underside of roof drain sumps / bearing pans shall be insulated with self-adhering sheet form closed-cell elastomeric insulation, securely adhered to the underside. All joints shall be adhesive sealed, vapor-tight, to minimize the potential for condensation forming. Blanket type fiberglass insulation shall not be used.

I. Protective jacketing shall be applied over insulation on piping, fittings, valves and devices as specified above. All joints and seams of the jacket located outside shall be sealed watertight.

3.4 Protection

A. Advise as to the requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.6 Reinsulate and re-label piping to match where existing insulation has been damaged or removed in the performance of work in this project.

END OF SECTION

22 11 16 INTERIOR DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 Piping, valves and associated devices and materials for non-potable, interior domestic cold water, hot water and hot water recirculating systems shall be provided as shown on the drawings and as specified.

1.2 Refer to Section 22 05 07 - Piping Materials and Methods for Plumbing, Section 22 05 23 – General Duty Valves for Plumbing Piping, Section 22 05 29 Hangers and Supports for Plumbing Piping and other related sections for required provisions.

1.3 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Water piping and associated devices, materials and accessories shall be as described in Section 22 05 07 Piping Materials and Methods for Plumbing. Piping shall be:

A. All piping 4 inches and smaller unless specifically noted below - Type C1.

B. Underfloor and other buried pipe - Type C3, soft copper tubing with silver brazed joints.

C. Pipe nipples extending out of the wall to connect fixtures - brass with screwed ends. Exposed piping shall be chrome plated.

2.2 Valves for the various services shall be as listed below and as described in Section 22 05 23 General Duty Valves for Plumbing Piping.

A. Shutoff

1. Ball	B1, B4

B. Check

1. Swing	C1, C2
2. In-line spring	C3, C4

PART 3 - EXECUTION

3.1 Installation shall conform to provisions in Section 22 05 07 Piping Materials and Methods for Plumbing and Section 22 05 29 Hangers and Supports for Plumbing Piping.

3.2 Maintain a minimum 4 inches backfill depth between the top of the pipe and bottom of the floor slab for all piping installed in grade below the floor.

END OF SECTION

22 11 19 INTERIOR DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 Water system specialties shall be provided as shown on the drawings and as specified.

1.2 Refer to 22 05 07 Piping Materials and Methods for Plumbing, 22 05 23 General Duty Valves for Plumbing Piping, 22 05 19 Meters and Gauges for Plumbing Piping (for thermometers and pressure gauges) and 22 11 16 Interior Domestic Water Piping.

1.3 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Strainers shall 125 lb. w.s.p. "Y" pattern cast iron or bronze construction with removable stainless steel strainer element, tapped outlet for blow-down and screwed or flanged ends. Inside and outside of cast iron bodied strainers shall be NSF and FDA approved epoxy coated, ASTM B62 and meet NSF 372. Strainer elements shall be 20 mesh for 2 inches and smaller, 0.0625 inch for 2.50 inches, 3 inches and 4 inches and 0.125 inch for larger sizes. In 2.50 inches and larger sizes, a 20 mesh liner shall also be included for insertion inside the standard screen.

2.2 Point-of-Use Thermostatic Mixing Valves

A. Point-of-use mixing valves shall be designed to thermostatically blend hot and cold water for sink and lavatory supply. Valve construction shall be solid brass or bronze, with corrosion-resistant internal actuation components, union ends, and integral check valve and removable strainer on each inlet. Temperature control knob (field adjustable from 80 to 120 degrees F) shall have an adjustable stop and vandal-resistant locking mechanism. Unit shall be ASSE 1070 listed.

B. Valves serving individual faucets shall control to a minimum flow of 0.5 GPM and have a maximum 5 PSI pressure drop at 2.0 GPM. Valves shall have 0.375 inch compression, or 0.5 inch union-threaded or union-sweat connections.

C. Valves serving multiple faucets shall control to a minimum flow of 0.5 GPM and have maximum 10 PSI pressure drop at 4.0 GPM. Valves shall have 0.5 inch union-threaded or union-sweat connections.

D. On valves serving multiple fixtures, provide a temperature test plug (Pete’s plug) on the outlet to assist in setting the discharge temperature. See Section 22 05 19.

E. Point-of-use mixing valves shall be Powers, “Hydrogard” Series LFLM495 or equal by Sioux Chief, Apollo, Acorn, Bradley, Cash Acme, Leonard, Wilkins Caleffi, or Watts.

2.3 Wall hydrants shall be bronze, quarter turn, non-freeze, automatic draining type, with stainless steel face and integral vacuum breaker and dual check valve, 0.75 inch hose thread outlet, loose key stop, stainless steel recessing box with hinged locking cover, internal wheel handle and outer brass casing of length required for the wall thickness with integral union elbow. Unit shall comply with ASSE 1052. Hydrants shall be Smith 5619 or equal by Woodford, Wade, Mifab or Zurn.

2.4 Water hammer arresters shall be precharged sealed stainless steel gas bellows or diaphragm type conforming to PDI Standard WH-201 and ASSE 1010. Piston type are prohibited. Units shall be

sized and installed as required. Units shall be by Smith, Wade, Josam, Mifab, Watts, Sioux Chief or Zurn.

PART 3 - EXECUTION

3.1 Strainers 2 inches and larger shall be fitted with a ball type blow-down valve. Discharge piping shall be extended to a floor drain.

3.2 Thermostatic mixing valves shall be installed in accordance with the manufacturers recommendations and details on the drawings.

3.3 Wall hydrants shall be located approximately 24 inches above final grade. Verify length of casing vs. wall thickness and location of wall insulation to preclude a freezing condition for the hydrant.

END OF SECTION

22 13 16 INTERIOR DRAINAGE AND VENT SYSTEMS

PART 1 - GENERAL

1.1 Interior drainage and vent systems including soil, waste and vent system, and storm drainage system shall be provided as shown on the drawings and as specified.

1.2 Refer to 22 05 09 Excavation Backfill and Surface Restoration, 22 05 07 Piping Materials and Methods for Plumbing, 22 05 29 Hangers and Supports for Plumbing Piping and other related sections for provisions affecting this Section.

1.3 All referenced standards shall be of the latest edition adopted by the jurisdiction unless specifically noted otherwise.

1.4 All cast iron drainage and vent pipe, fittings and joining materials shall be listed to the respective standard(s) stated below and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

PART 2 - PRODUCTS

2.1 Interior soil, waste and vent piping.

A. Pipe in grade below the floor slab shall be coated cast iron, centrifugally cast with hub and spigot ends, ASTM A74. Fittings shall be drainage type. Joints shall be push-tight with elastomeric gaskets, ASTM C564 and ASTM C1563.

B. Pipe, fittings and joints above grade shall be:

1. Pipe shall be coated cast iron, centrifugally cast with hubless ends, ASTM A-888 and CISPI 301. Fittings shall be drainage type with hubless ends. Joints shall be made with no-hub couplings consisting of a neoprene gasket, ASTM C564, Series 300 stainless steel shield and stainless steel band, CISPI 310, NSF certified and marked.

2.2 Storm Drainage Piping

A. Pipe in grade below the floor slab shall be coated cast iron, centrifugally cast with hub and spigot ends, ASTM A74. Fittings shall be drainage type. Joints shall be push-tight with elastomeric gaskets, ASTM C564 and ASTM C1563.

B. Pipe, fittings and joints above grade shall be:

1. Pipe shall be coated cast iron, centrifugally cast with hubless ends, ASTM A-888 and CISPI 301. Fittings shall be drainage type with hubless ends. Joints shall be made with no-hub couplings consisting of a neoprene gasket, ASTM C564, Series 300 stainless steel shield and stainless steel band, CISPI 310, NSF certified and marked.

PART 3 - EXECUTION

3.1 Cut pipe to required length and ream ends to remove burrs. Align horizontal piping to attain even pitch, minimum of 0.25 inch per ft. on sizes 2.50 inches and smaller, 0.125 inch per ft. on sizes 3 inches and larger unless specifically noted on drawings.

3.2 Trenching, bedding and backfill for piping in grade below floor slab shall be in accordance with 22 05 09 Excavation, Backfill and Surface Restoration.

3.3 Piping shall not be run above electrical switchgear or panelboards, nor above access space in the immediate vicinity of the equipment, in accordance with N.E.C. Article 110.26.

3.4 Gasket lubricant shall be used in the assembly of push-tight joints.

3.5 The use of sealers or sealants for couplings in No-Hub cast iron systems is not acceptable unless specifically recommended by the coupling manufacturer. No-Hub type couplings shall be installed in strict conformance with manufacturer's recommendations.

3.6 Horizontal above grade piping, in sizes 4 inches and larger, shall be rigidly braced to prevent horizontal movement and joint separation at each branch opening and change of direction greater than 45 degrees. Bracing methods shall be as recommended by pipe manufacturer's installation instructions and the Cast Iron Soil Pipe Institute (CISPI) Handbook.

3.7 Provide cleanouts in drainage piping as indicated on the drawings and:

A. In horizontal piping at intervals no greater than 100 ft. for 4 inch and smaller pipe, 100 ft. for 5 inch and larger pipe.

B. At the base of each soil and waste stack and at the base of each downspout.

C. Above each sanitary cross.

D. In sanitary and storm piping leaving the building for cleanout and testing purposes.

3.8 Maintain a minimum 4 inches backfill depth between the top of the pipe and bottom of the floor slab for all piping installed in grade below the floor.

END OF SECTION

22 13 19 DRAINAGE SYSTEMS SPECIALTIES

PART 1 - GENERAL

1.1 Drainage systems specialties shall be as shown on the drawings and as specified.

PART 2 - PRODUCTS

2.1 Floor drains and roof drains shall be as shown and scheduled on the drawings. Drains shall be equal to listed catalog numbers, type, size, materials and features. Drains shall be manufactured by J.R. Smith, Wade, Josam, Watts, Mifab or Zurn.

A. Floor drain traps shall be same material as the connecting piping.

2.2 Carriers for Wall Hung Fixtures

A. Closet chair carriers, ASME A112.6, shall be adjustable type, cast iron and steel construction, with neoprene gasket, floor plate, anchor foot assembly and rear anchor tie down. Wax gaskets are not acceptable. The nipple shall be adjustable without cutting or defacing the wall and yet maintain a tight joint. Closet chair carriers shall be capable of supporting a 500 lb load.

B. Closet chair carriers shall be so selected and installed that the stud plate is tight against the back of the wall to afford a rigid mounting. Closet chair carrier configurations and auxiliary inlets shall be provided to comply with the piping configurations shown on the drawings. Plastic or metal positioning frames shall be furnished with closet chair carriers to separate the bolts from the wall construction.

C. Lavatory chair carriers, ASME A112.6, shall be concealed arm/hanger plate type, steel construction, welded footplates, adjustable positive mechanical locking device, designed for thin wall construction. Lavatory chair carriers shall be capable of supporting the lavatory with a 250 lb. vertical load applied to the front of the fixture.

D. Electric water cooler and drinking fountain chair carriers, ASME A112.6, shall be hanger plate or dual hanger plate type, steel construction, welded footplates, designed for thin wall construction. Electric water cooler chair carriers shall be capable of supporting the cooler with a 250 lb. vertical load applied to the front of the fixture.

E. Plumbing fixture carriers shall be provided for all wall hung fixtures, unless specifically noted otherwise, and shall be of the same manufacturer as floor and roof drains.

2.3 Cleanouts

A. Cleanouts shall be of the same manufacturer as floor and roof drains and equal to the listed catalog numbers in type, materials and features.

B. Cleanouts located in floors shall be J.R. Smith Series 4020 consisting of two-piece adjustable housing, ABS, cast iron or bronze NPT gasketed plug and round non-slip nickel-bronze cover with securing screw. Additional features such as clamping device for waterproof membrane, synthetic covering top, heavy duty top, carpet flange or carpet marker shall be provided as appropriate for the installation.

C. Cleanouts located in walls and partitions shall be J.R. Smith Series 4472 consisting of cast bronze plug and round stainless steel access cover secured by vandal-proof center screw.

Wall cleanouts that cannot be made accessible in this manner shall be provided with an access panel as described in 22 05 04 Basic Plumbing Materials and Methods.

D. Exterior cleanouts in areas not subject to vehicular traffic shall be J.R. Smith Series 4220. Cleanouts shall consist of a cast iron two-piece adjustable housing, ABS, cast iron or bronze NPT gasketed plug and round non-slip cast iron top with securing screw. In area with decorative paving, tops shall be nickel bronze or bronze.

E. Exterior cleanouts in areas subject to vehicular traffic shall be J.R. Smith Series 4250. Cleanouts shall consist of ABS or cast iron gasketed plug, heavy duty double flanged housing and round non-slip cast iron cover with securing screws.

F. Refer to Part 3 for installation and concrete anchorage of exterior cleanout covers at grade.

PART 3 - EXECUTION

3.1 Floor drains shall be set with rim below finish floor level to permit continuous floor pitch to drain, unless otherwise noted or directed. Verify exact location and desired rim elevations before installation.

3.2 Roof drains shall be set as low as practicable in the roof construction to enhance the probability of complete drainage of the roof area served. Drains shall be compatible with the related roof construction. Installation shall be in accordance with architectural details when such details are provided.

3.3 Roof drains shall be installed with bearing pans extending 8 inches out from the clamping ring of the drain. The pan shall be placed on the roof deck below the insulation. Secure the clamping ring and drain top after the roofing membrane has been installed.

3.4 All carriers shall be equipped with feet properly adjusted to rest firmly on the floor. Carrier feet shall be block base type and shall be bolted securely to the floor slab using all bolt holes provided.

3.5 Cleanouts shall be same size as pipe thru 4 inch size. Maximum size of cleanouts shall be 4 inches diameter unless larger units are required for testing or special access purposes. Provide cleanouts where indicated on the drawings and at other locations where deemed advisable. Location of cleanouts as stipulated by applicable code shall be considered as the minimum requirement.

3.6 Exterior cleanout covers, when not installed in concrete or other poured hardscape surfaces, shall be set flush with grade and secured with 1 cu. ft. of concrete formed square, with top surface finished.

END OF SECTION

22 13 29 PLUMBING PUMPS - DRAINAGE

PART 1 - GENERAL

1.1 Drainage pumps, basins and associated controls shall be provided as shown on the drawings and as specified.

1.2 Except where noted and/or for tile or concrete basins are used, basins covers, accessories and controls shall be furnished with the pump by the pump supplier.

1.3 Refer to Section 22 05 07 Piping Material and Methods, Section 22 05 09 Excavation, Backfill and Surface Restoration, Section 22 05 13 Electrical Requirements for Plumbing Equipment, Section 22 05 23 General Duty Valves, and other sections for work related to this section.

PART 2 - PRODUCTS

2.1 Sewage Ejectors - Zoeller, Weil, Crane, Hydromatic or LIberty

A. Type B1 - Submersible - Simplex - 2 HP and smaller

1. Pump to be automatic submersible type, UL listed. Pump construction shall be all ASTM Class 25 cast iron. Impeller shall be non-clogging vortex design constructed of engineered glass-filled plastic with a metal shaft inset. Shaft seal shall be ceramic-carbon type. All exposed fasteners shall be 300 Series stainless steel along with lift handle and pump removal/lift cable. Motor shall be permanent split capacitor type with automatic reset thermal overloads and hermetically sealed with high quality oil for cooling the windings and permanently lubricated motor bearings. Motor shall be equipped with an UL Listed 3 wire cord of sufficient length to allow connection to the electrical control panel without splicing. Pump shall be capable of passing 2 inch solids, maximum 130 degrees F. sewage discharge temperature with a 2 inch threaded discharge connection.

2.2 Pump discharge piping from pump discharge port, through valves, to termination or connection point at sanitary main shall be:

B. Schedule 40 PVC pipe, ASTM 2665. Fittings shall be drainage type with socket ends. Joints shall be solvent welded. PVC piping shall not be installed in ceiling air plenums.

2.3 Basins and Covers

A. Basins to accommodate pumps shall be the following type. Refer to the drawings for minimum basin size required and inlet and vent connections.

1. TYPE C1
Fiberglass basin shall be constructed of commercial grade polyester with reinforcing material of commercial grade fiber (continuous strand or continuous mat) and a coupling agent to bond the glass reinforcement and resin. The basin shall be designed to withstand buckling and wall collapse two times the assumed loading at the depth of the basin as indicated on the drawings. Basin shall include anti-floatation and top flanges with Series 300 stainless steel inserts that are all fully encapsulated with non-continuous or chopped-strand glass strand reinforcement. Finished basin shall meet Barcol hardness of at least 90 percent of the resin manufacturer's specified hardness for the fully cured resin. The Barcol hardness shall be the same for both the interior and exterior surfaces. Cover shall be epoxy coated steel , with flanged openings for vent piping, discharge piping and wiring, all sealed gas tight. Cover shall be furnished with Series 300 stainless steel bolts and washers minimum 0.25 inch diameter for cover attachment to basin.

2.4 Refer to Section 22 05 23 for shutoff and check valves for the discharge piping of sewage ejector pump. Check valve shall be type C1.

PART 3 - EXECUTION

3.1 Ensure that sump inlet is sufficiently low to accommodate all flow inlets at not less than 0.125 inch per ft. slope. Ensure that electrical is accommodated under floor to sump pumps. Ensure head room for pump removal; offset piping connections and locate unions in a manner to accommodate disconnect and lifting of pumps.

3.2 Install a check valve on each pump discharge, downstream, from disconnecting union or flange. Vent thru roof all sewage ejector sumps and closed cover bilge pumps. Check valves shall be installed in the horizontal plane.

3.3 Drill a 0.1875 inch vent hole in discharge pipe, within the basin, between pump and check valve.

3.4 Install the “pump off” float above lowest pump intake (to eliminate possibility of air entering pump).

3.5 Provide cord seals at cover interface.

END OF SECTION

22 42 00 PLUMBING FIXTURES

PART 1 - GENERAL

1.1 Plumbing fixtures installed in place complete with supports, supply and waste trim shall be provided as shown on the drawings and as specified.

1.2 Refer to Division 7 for submittal, qualification, storage, handling warranty and installation requirements for joint sealants. Shop drawings shall be submitted to the Architect / Engineer for review and approval.

1.3 All plumbing fixtures, equipment and trim shall meet the dimensional and performance requirements of the ANSI, ARI, ASME, ASSE and/or CSA standards listed in the current jurisdictional plumbing code.

1.4 All piping, fittings, valves, solders, fluxes, seals, fixtures, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Fixtures and Trim:

A. Refer to schedule on the drawings for fixture specifications, including supply and waste trim and carriers where required. The schedule lists catalog numbers of various manufacturers. These catalog numbers are for the purpose of comparison to establish the construction material, quality and features of the fixtures and their components. Fixtures of equal quality by manufacturers listed in each category will be acceptable.

B. Fixture supply trim shall be of non-ferrous construction and supplies to each fixture shall be individually valved. Valves, supplies and escutcheons shall be furnished with the fixture supply trim.

C. Where exposed to view, all waste trim and supply trim shall be brass chrome plated furnished with wall escutcheons.

D. Screwed nipples serving fixtures from copper tube supply system shall be solid brass to avoid electrolytic corrosion. Exposed nipples shall be chrome plated.

E. Fixtures shall be white unless otherwise noted.

2.2 Joint Sealants

A. Joint sealants shall be by Pecora, Sonneborn, Tremco, or equal by Division 7 listed manufacturers.

B. One part, mildew resistant silicone, ASTM C-920, Type S, Grade NS, Class 25 with fungicide, white, equal to Pecora 898.

C. One-part mildew resistant acrylic latex, ASTM C-834, silicone additive, paintable, white, equal to Pecora AC-20.

PART 3 - EXECUTION

3.1 Installation

A. Space fixtures and rough-in carefully. Fixtures shall be carefully assembled and connected to the required plumbing outlets so the equipment will be ready for use when work is completed. Height shall be within 0.50 inch of specified nominal.

B. Secure supply and waste piping in chases and walls to preclude loose and ill-fitting pipes thru wall. Drop ear ell fittings shall be utilized at all supply nipples and shower arms.

C. After installation of the fixtures is completed, all connecting pipes shall be flushed out through the fixtures to eliminate scale, and all valves shall be properly adjusted and fixtures left complete and ready for use. All fixtures shall be cleaned immediately prior to acceptance by the Owner.

D. Seal joints around each fixture at wall, floor and any adjacent construction.

END OF SECTION

DIVISION 23

HVAC EQUIPMENT

23 05 01 BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, and Supplementary Conditions, including Divisions 00 and 01, apply to work specified in this Division.

B. The scope of the Division 23 work includes furnishing, installing, testing and warranty of all work and complete HVAC systems as shown on the M-series drawings, and as specified in Division 23 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors to the Prime Contractor, assignments of work by division are not intended to restrict the Prime Contractor in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the Division 23 work. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Inspect the project site and the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect and Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having ductwork, pipe and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install ductwork, piping and equipment.

D. The Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's / decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary drains and minor valves, traps, dampers and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect.

1.5 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 23 Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

C. Material provided for work performed under Division 23 shall not contain asbestos.

1.6 Coordination Drawings

A. The Division 23 Contractor shall prepare and be responsible for 0.25inch scale electronic coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format with the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 23 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval, and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings, and that specified ceiling heights are maintained.

C. In addition, submit separate “Sheet Metal Only” drawings for review by the Engineer.

1.7 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.8 Record Drawings

A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work, and within 90 days of system acceptance, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.9 Operating and Maintenance Manuals

A. Provide a tabbed PDF that has all the components as a hard copy. Provide table of contents, cover sheets, tabs, and all required content.

B. Once PDF is approved assemble two copies each of operating and maintenance manuals for the HVAC work.

C. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

D. Final air and water balance reports and as-built automatic temperature controls drawings and specifications shall also be included.

E. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.10 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 23 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected their work and so states at the time of the request for the final inspection.

B. Requests to the Architect and Engineer for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken to the satisfaction of the Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.11 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Use of equipment for temporary heating or cooling is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.

C. This provision shall not be construed to include maintenance items such as replacing filters, re-tightening or repacking glands, greasing, oiling, belt tightening and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

A. All equipment and appliances shall be listed and labeled in accordance with the Mechanical Code. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance.

2.3 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.4 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will only be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Within ten (10) days after award of contract, the names of Subcontractors and manufacturers of the major items of equipment which are proposed shall be submitted to the Architect / Construction Manager for approval. Refer to the list of equipment below.

D. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

E. If extensive changes in pipe, duct or equipment layout, electrical or control wiring, or equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract, including other effected trades.

2.5 Shop Drawings

A. One electronic copy of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer’s attention in a separate clearly stated notification at the time of submittal for the Engineer’s review.

C. Shop drawings of the following HVAC equipment and materials shall be submitted:

1. Pipe, fittings and joining methods for the various systems.
2. Pipe hangers and saddles.
3. Valves.
4. Flexible connectors.
5. Gauges.
6. Vibration isolators.
7. Pipe insulation.
8. Ductwork insulation.
9. Ductwork
10. Pumps.
11. Air-cooled Chillers.
12. Rooftop air handling units.
13. VRF Split System heat pumps
14. Air filters.
15. Air outlets and inlets.
16. Variable Frequency Drives
17. Automatic Temperature Controls.

PART 3 - EXECUTION

3.1 Pipe Testing

A. All piping provided in this work shall be pressure tested, as specified below, including all connected coils and equipment.

B. Pipe testing for HVAC piping shall be:

1. Water piping - metallic - hydrostatic at 125 psig or 1.50 times maximum operating pressure throughout the system, whichever is higher for 6 hours at the low point of the system.
2. Condensate drainage piping, same as for plumbing drainage piping.
3. Refrigerant piping - refer to appropriate Refrigeration Sections.
4. Other piping - refer to appropriate Sections.

C. Testing shall be performed prior to application of insulation. Ensure that air is vented from piping when piping is hydrostatically tested.

D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

F. Where a new pipe connects to an existing pipe, provide the following to facilitate testing, cleaning, draining and eventual shutoff service:

1. A shutoff valve in the new pipe near the point of connection.
2. Strainer with blowdown valve and hose connection (supply and return). Remove strainer after systems have been running together and are deemed to be clean.
3. A 0.75 inches valved stub with capped 0.75 inches hose connector beyond the valve for testing of the new pipe extension. Close valve, remove handle after testing is complete. Wire handle to valve body.

3.2 Pipe Cleaning

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

B. Hydronic and other closed circuit water system piping and connected equipment shall be further cleaned by introducing a low foaming detergent solution and circulating the solution throughout the system for a 2-hour period. However, equipment that is subject to fouling from the flushing process shall be isolated when recommended by the equipment manufacturer. This may include boilers, plate and frame type heat exchangers, and small coils. Follow equipment manufacturers' cleaning and flushing instructions. Clean strainers at the end of this period. Pump suction diffuser start-up strainers shall be removed after initial circulation and cleaning of the system. The system shall be thoroughly flushed with clean water before refilling.

C. Refer to appropriate Sections for cleaning of other piping for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each piping system and air distribution system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing air and water systems, adjusting fan speeds, belts, pulleys, tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

C. Test relief valves, air vents and regulating valves to ensure proper operation.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner, Engineer and Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

3.5 Spare Filters

A. Furnish one complete initial set of filters and one complete set of spare filters for each filter bank in the project. This is in addition to filters used for temporary heating.

END OF SECTION

23 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. **Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form.** Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All electronic files shall be stripped of the Project's name and address, the Architect's and Engineer's and any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.9 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its

consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.10 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

23 05 02A
ELECTRONIC FILES HEAPY RELEASE FORM TO CONTRACTORS

Project: New Castle – Henry County Public Library – Interior & Exterior Renovations
376 S 15th St
New Castle, IN 47362

Owner: Henry County Public Library

Heapy Engineering Project Number: 2022-07145

Heapy Engineering Project Manager: Mat Root

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Name of authorized Recipient Representative: _____

Title of authorized Recipient Representative: _____

E-mail address of authorized Recipient Representative: _____

Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____
_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ Heapy FTP ☐ User's FTP site ☐ Project FTP site (when available)

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 20XX DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG
Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 23 Electronic .DWG Files:

First Drawing: $50.00 $50.00

Additional Drawings $15.00 each _____ x $15.00 = $ _____

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _____ x $ 5.00 = $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____
All files will be bound together.

Available electronic Revit file format:
☐ 20XX .RVT

Cost of Preparation of Division 23 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

23 05 04 BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Temporary Heating and Cooling

A. The temporary heating and cooling for construction is provided by the Contractor. Refer to Division 01 - General Requirements.

B. Fuel and electric costs attendant to temporary heating and cooling are not included in Division 23.

C. The use of the permanent HVAC systems for temporary heating and cooling during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period. Provide and maintain temporary air filters (same as specified permanent filters) to protect coils and ducts. Replace temporary filters with the clean specified filters when the systems are turned over to the Owner. Air filters specified for the systems and units, including specified spare filters, are not to be used for temporary service.

D. Cover all return duct openings with temporary MERV 8 filter media. Stop fans during heavy dust generating operations. Before turning the system over to the Owner, clean duct interiors and interior surfaces and components of the air handling equipment.

E. If existing AHU's are used to maintain space conditions within the renovation, the existing ductwork and units shall be cleaned to new condition after construction is complete.

1.2 Continuity of Services

A. Work shall be so planned and executed as to provide reasonably continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner and Construction Manager shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Contractor to refer to phasing plan for purposed phasing.

C. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devices and equipment requiring service or adjustment.

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style "M" or equal.

B. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect or Construction Manager.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements and Special Conditions for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes and ducts are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Trades to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect or Construction Manager. Any damage caused to the building shall be repaired or rectified.

C. Where pipes and ducts are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching and refinishing of same shall be included in this contract. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls, etc. are to be cut for presence of existing utilities.

C. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system brace floor or alter location of new work to maintain existing system.

D. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

E. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

F. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

G. Engage a Roofing Contractor on a subcontract basis for roofing and roof insulation work necessitated by the HVAC work. The Roofing Sub-Contractor shall be certified for installation and repair of the roofing system so as to maintain the existing roofing warranty.

3.4 Removals, Alterations and Reuse

A. Refer to the drawings for the scope of remodeling in the existing building.

B. Cooperate with all trades and Construction Manager regarding all removal and remodeling work. Unless otherwise noted, remove existing work which is associated with Division 23 and which will be superfluous when the new work is installed and made operational.

C. Extraneous ductwork and piping which is or becomes accessible shall be removed and stubs shall be capped at the first active duct or pipe encountered. Ductwork and piping that is and remains inaccessible shall be abandoned. Ends of abandoned duct and pipe shall be capped so as to be concealed by finished surfaces. Upon completion of the work no abandoned duct, pipe, valve or stub shall extend thru finished floors, walls or ceilings.

D. When it is necessary to reroute a section of active ductwork or piping the rerouted section shall be installed before removing the existing in order to minimize system down time. Rerouted sections shall be insulated as required for new work. Patch insulation on existing ductwork and piping which has been damaged or removed in this work.

E. Materials and equipment which are removed shall not be reused within the scope of this project unless specifically noted to be relocated or reused. Turn over to the Owner and place where directed on the premises all removed material and equipment so designated by the Owner. All material and equipment not claimed by the Owner shall become the property of the Contractor responsible for removal and shall be removed from the premises.

F. Remove, store and reinstall lay-in ceiling tile and grid as needed to perform work in areas where such removal and re-installation is not to be done by others. Damaged tile and/or grid shall be replaced with new matching tile and/or grid.

G. In areas of minor work where the space is not completely vacated, temporarily move portable equipment and furnishings within the space as required to complete the work. Coordinate this activity with Owner and Construction Manager. Protect the Owner's property by providing dust covers and temporary plastic film barriers to contain dust. Remove barriers and return equipment and furniture upon completion of the work.

H. Refinish any surface disturbed under this work to match existing, except where refinishing of that surface is included under the General Contract.

3.5 Painting

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.

3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite / 221 cold galvanizing compound or approved equal, for touch-up of previously galvanized surfaces.
5. Inside of ducts, behind grilles and registers, shall be painted flat black to eliminate the viewing of shiny surfaces.

B. Paint, surface preparation and application shall conform to industry standards. All rust must be removed before application of paint.

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

3.6 Access Panels

A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

3.7 Miscellaneous Component Installations

A. Certain miscellaneous items and components are furnished loose and require installation into the duct systems, piping systems, and other HVAC systems. These items shall be installed per the suppliers and manufacturers instructions.

B. This shall include, but by no means be limited to, items such as balancing dampers, backdraft dampers, motorized dampers, gravity dampers, fire and/or smoke dampers, sound attenuation products, control valves and components and other similar items.

C. Provide compatible connection means for all items being installed.

D. Provide bulb wells for temperature control equipment, and coordinate accordingly. Other types of control devices (dp switches, flow switches, flow meters, etc.) shall also be installed, with devices, needed fittings (tees, weldolets, threadolets, etc.), locations and installation details closely coordinated.

E. Provide all required access means (access doors, etc…) required for installation, service and inspection.

END OF SECTION

23 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping and non-fire dampered ducts thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and HVAC drawings for pipe and duct layouts.

1.2 New piping and ductwork penetrating existing building elements shall be firestopped.

1.3 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.4 Firestopping materials, assemblies and installation shall conform to requirements of the code and the Authority Having Jurisdiction.

1.5 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.6 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions. Submittals shall include all information required by the Building Code.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

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

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Firestopping shall not be installed at fire dampers that would impair the needed free expansion of damper, sleeve and retaining angles in a fire condition. Refer to the installation instructions of the fire damper manufacturer.

3.4 Refer to 23 05 07 Piping Materials and Methods for pipe sleeve requirements and treatment of penetrations not requiring firestopping. Refer to 23 31 13 HVAC Ductwork for duct sleeve requirements where firestopping is required.

END OF SECTION

23 05 07 PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Piping materials and methods shall be as specified herein and as shown on the drawings.

1.2 Included in this section are:

A. Pipe, fittings and joining methods.

B. Unions and flanges.

C. Dielectric connectors.

D. Pipe sleeves, openings, curbing and escutcheons.

E. Installation methods of piping.

1.3 Refer to other Sections in Division 23 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.4 Refer to Section 23 05 05 Firestopping for firestopping requirements.

1.5 Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications. Submit welder certifications for record.

1.6 Welding procedures and testing shall comply with ANSI Standard B31.1.0 - Standard Code for Pressure Piping, Power Piping and The American Welding Society Welding Handbook.

1.7 Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to the various trades in new walls, partitions, floors and roof slabs, same as for new piping.

1.8 Sleeves are not required:

A. In floor slabs on grade.

B. For insulated piping passing thru stud and gypsum board or plaster walls and partitions which are not fire rated.

1.9 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 Steel pipe and fittings and joints shall be:

A. Type S1
Pipe - Schedule 40 black steel, ASTM A-53, Types E and F.

Fittings and joints - 150 lb., except 300 lb. on systems exceeding 125 psig, seamless steel welding type. ELL's shall be long radius type (1.5 R).

2.2 Copper tubing, conforming to ASTM B88, Standard Specification for Seamless Copper Water Tube and Fittings and Joints, shall be:

A. Type C1
Pipe - Type "L" seamless hard drawn copper tubing.
Fittings - wrought copper or cast bronze, solder ends, ASTM B16.
Joints - soldered with lead-free tin alloy, 95-5 tin-antimony or silver-bearing tin equal to Harris "Stay-Brite", "Stay-Brite 8" or "Bridgit".

B. Type C4
Pipe - Type "L" seamless hard drawn copper tubing.
Fittings - wrought or cast DWV, solder ends, ASTM B16.
Joints - soldered with lead-free tin alloy, 95-5 tin-antimony or silver-bearing tin equal to Harris "Stay-Brite", "Stay-Brite 8" or "Bridgit".

2.3 Unions and flanges shall be:

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

B. Unions on steel pipe 2 inches and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

C. Flanges on steel pipe with welded or screwed joints, 2.50 inches and larger. Gaskets shall be 0.0625 inches thickness full face compressed sheet suitable for temperature and pressure ranges of the application.

2.4 Dielectric connectors are required at each connection between ferrous and non-ferrous piping. Insulating materials shall be suitable for system fluid, pressure and temperature. Connectors shall be one or more of the following:

A. Brass adaptor.

B. Dielectric Waterway (may only be used on water systems operating at less than 100° F.): Fittings shall be a copper-silicon casting conforming to UNS C87850, and UL classified in accordance with ANSI / NSF-61 for potable water service. Fittings shall have threaded ends, grooved ends, or a combination. Victaulic Style 647.

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum working pressure as required to suit system pressures, and suitable for 225 degrees F. or higher.

1. Acceptable Manufacturers:
   a. Capitol Manufacturing Co.
   b. Epco Sales, Inc.
   c. Watts Industries, Incl.; Water Products Div.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly, Include flanges, full-face-or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers, all suitable for 225 degrees F continuous service or higher.

1. Acceptable Manufacturers:
   a. Advance Products & Systems, Inc.

b. Calpico, Inc.
c. Pipeline Seal and Insulator, Inc.

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

2.5 Pipe sleeves shall be:

A. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

2.6 Piping and conduits extending thru the roof may be fitted with a manufactured pipe curb weatherproofing assembly, with required curb cap and all associated boot accessories/clamps to form weathertight curb cap seal, constructed of heavy gauge galvanized steel with minimum 1.5" thick curb insulation and wood nailer, equal to Pate pca and mpca, as an alternative to riser sleeves with clamping rings specified above. Provide curbs with cants where required by roofing contractor.

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

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Piping shall be pitched for drainage. The low points shall be fitted with a 0.75 inches drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1.25 inches and smaller where a drain valve is not shown, a drain plug is acceptable. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.

3.3 Piping shall be installed consistent with good piping practice and run concealed wherever possible. Coordinate with other trades to attain a workmanlike installation.

3.4 Piping shall be supported as specified in Section 23 05 29 Hangers and Supports for HVAC Piping. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.

3.5 Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering. Where silver brazing is specified, solder connection of valves shall be used to reduce the danger of damage.

3.6 Piping within 2 ft. of the coil connections to small heating and/or cooling units, reheat box coils and duct coils may be Type "K" soft copper to facilitate connection in a confined space. Joints shall be brazed or soldered consistent with the piping system or flared-tubing fittings may be used where appropriate.

3.7 Close open ends of piping during installation to keep interior of the pipe clean.

3.8 Pump suction diffuser start-up strainers shall be removed after initial circulation and cleaning of the system.

3.9 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the National Electric Code (NEC).

3.10 Pipe sleeves shall be placed, and structural footing relieving arch requirements shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the project Structural Engineer.

3.11 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water, refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.12 Refer to 23 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.13 In lieu of firestopping and where permitted by the Indiana Building Code uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar).

3.14 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with caulking to retard the passage of smoke.

3.15 Dielectric connectors shall be provided at all locations described herein, at each connection between ferrous and non-ferrous piping, and as shown on the drawings.

3.16 Cooling condensate drain piping shall be installed per details and equipment manufacturer's instructions. Horizontal runs shall be pitched to drain, constructed with DWV fittings, and provided with a clean-out every 50 LF of piping unless shown more frequently on the plans.

END OF SECTION

23 05 13 ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 Motors, starters, disconnects, devices, fuses, wiring and other electrical work included in Division 23 shall be factory installed or furnished and field installed as specified in the various specification sections and as shown on the drawings. Refer to the project documents for requirements related to each trade. Coordinate all aspects of electrical components and wiring to complete the systems.

1.2 Equipment control panels containing power control components shall be marked with the minimum SCCR rating. The rating shall not be less than the available fault current. Refer to the electrical drawings for the calculated available fault at the distribution panel, MCC or panelboard serving the equipment. Include confirmation of being protected from the fault current in the equipment shop drawing submittal.

1.3 Note: Equipment with Electronically Commutated Motors (ECM's) are sometimes factory programmed to limit current draw to the motor, to limit the available brake horsepower to better match specified performance and reduce required power circuiting. This reduced brake horsepower is likely below the motor's nameplate rating. The electrical design documents may be sized based on the ECM's nameplate motor horsepower. The equipment supplier shall notify the Division 23 and 26 contractors and the Engineer if the maximum overcurrent protection on the design documents differs from their selected equipment's nameplate data. Any required revisions to the electrical circuiting, including maximum over-current protection devices, shall be documented on the shop drawing submittal. The required revisions must be forwarded to the Division 26 contractor with enough time to adjust the over-current protection and the electric circuit installation. However, any additional cost associated with increased electrical feeder/breaker sizes or lack of coordination listed above shall be the Division 23 contractor's responsibility.

1.4 Refer to the Electrical drawings and verify adequacy of feeder size, sets of conductors and size, disconnecting means and other electrical requirements. Compare these to the requirements of the equipment to be furnished and report deficiencies and / or discrepancies to the Engineer in the bid period for resolution by addendum. Bear all costs for electrical changes where such issues are not properly resolved.

1.5 Equipment and devices shall comply with applicable standards of NEMA and shall be UL listed. All work shall comply with the National Electrical Code.

1.6 Electrical equipment, devices, fuses, wire, conduit and methods shall comply with applicable provisions of Division 26 - Electrical.

PART 2 - PRODUCTS

2.1 Motors

A. General purpose motors shall be induction type 1750 rpm NEMA Design "B" with copper windings, Class B or F insulation, and motor enclosure to suit the application. Service factor shall be 1.15 minimum.

B. Two-speed motors shall be two-winding type with six leads unless otherwise specified.

C. Motors for other than general duty application shall be furnished to suit the application and operating environment.

D. Premium efficiency motors shall be equal to Century "E + 3", General Electric "Energy Saver Premium Efficiency", Baldor "Super E Premium Efficient" or Reliance "Premium Energy

Efficient" series. Motor efficiencies shall be tested and conform to NEMA Standard Publication MG-1 and IEEE 112 Test Method B.

E. Motors used with Adjustable Frequency Motor Controllers (Variable Frequency Drives) shall be rated for inverter service in accordance with NEMA Standard Publication MG-1, Part 31 and designed with Class F or H insulation, but with a Class B temperature rise. Motors connected to VFD's shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer.

F. Motor sizes shown on the drawings are to be considered minimum. Motors furnished shall be sized so as to not operate in the service factor range. Motors for direct driven pumps and fans shall be selected so as to not operate in the service factor range at any point on the curve.

G. Compare the electrical power requirements of the intended equipment with power feeders to the equipment shown on the Electrical drawings. Verify adequacy and compatibility of voltage, phase, wiring capacity, number and size of conductors (versus equipment connection points), maximum over-current protection, fusing and other information to that required for the equipment. If the selected equipment requires revision of the electrical, include any added cost to do so.

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

2.3 Wire and conduit shall comply with applicable provisions of Division 26 - Electrical specifications. Control wiring lighter than No. 12 AWG is acceptable where lesser ampacity will permit. All power and control wiring shall be overcurrent protected per the National Electric Code.

PART 3 - EXECUTION

3.1 Motor connections of factory assembled equipment shall be made with flexible conduit except for plug-in electric cord connections.

3.2 All power wiring shall be run in conduit. Control wiring shall be run in conduit except where open wiring is specified in the various sections.

3.3 Fuses shall be furnished and installed in fuse clips of equipment and switches.

END OF SECTION

23 05 14 ADJUSTABLE FREQUENCY MOTOR CONTROLLER

PART 1 - GENERAL

1.1 Provide a single enclosure adjustable frequency speed control package for induction motors where shown on the drawings and included in the Specifications with input power at the voltage and phase as scheduled on the drawings. The output power rating of the controller shall not be less than the full load rating of the motor, plus 5 percent. Controller shall be the latest design solid-state device, listed by UL, CSA or etc.

1.2 The adjustable frequency controller is to be PWM (pulse-width-modulated) design for motor voltage, current and frequency control. Impact three-phase AC line voltage is rectified to DC voltage for full conversion to near sensor output.

1.3 The supplier of the drives shall have factory trained service personnel on staff and shall submit documentation showing so with the shop drawings. Lack of documentation will result in unapproved shop drawings. The supplier shall also provide a 5-year parts and labor warranty, and a 5-year service contract for the supplied drives.

1.4 The drive shall have the same control logic board for all horsepower ratings. The 32-bit microprocessor will deliver the computing power necessary for complete three phase motor control.

1.5 The drive MTBF (Mean Time Between Failures) shall not be less than 20 years.

1.6 The term “Variable Frequency Drive”, “VFD”, “Variable Speed Drive” and other similar terms as used in Division 23 and on the drawings shall refer to Adjustable Frequency Motor Controller.

1.7 Motors connected to VFD’s shall comply with 23 05 13 Electrical Requirements for HVAC Equipment and shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer.

1.8 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Manufacturers and Suppliers

A. Adjustable frequency motor controllers shall be manufactured by ABB, Allen Bradley (1336 plus II), Mitsubishi, or Eaton.

B. Suppliers of adjustable frequency motor controllers must be an authorized service agent of the controller. Proof of this shall be provided with shop drawing submittals.

C. When adjustable frequency motor controllers are specified to be included in a factory-installed packaged system specified elsewhere in these specifications, the manufacturer of the controller is not limited to the acceptable manufacturers listed above. However, the supplier of the packaged system shall be an authorized service agent for the adjustable frequency motor controller being provided.

2.2 The controller shall be capable of varying its output in response to a remote 0 10 VDC signal, proportional to drive monitor functions. Provide controls mounted in face of the enclosure for the following functions:

A. Digital operator keypad and display, with copy function, provides local control and readout capability: Hand/Off/Auto, Speed Reference, and Reset commands.

B. Power On, Run on Drive, Run on Bypass (when bypass is specified), and Fault LED Pilot Lights.

C. Door mounted (face of cover) diagnostic indicator with touchpad interface shall incorporate:

1. Controller Run
2. Voltage to Motor
3. Current to Motor
4. Speed Indication in Hertz, Percent, RPM
5. KW
6. Elapsed Time Meter
7. Overtemperature
8. Overcurrent
9. Overfrequency
10. Overvoltage
11. Undervoltage
12. Motor Overload
13. Ground Fault
14. Short Circuit
15. Phase Loss
16. Control Circuit Fault

D. "Manual/Auto" speed control selector switch and manual speed adjustment with switches and indication on face of cover. Switch shall select control of motor speed from either the ATC system or the manual speed adjustment.

2.3 The controller shall include the following inputs and output functions at a labeled terminal strip. All inputs and outputs must be completely isolated from the analog reference signal:

Inputs

1. Remote/Local operation selection
2. Detection of external overheat condition
3. Preset speed selection
4. Serial communication selection
5. PI control disable
6. Run/Stop control
7. Fault reset
8. Manual/Remote speed reference
9. Speed Control Signal
10. External Trip Contact NO/NC
11. Freezestat Trip
12. Smoke Detector Trip

Outputs

1. Two (2) programmable multiple function output relays providing any two (2) of the following: zero speed detection, low and high frequency detection, missing frequency reference, overtorque/undertorque detection, serial communication status, or no load detection (broken belt alert).
2. Trip “Fault” (Form C Contact)
3. Output Frequency (0-10VDC)
4. Choice of Output Current, Voltage and Frequency

2.4 Speed control shall be linear from 10 to 100 percent of full speed. Both the minimum and maximum speed limits shall be adjustable. The controller output frequency shall not change as a result of up to a 10 percent input voltage fluctuation. The acceleration and deceleration rates shall be fully adjustable. Provide current limit function to avoid excessive automatic acceleration and deceleration when an overcurrent condition exists. The volts to hertz ratio shall be adjustable. Critical frequency rejection points shall be provided and shall be programmable, minimum of 3; deadband available.

2.5 The speed control output transistors are to be Insulated Gate Bipolar Transistor (IGBT) type for PWM design to facilitate a switching frequency of up to 12 kHz to eliminate the audible noise associated with PWM designs. The audible noise emitted from the motor must be within 5 db of the noise during across-the-line operations at all frequencies within the human audible spectrum (up to 12 kHz operating frequency). The drive must be selected for operation at or above 5 kHz without derating to satisfy the conditions for current, voltage or horsepower as shown on the drawings.

2.6 The controller shall permit disconnection of power from the input or output line voltage with the controller running under load without damage to the controller components. The controller shall be able to withstand an output line short (phase to phase or phase to ground) without damage to the controller components. Controller shall shut down on short circuit and detection of any of the following conditions: current 110 percent above rated current for 60 seconds; phase loss; input overvoltage and undervoltage; high internal temperature; ground fault and under frequency. Short circuit current rating (SCCR) shall not be less than 65,000 amps RMS, 100,000 amps RMS with link choke.

2.7 The controller shall have an automatic restart function to attempt restart after the unit trips off when power is lost to the unit. A time delay shall be provided between restarts. The unit shall not attempt to restart more than five times in the automatic mode. In addition, the controller shall have a power loss ride thru feature of at least 2 seconds (120 cycles) to prevent unnecessary trip out due to momentary input power interruptions.

2.8 The drive system (motor and controller) shall provide a minimum power factor of .95 at power input throughout the speed range, and a minimum efficiency (output to input line) of .82 at 100 percent speed and .70 at 50 percent speed.

2.9 The controller and any associated hardware shall be load tested at the controller manufacturer's plant prior to shipment.

2.10 The controller shall not create any feedback noise on the input line that will adversely affect electronic or microprocessor based equipment (such as computers or electron microscopes), and the controller shall not impress voltage or current spikes on the system. The minimum requirements shall conform to IEEE Standard 519, Special Applications for Line Notching and Distortion maximum 5 percent THVD at the point of connection to other building loads. The manufacturer shall provide at no additional cost any equipment to meet this requirement; i.e., A.C. line filters of the RLC type and/or isolation transformer, or both as required to meet full compliance with IEEE 519, if controller does not meet all standards.

2.11 Provide a 3 percent or 5 percent AC line reactor on all equipment that does not comply with the THVD requirements stated above.

2.12 Provide 5 percent output reactor and dv/dt filter where motor lead length is greater than 50 feet. Also provide terminations suitable for shielded output power cables.

2.13 The controller shall meet the requirements for Radio Frequency Interference (RFI) above 7 MHz per FCC regulations, Part 15, Subpart J for Class A devices.

2.14 The following additional functional features shall be provided for the controller:

A. Each controller shall be provided with a door interlocked disconnect means and semi-conductor rated fuses.

B. Input line circuit breaker – a main power circuit breaker shall be provided for input power. Door shall be interlocked and through-the-door breaker operating mechanism included. The breaker shall be able to be padlocked with the door open or closed. Breaker to be rated for short circuit current available.

C. Output Overload Relay - Provide an overload relay for motor protection with manual reset pushbutton, all inside the enclosure. Provide the proper size overload elements to match motor nameplate ratings before allowing the motors to be put into service. Provide overload for each motor where multiple motors are served by one controller.

D. Serial Communications – The controller shall provide serial communication to the building automation system via one of the following protocols as coordinated with the BAS: LONWorks, BACnet, Modbus, Ethernet. The following data shall be shared between the drive and the BAS:

Analog Inputs – Speed Reference, Output Speed, Output Cement, KWH Meter, Output Power, Drive Temperature, PI Feedback, AC Output Voltage, DC Bus Voltage, Fault Code, Elapsed Time-Hours, Megawatt Horn Meter, Drive Rated Current, Communication Error Code, PI Deviation, PI Output Capacity, PI Reference, Last Fault Code, Frequency Reference @ Fault, Output Frequency @ Fault, Current and Voltage @ Fault, Operation Status @ Fault, Elapsed Operation Time @ Fault.

Analog Outputs – Speed Command Acceleration Time, Deceleration Time, PI Proportional Gain, PI Integral Time, PI Mode Select, Frequency Command Upper Limit, Frequency Command Lower Limit, Number of Auto Restarts, PI Integral Limit, PI Upper Limit Value, PI Offset Adjustment, PI Primary Delay Time.

Digital (Binary) Inputs – Run/Stop Monitor, Forward/Reverse Monitor, Drive Ready Monitor, Fault Monitor, Drive Communication Error Monitor, Multi-Function Outputs, Emergency Safety Interlock Monitor, Hand/Auto Reference Monitor, Multi-Function Inputs Monitor.

Digital (Binary) Outputs – Run Forward Command, Run Reverse Command, Fault Reset Command, Panel Key Lock Command.

Provide all software and hardware necessary to complete the interface to the BAS. Provide the temperature controls installer with all necessary electronic files including XIF and object files. Provide on-site assistance to the temperature controls installer for programming, checkout, start-up and commissioning.

E. NEMA 1 Enclosure - Controllers located indoors or in a conditioned environment shall be provided in a ventilated enclosure intended for indoor use.

PART 3 - EXECUTION

3.1 Provide complete wiring diagrams for use in interfacing the BAS equipment. Also submit these diagrams with the shop drawings.

3.2 Wiring shall be in strict accordance with the manufacturer's recommendations. Provide the controller, all control and interlock wiring, and all set-up and commissioning. Coordinate power wiring requirements.

3.3 Each controller shall be mounted to a Unistrut frame where indicated on drawings. Provide 8 inches square by 0.375 inch painted steel base plate at floor below each vertical Unistrut channel to distribute weight on floor. Floor set controller shall be set on 4 inches high concrete base. Small

units may be direct mounted to the air-handling unit casing when the AHU manufacturer approves such installation.

3.4 Controller shall be wall mounted or mounted on unistrut framing system.

3.5 Shielded VFD cable (see Specification section 26 05 19 Low-Voltage Electrical Power Conductors) shall be provided between drive and motor for entire length of motor lead.

3.6 Refer to "Identification" Paragraph for nameplate requirements.

3.7 Check full load ampere and service factor rating for each motor after installed and furnish the proper size overload heater elements to protect the motor.

3.8 Each controller shall be started up under the supervision of the manufacturer's representative. Start-up services shall consist of an initial start-up programming and check out of the drive for proper operation. After initial startup the representative shall meet with and work with the Contractor as part of commissioning the Automatic Temperature Control system, providing additional programming and control interface as directed. In addition to start up services, the manufacturer's representative shall provide a minimum of two (2), four hour training classes at the job site for Owner operation, maintenance and servicing.

END OF SECTION

23 05 19 GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 Thermometers and pressure gauges shall be provided as shown on the drawings and as specified herein.

1.2 Hand held portable differential pressure meters related to combination balancing - shutoff valves are specified in Section 23 05 23 – General Duty Valves for HVAC Piping.

1.3 Gauges and meters furnished as a part of factory assembled equipment are specified with such equipment.

PART 2 - PRODUCTS

2.1 Thermometers

A. Thermometers shall be 9 inches blue or green reading spirit (organic) liquid filled tube column type, Winters TIM Series or Trerice BX9 series or equal by Miljoco, with Fahrenheit scale, adjustable head and brass separable socket. Tailor the range and stem length to the application. Direct-reading thermometers in mechanical rooms & other unfinished spaces shall not be positioned over 6-feet above the floor; install remote head type thermometers as required to conform with this restriction. Mount the remote head at 5'0" above the floor and provide an engraved brass/plastic label indicating the service line duty (chilled water supply, heating hot water return, condenser water to tower, etc.).

B. Separable socket insertion well shall be furnished with each thermometer. An extension neck separable stem length socket insertion well, with appropriate increase in thermometer stem length, shall be furnished where insulation thickness exceeds 2 inches.

C. Ranges of thermometers shall be selected to be consistent with anticipated temperatures. Select thermometer so that the normal operating temperature is near mid-range of the thermometer, example chilled water (45 degrees F) thermometer range 0 - 100 degrees F. The shop drawings shall be marked with the range identified for each thermometer to be furnished.

2.2 Pressure Gauges

A. Pressure gauges shall be Bourdon tube type with 4.50 inch dial and cast aluminum case, equal to Trerice 600CB Series. Accuracy shall be 1 percent at mid-range.

B. Pressure gauges for low pressure application, calibrated in inches of water gauge, ounces per sq. in. or 0 - 5 psi, as appropriate, shall be equal to Trerice 765B.

C. Pressure gauges at pumps shall be liquid filled Bourdon tube type with 4 inch dial and stainless steel case and internals, equal to Trerice 700 Series.

D. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.

E. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location, such as, if steam pressure is 15 psi select a pressure gauge with range from 0-30 psi. The shop drawings shall be marked with the range identified for each pressure gauge to be furnished.

F. Direct reading pressure gauges in mechanical rooms and other unfinished spaces shall be installed with the gauge face at eye level. (5-6 feet above the floor and in a location chosen for ease of reading). If eye level mounting cannot be accomplished gauges may be mounted on the pipe anywhere between 1'0" to 8'0" above the floor as long as the gauge face is aimed toward the eyes of the reader standing nearby on the floor. An elbow or swing joint between the main line and the gauge shall be utilized to adjust the angle of the dial face. Vertical pipe may be tapped for gauge installation at any location around the perimeter that facilitates ease of reading. Horizontal pipe must be tapped in the upper half of the pipe to reduce the chances of dirt clogging the gauge. If a water or water/glycol filled pipe cannot be tapped for gauge installation between 1'0" and 8'0" above the floor the gauge shall be remote wall, or floor stand, mounted at eye level and piped to the nearby tap location. Steam line gauges shall not be remote mounted but the gauge face shall be aimed toward the eyes of the reader standing on the floor nearby. Remote mounted water or water/glycol gauges shall be labeled with an engraved brass/plastic label mounted above the gauge indicating the service line duty (heating hot water supply, chilled water return, etc.). Gauges must be installed in accordance with the gauge manufacturer's instructions which shall take precedence over the above installation requirements in the event of conflicts.

2.3 Pressure-temperature test plugs for insertion of a field test pressure gauge or field test thermometer shall be a brass fitting with a Nordel self-sealing insert and knurled brass cap with plastic capture tab. Nordel insert shall be suitable for temperatures up to 275°F. Test plugs are only to be used in hydronic water systems. NOTE: Test plugs for use in condenser water piping systems must be located in a constantly flooded line. Test plugs are not to be used in steam piping systems. Test plugs shall be minimum 0.25" NPT connection size. The minimum length shall be 3" long but in every case the finished installation shall have the knurled brass cap extending a minimum of an inch beyond any insulation & jacket installed. Add an appropriately sized pipe nipple if required to position the knurled cap an inch outside the insulation jacket. Fittings shall be equal to Petersen's "Pete's Plug" or Trerice "Test Plugs". Furnish minimum two test thermometers and minimum two test pressure gauges with integral insertion stem and appropriate temperature and pressure ranges for use with the test plugs.

PART 3 - EXECUTION

3.1 Thermometers shall be installed where shown on the drawings and also at:

A. The inlet(s) and outlet(s) for each:

1. Pump
2. Chiller evaporator
3. Air Handling Unit Heating and Cooling Coil(s)
4. Piping loop supply and return mains including primary, secondary, tertiary loops in heating hot water, chilled water, condenser water and heat recovery systems.

3.2 Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:

A. The inlet(s) and outlet(s) for each:

1. Pump (installation must permit pump differential pressure measurement).
2. Chiller evaporator
3. Air Handling Unit Heating and Cooling Coil(s)
4. Piping loop supply and return mains including primary, secondary, tertiary loops in heating hot water, chilled water, condenser water and heat recovery systems.

3.3 Thermometers and gauges shall be positioned to be read with unobstructed view from the floor. Refer to Part 2 – Products for specific requirements.

3.4 Install thermometer wells in threaded piping systems using threaded tees. Use thread-o-lets in welded piping systems. To insure minimum thermometer response time, apply heat transfer paste to the sensing portion of the thermometer before insertion into a thermowell. Trerice Heat Transfer Paste (Item Number 107-0001); Honeywell Heat Conductive Compound (Part number 107408); Virginia Chemical Thermal Mastic (PM8); or equal. Secure the thermometer in position

3.5 Pressure temperature test plugs shall be installed where shown, located in a position to be most accessible. Test plugs installed in horizontal lines shall always be installed in the upper half of the pipe so as not to collect dirt in the gauge or test plug fitting. Test plugs are for occasional short term insertions only.

END OF SECTION

23 05 23 GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 Refer to Section 23 21 13 Hydronic Piping for selection of valves for the various services. Valves peculiar to individual systems are referenced or specified in Sections related to those systems.

1.2 Valves and materials shall comply with applicable standards and specification of ANSI, ASTM, ASME and MSS. Working pressure and temperature ratings of each valve shall exceed those imposed by the service in which it is applied.

A. ANSI B16.10, MSS SP-67-90 Butterfly Valves.

B. MSS SP-70-90 Cast Iron Gate Valves, Flanged or Threaded Ends.

C. MSS SP-80-87 Bronze Gate, Globe and Check Valves.

D. MSS SP-85-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

E. ANSI B16.34, MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

F. Valves for potable-water service shall have materials compliant to NSF 61.

G. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

PART 2 - PRODUCTS

2.1 Butterfly Valves - Nibco, Apollo, Crane, Milwaukee, Watts

A. Type A1. 2.50 inches to 6 inches
Nibco LD 2000, 175 w.w.p., ductile or cast iron tapped lug body, aluminum bronze disc, EPDM seat, 416 SS stem, 10 position handle.

2.2 Ball Valves - Nibco, Apollo, Crane, Milwaukee, Watts

A. Type B1. 2 inches and smaller. 2 piece, non-repairable
Nibco T 580-70 and T-585-70, 150 w.s.p., two piece bronze body, screwed ends, chrome plated brass ball and silicone bronze stem, PTFE seat and seal, handle.

B. Type B3. 2.50 inches and 3 inches. 2 piece, non-repairable
Nibco T 580 70-66, 150 w.s.p., two piece bronze body, screwed ends, 316 stainless steel ball and stem, standard port, reinforced PTFE seat and seal, handle.

2.3 Check Valves –Nibco, Crane, Milwaukee, Apollo, Bray

A. Type C1. 2 inches and smaller. Swing check
Nibco T 413-Y, 125 w.s.p., bronze body, screwed ends, renewable bronze swing disc with PTFE seat ring.

B. Type C2. 2.50 inches and larger. Swing check
Nibco F 918 B, 125 w.s.p., iron body, bronze trim, flanged ends, renewable bronze swing disc and seat ring.

C. Type C3. 2 inches and smaller. In-line spring
Nibco T 480-Y, 125 w.s.p., in line spring actuated center guided silent check, bronze body, screwed ends, PTFE disc and seat ring.

D. Type C4. 2.50 inches and larger. In-line spring
Nibco F 910 B, 125 w.o.g., in line spring actuated center guided silent check, globe style, iron body for installation between flanges, bronze seat and disc.

2.4 Balancing Shutoff Valves - manufacturers as stated:

A. Type E1. Globe
Armstrong CBV Series, Tour & Anderson TBV and STA Series, Nibco T1810 for 0.5 inch – 2 inches and F737A for 2.5 inches – 12 inches, Anvil CSV-9520 Series 0.5" thru 1" and MBV-9510 Series for 1.25" and larger, Bell & Gossett Model CB Circuit Setter. Globe type, DZR brass or bronze body, positive shutoff design, 125 psi construction, with adjustment shutoff handwheel, memory stop, drain fitting with hose thread end and cap and pressure temperature gauge ports with brass caps and security bands.

Note that an independent shut-off valve is required at each balancing valve (balancing valve shall not act as the shut-off valve).

Note that grooved connections are only allowed if grooved piping systems have been specified for associated systems in 23 21 13.

A. Type E3 – 2" and smaller only. Ball
Bell & Gossett Circuit Setter Plus, Watts CSM Series, or RWV 952x Series. Ball valve, positive shutoff design, 200 psi, with adjustment shutoff knob, calibrated scale, memory stop set screw and pressure-temperature gauge ports with brass caps and security bands.

Note that an independent shut-off valve is required at each balancing valve (balancing valve shall not act as the shut-off valve).

B. A portable differential pressure gauge with cocks, hoses and connectors shall be provided in conjunction with the combination balancing valves and flow controllers. Furnish additional gauges as appropriate if one gauge cannot facilitate the various valves.

C. A molded polyurethane container shall be provided with each valve on cold services, to be utilized as an insulating cover.

2.5 Automatic Flow Controllers

D. Type F1.

1. Flow controllers shall be automatic pressure compensating flow control valves factory manufactured for the stated flow rates. Valves shall be selected by the supplier, utilizing the minimum required spring rate or diaphragm range for the system pressure (1-14 psig, 2-32 psig, 4-57 psig, or other as required) and per the drawings, details and schedules. The flow controller body shall be forged or cast brass with ISO-9001 certificate of registration, bronze, or ductile or gray iron. For spring-cartridge type units, spring shall be stainless steel and the cartridge shall be stainless steel or chrome plated brass with stainless steel wear surfaces. For diaphragm-orifice type units, the diaphragm shall be elastomeric, with a polyphenylsulfone orifice seat. Valve's flow and psid range shall be permanently marked on a label affixed to the flow controller. Valve assembly (not just the cartridge) shall carry a 5-year warranty (excluding union EPDM O-rings and hose liners). Shop drawing submittal shall include warranty certificate showing compliance. All 3" and smaller flow controllers and diaphragms shall be easily replaceable and removable

without breaking the main piping. When a shut-off valve is shown adjacent to the flow controller, it shall not be incorporated into the flow controller. A strainer with stainless steel 20 mesh screen and a blow-down cock with hose bib shall be incorporated in or with each flow controller assembly. This strainer is NOT to be provided if the flow controller is on the return-side of a heat exchange device and a strainer is shown/required on the supply–side. The controller shall have two pressure/temperature measurement taps. Accuracy at 3 psi differential and above shall be +/- 5 percent. Provide an 18 month cartridge exchange service to allow commissioning of the system due to pressure or flow change requirements. Flow controllers shall be manufactured by Griswold, Pro-Hydronic Specialties, Hays Fluid Controls, Nexus, NuTech, Flow Design "Autoflow", HCI Terminator A, Bell & Gossett.

Note that grooved connections are only allowed if grooved piping systems have been specified for associated systems in 23 21 13.

2. Submittals shall be provided with complete documentation showing cut sheets, flow rate (GPM), pressure drop, and tagging for each device. Also include warranty certificate for review. Flow Controller Submittals shall not be submitted for review until associated coils have been submitted and stamped Approved so that GPM's can be matched.

2.6 Coil Hook-Up Packages

E. Coil hook-up packages shall be provided in lieu of field assembled components, for terminal units only (not for air handling units). All components shown on the drawings and specified herein shall be provided as part of the coil hook up package. Packages shall be provided by the or flow controller manufacturer. When an independent shut-off valve or strainer is specified or shown, shut-off valves and stainless steel strainers of equal construction to those specified in this Section 23 05 23, including bronze or iron body, may be of same manufacturer as balancing valve / or flow controller manufacturer.

Note: Shut-off valves shall NOT be combined with other components, no exceptions.

All packages shall be pre-assembled and factory tested, packaged as individual assemblies, and plastic shrink-wrapped with tagging per shop drawings and project plans.

F. Grooved connections are only allowed if grooved piping systems have been specified for associated systems in 23 21 13.

G. Submittals shall be provided with complete documentation showing cut sheets, flow rate (GPM), pressure drop, and tagging for each device. Clearly identify supply and return hook-up devices. Also include warranty certificate for review. Submittals shall not be submitted for review until associated coils have been submitted and stamped Approved so that GPM's can be matched.

2.7 Sweat end valves of equal construction and features are acceptable in lieu of those specified with screwed ends.

2.8 Butterfly valves and ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation thickness, but minimum 2".

PART 3 - EXECUTION

3.1 Drain valves shall be the same as for shutoff service. Provide a 0.75 inch hose thread adapter on the outlet of each drain valve that is not piped to a drainage point. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.

3.2 Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing.

3.3 Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.

3.4 Packing glands shall be tightened before placing the valves in service.

END OF SECTION

23 05 29 HANGERS AND SUPPORTS FOR HVAC PIPING

PART 1 - GENERAL

1.1 All piping shall be supported from the building structure.

1.2 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment and 23 05 49 Vibration Control for HVAC for additional requirements.

1.3 All products and assemblies installed with-in the building shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other applicable manufacturers are B-line, Erico, Fee, Mason and PHD.

2.2 Hangers and supports for horizontal piping shall be equal to:

A. General service - clevis type Anvil Fig. 260.

B. Uninsulated copper tubing - copper plated clevis type - Anvil Fig. CT-65 (or plastic coated clevis).

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis, trapeze and swivel ring type hanger.

Pipe Sizes	Min. Rod Dia.
2” and smaller	0.375"
2.5” to 3"	0.50"
4” to 5"	0.625"
6” to 8”	0.75”

2.4 Where the length of the hanger rod between the top of the hanger and the attachment device is 3 inches or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel.

2.5 Hanger rod attachment devices for attachment to the structure shall be:

C. After-set steel expansion type concrete inserts.

D. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

E. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.6 Refer to Part 3 for steel spring and neoprene isolators in hanger rods, required for piping connecting to vibration isolated and/or motor driven equipment.

2.7 Base mounted pipe supports shall be factory or shop prime coat painted equal to Anvil catalog numbers as follows:

A. Pipe slide having carbon steel base (with guide arrangement) and inverted tee with Teflon slide plate on each - Fig. 257, type 3.

B. Base mounted pipe roller stand - Fig. 271.

2.8 Pipe riser supports shall be as follows:

C. Riser clamps on cold service piping (chilled water) - insulated pipe riser clamp assembly, Pipe Shields, Inc. E1000, with polyisocyanurate insulation, galvanized steel jacket, steel top thrust plates and steel riser clamps.

D. Riser clamps on piping other than cold service Anvil Fig. 261 except, on copper tubing, CT-121 (copper plated) or CT-121C (plastic coated).

2.9 Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension. Piping 1" and smaller and specified to be insulated with elastomeric type insulation may utilize Anvil's 25/50 flame/smoke rated KLO-Shure strut-mounted TPO plastic insulation couplings with steel strut clamp. Insulation wall thickness shall be 0.75 thickness. Transition to required service insulation thickness within 2" of either side of coupling.

2.10 Pipe supports for pipe and conduit running across the roof to be molded polycarbonated pillow block, UV stabilized polypropylene, or UV stabilized 100% recycled rubber pipe stands. Manufactured by Miro Industries, ABI, Inc., or Anvil H-Block. Pipe supports shall require no attachment to grade. Associated metallic hardware shall be 304 stainless steel.

2.11 Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, provide insulation inserts and shields as specified in 23 07 19 HVAC Pipe Insulation.

2.12 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as follows, unless otherwise shown on drawings:

A. Steel pipe (vertical) - at the base, at each floor level, and 15 ft. maximum spacing.

B. Steel pipe (horizontal) - 7 ft. intervals for piping 1.50 inches size and smaller, 10 ft. spacing for piping 2 inches thru 6 inches, 12 ft. spacing for larger pipe.

C. Copper tubing (vertical) - at the base, at each floor level, and 10 ft. maximum spacing.

D. Copper tubing (horizontal) - 6 ft. spacing for tubing 1.25 inches size and smaller, 8 ft. spacing for 1.50 inches thru 2.5 inches sizes, 10 ft. spacing for tubing 3 inches size and larger.

3.2 Attachment of pipe hangers to the structure shall be with:

E. After-set concrete inserts, in 4 inches minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

F. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment.

G. Unistrut type channel support system may be utilized where a number of pipes are run parallel. Channel shall be pre-set or attached to the structure with inserts or clamps.

H. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

3.3 Pipe supports manufactured by Miro Industries, ABI, Inc., or Anvil H-Block for pipe running across the roof shall be installed in accordance with the manufacturer's instructions and as detailed.

3.4 Pate style support curbs shall be attached to the roof deck and flashed into roofing system.

3.5 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.6 Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within the pipe chase. Ensure that adequate support is still maintained.

3.7 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.8 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

I. MSS SP-58 on Materials, Design and Manufacturer

J. MSS SP-69 on Selection and Application

K. MSS SP-89 on Fabrication and Installation Practices

END OF SECTION

23 05 30 BASES AND SUPPORTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 Equipment shall be supported on concrete bases, roof curbs and structural steel supports as shown on drawings or as specified. All bases, curbs and supports shall be included except as otherwise noted.

1.2 Wind Load Analysis

A. HVAC equipment exposed to wind shall have positive attachment to the building structure or ground to comply with wind load requirements of the building and mechanical codes.

B. Wind speed design shall be 115 MPH. Refer to structural drawings for additional design requirements.

C. The contractor shall retain a specialty consultant to perform wind load calculations in accordance with the code and additional requirements specified in this Section. A professional engineer experienced in wind load attachment design and installation and licensed in the state where the project is located shall be responsible for calculations, attachment selections and installation details.

D. The Wind Load Analysis consisting of attachment design, calculations, attachment selection, installation details including anchoring methods, fastener specifications, embedment and/or welded length, etc..shall be submitted for review and record. This submittal shall be signed and sealed by a professional engineer, as stated above. This submittal will become part of the project design calculations, included in the project records, and when required, will be submitted to the authority having jurisdiction.

E. The wind load attachment design shall clearly indicate the attachment points to the building structure and design forces in all horizontal and vertical axes at the attachment points. The wind load attachment engineer shall coordinate all attachments with the projects structural engineer of record, who shall verify the attachment methods and the ability of the building structure to accept the loads imposed.

F. The wind load attachment design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from submittals or the manufacturers. The equipment manufacturer shall verify that the attachment points on the equipment can accept the combination of wind load, weight, and other loads imposed.

G. At the project Engineer of Record's discretion, equipment submittals may not be approved until the Wind Load Analysis has been submitted. It is the contractor's responsibility to schedule and coordinate the process in a timely fashion, including follow-up Wind Analysis submittals for equipment approved pending a Wind Analysis submittal.

PART 2 - PRODUCTS

2.1 Support for equipment shall be by one or more of the following methods:

A. Concrete bases and pads with anchor bolts cast in place. Provide a 4" thick concrete pad that is minimum 4" wider than the equipment in each direction, formed on all sides and hand troweled to a smooth, dense finish with neatly chamfered corners. Large concrete pads on grade shall be constructed with reinforcing steel or reinforcing roadway mesh. Set anchor bolts as required for the equipment.

B. Structural steel angles, beams or channels, unistrut type channels or pipe. Supports shall be fabricated into a rigid framework with welded or bolted connections and cross bracing or sway bracing. Supports shall be set on slab with base plates, or attached to the building structure as required. Brackets for relatively lightweight equipment may be attached to the wall. Equipment shall be set on and attached to the framework.

C. Solid steel hanger rods supported from the structure above similar to pipe hangers. Provide sway bracing for equipment supported in this manner.

2.2 Provide exact dimensions, locations and other detail for the specific equipment provided that requires bases or supports. Set anchor bolts as required for the equipment.

2.3 Equipment roof supports shall be heavy gauge galvanized steel support curbs with base plate, continuous welded corner seams, integral raised cant to match roof insulation, internal insulation, wood nailer and counterflashing. Unless otherwise noted, top of curbs shall extend 12” above the finished roof surface, 18” above for intake applications. For sloped roofs, the curb shall have a built-in slope to match roof slope so that top of curb is level.

2.4 Roof mounted air handling units shall be roof curb mounted.

A. DOAS-1 shall sit on the existing curb. Existing curb shall be modified if required for the new unit to sit on the existing curb.

PART 3 - EXECUTION

3.1 Bracing and Attachment

A. All equipment and curbs exposed to wind shall be installed and attached to structure in strict accordance with the wind load attachment design provided by the engineer to conform with requirements of the Code and referenced standards and in strict accordance with the manufacturers written instructions.

B. No rigid connections between equipment and the building structure shall be made that would degrade noise and vibration control.

C. Coordinate work with other trades. When conflicts develop in installation, they shall be brought to the attention of all involved parties and a suitable solution must be determined.

D. Each manufacturer of equipment shall furnish a statement stamped by a professional engineer indicating that the equipment is designed and constructed to withstand wind loads required by the code. Statement shall be based on analysis, testing or experience data, and supporting documentation shall be available upon request.

3.2 Attachment to manufactured trusses, joists, purlins, and other engineered structural members and supports shall be done in strict accordance with the structural engineer’s or manufacturer’s recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural engineer or manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances. In the case of existing trusses, the structural engineer must review and approve hanger attachment methods.

END OF SECTION

23 05 31 HVAC EQUIPMENT DRIVES

PART 1 - GENERAL

1.1 Belt driven equipment shall be provided with pulleys and drive belts as specified and as required for the service.

1.2 Exposed pulleys, belts, drives and couplings shall be protected with guards in accordance with OSHA requirements.

1.3 Unless noted otherwise adjustable frequency motor controllers (VFD's) shall be provided under Division 23. Refer to specification section 23 05 14 Adjustable Frequency Motor Controllers.

PART 2 - PRODUCTS

2.1 Drive belts shall be "V" type unless another design is standard for the equipment manufacturer. Belt drives shall have a capacity rating of at least 150 percent of the motor horsepower.

2.2 Drive pulleys shall be adjustable unless a fixed pulley is specified. Adjustable drive pulleys shall be selected near the mid-point of range.

2.3 Drive guards in the air stream of fans shall be flattened expanded metal which does not appreciably restrict air flow.

PART 3 - EXECUTION

3.1 Pulleys and belts shall be aligned, pulleys adjusted and belt tension set for proper operation and specified duty.

3.2 Provide a drive change-out (sheaves, pulleys and, if necessary, belts) when, during final air balancing, it is deemed necessary to attain the specified air quantity and/or the desired performance. The Engineer shall have final say as to whether or not a drive change-out is required.

END OF SECTION

23 05 49 VIBRATION CONTROL FOR HVAC

PART 1 - GENERAL

1.1 Vibration isolators shall be provided at equipment as shown on the drawings and as herein specified.

1.2 The supplier of isolation equipment shall study the application, the equipment to be isolated and the structure. The supplier shall assume responsibility to determine required minimum deflections and optimum deflection characteristics accounting for dynamic and static forces.

PART 2 - PRODUCTS

2.1 Following is a description of the various types of isolators, bases and rails required. Catalog designations are those of Mason Industries.

Type A1
Ribbed or waffled neoprene pad. Series W.

Type J1
Hanger rod vibration isolator with combination steel spring and neoprene-in-shear isolators. Series 30N.

2.2 Springs shall have a minimum additional travel to solid equal to 30 percent of the rated deflection.

PART 3 - EXECUTION

3.1 Manufacturer's instructions shall be followed carefully in setting and adjusting vibration isolators. Ensure that no direct hard surface to surface contact exists. Fasten to the building structure as recommended by the isolation supplier.

3.2 Where electrical connections are made to equipment mounted on isolators, caution the Electrical Contractor to connect thru flexible conduits.

3.3 Refer to Section 23 05 29 Hangers and Supports for HVAC Piping for spring isolator sections in pipe hanger rods.

END OF SECTION

23 05 50 FLEXIBLE HVAC PIPE CONNECTORS

PART 1 - GENERAL

1.1 Flexible pipe connectors shall be of the size and extent shown or indicated on the drawings.

PART 2 - PRODUCTS

2.1 Flexible pipe connectors shall be molded sphere type and corrugated metal with woven wire braid jacket, as shown on the drawings.

2.2 Molded spherical flexible pipe connectors shall be constructed of molded EPDM, utilizing a peroxide curing method, with Kevlar reinforcement tire cord. Tire cord shall be wrapped around a solid steel ring that is clamped down in the flange lock to prevent pull-out. Body shall be twin sphere. Cable or solid rod control units shall be incorporated where appropriate for the application or working pressure. Rated working pressure shall be minimum 150 psi at 200 degrees F. Pipe connectors shall be Mason “Safe Flex”, Metraflex “Mighty DoubleSphere” with Kevlar reinforced tire cord, or pre-approved equal.

2.3 Flexible metallic pipe connectors shall be constructed of seamless corrugated inner tubing of Type 304 or 321 stainless steel, woven wire braid outer jacket of the same alloy and flanged or screwed ends. Rated working pressure and live connector length shall be safely in excess of the duty imposed.

Pipe connectors shall be equal to Mason FFL, Twin City Hose “TCH”, or Metraflex MLP.

PART 3 - EXECUTION

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

END OF SECTION

23 05 53 IDENTIFICATION OF HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 Identification of Division 23 equipment shall consist of equipment labeling, pipe and duct marking and valve tagging as specified hereinafter.

1.2 Each item of major equipment shall be labeled. This shall include chiller, pumps, rooftop unit, and other similar equipment.

1.3 Pipe markings shall be applied to all piping.

1.4 Duct markings shall be applied to all ductwork.

1.5 Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8.50 inches x 11 inches paper, tabulating valve number, piping system, system abbreviation, location of valve (room or area) and service (e.g. - South wing reheat boxes).

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

1.7 Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.8 Submit product data noting materials, sizes and dimensions for identification systems.

PART 2 - PRODUCTS

2.1 Equipment labeling shall be either, or a mix, of the following:

A. Permanently attached engraved brass or plastic laminated signs with 1 inch high lettering. Signs on exterior equipment shall be brass.

B. Stencil painted identification, 2 inches high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 Pipe markings shall be:

A. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color-coded pipe markers extending fully around the pipe and insulation.

B. On piping and insulation 6 inches and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1.50 inches wide, full circle at both ends of the marker.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.3 Duct markings shall be laminated plastic color-coded pressure sensitive vinyl tape, 2.50 inches width, 3 mils minimum thickness. Identification shall include service (supply, return, exhaust, outside air) and direction of flow.

2.4 Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with "H" (for HVAC) and the designated number.

2.5 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after insulation and painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled on drawings.

3.3 The Contractors shall coordinate labeling, marking and tagging to attain coordinated and consistent systems of identification.

3.4 Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust fan labeling shall also indicate service or room or area of service.

3.5 Pipe and duct markers shall be placed:

A. At each piece of equipment.

B. At 25 ft. centers in mechanical rooms and concealed spaces, but at least once per room.

C. At 50 ft. centers in exposed finished areas, but at least once per room.

D. On mains at each branch take-off.

E. On duct access panels.

3.6 Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above. Copies of one set of schedules shall be framed under glass or plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION

23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 Provide air and water balancing of the new systems and existing systems affected by the new work. Balancing work shall be performed by qualified personnel of a member firm of the Associated Air Balance Council (AABC) or a member firm of the National Environmental Balancing Bureau (NEBB), who has no affiliation with the Contractor or any of its Sub-Contractors. Include a certification sheet signed and sealed by the certified testing and balancing authority. Include a list of instruments to be used for procedures, along with proof of calibration.

1.2 Methods, procedures, equipment, certifications, report forms and reporting information shall be in accordance with the standards of AABC or NEBB.

1.3 During the bid period, call to attention any requirements for additional balancing dampers, test ports, gage cocks, thermometer wells, flow control devices, valves, balancing valves and fittings and manual volume dampers which are deemed necessary in addition to those shown on the drawings, and provide such so that proper balancing can be performed. Prior to installation of the systems, verify that the proper number and location of balancing devices are adequate for completion of the balancing work.

1.4 Prepare a balancing plan that includes strategies and step-by-step procedures. This plan should include a list of items that must be completed before balancing can proceed. Prepare a schedule to ensure adequate time for the balancing process and submit this schedule to the Architect or Construction Manager for review.

1.5 When project is in phases and partial occupancy is planned, determine process to allow balancing work to be completed before occupancy.

1.6 Refer to Section 23 05 31 HVAC Equipment Drives and other Sections of Division 23 for requirements related to the balancing work.

1.7 Verify that all equipment start-up services have been completed before the beginning of any balancing work. After initial start-up has been completed, inform the balancer that the systems are operating properly, that all safety interlocks and protective devices are functioning, and the systems are ready to be balanced. **Refer to SMACNA Guide 2.6.1 for items to be included in system check.**

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Air Balance

A. The following existing systems shall be surveyed to record existing conditions prior to any work beginning, and balanced at the end of the project to match existing airflows after the modifications.

1. EX AHU-1, EX AHU-2. EX AHU-3, EX AHU-4: Survey existing unit to obtain a static pressure profile thru the ahu components; supply and return fan data (cfm; motor amps, motor rpm, fan RPM, motor nameplate data, VFD speed). Supply, return and outside air CFMs via duct traversing. Work with Owner to put unit into max cfm / 60 Hz prior to recording data. Obtain associated fan curves. Provide sketch of the ahu layout and accurately indicate where cfm and pressure readings were taken which shall include all fittings, indicating fitting type (i.e. mitered elbow), and all duct mounted equipment, such

as dampers, located between the pressure reading and the fan. Also provide sketch as to where duct traversing was performed.

B. Obtain job specific fan curves for each fan being balanced, new and existing, and include in report.

C. Record nameplate data from fan, motor, and air handling cabinet.

D. Record and measure fan and motor sheaves indicating number and size of belts along with center-to-center distances.

E. Test and record actual operating fan rpm.

F. Measure and record actual running amperage.

G. Each air supply, return, and exhaust system, when installation is completed, including the installation of clean filters, shall be set in operation for balancing. Determine the best location in main and branch ducts for accurate duct airflow measurements. Each air outlet and inlet device, item of equipment (fan coils, air control units, etc.), shall be balanced to the quantities listed on the drawings within plus or minus 10 percent. Central fan systems (AHU's, exhaust fan systems, etc.) shall be balanced to within plus or minus 5%. Intended pressure relationships in areas required by recognized standards and practice shall be attained.

H. Measure velocity reading across coils, filters, and dampers on the intake side of the fan. Include data in the report.

I. Coordinate with the Temperature Controls Installer in setting variable frequency drives and outside air, return air and vent air dampers. Supply air systems shall have ampere reading measured in the full heating, full cooling and economizer modes to determine the maximum brake horsepower.

J. Witness all duct pressure and leakage tests. Refer to 23 31 13 and coordinate accordingly.

K. Total air quantities of the supply fan, and exhaust fan shall be determined by pitot tube traverse. Where impossible to take good pitot tube traverses of duct system, use total sum of terminal device air volume readings. Final settings of fan speeds shall be determined with variable speed drives at full speed. Refer to item F. above for drive changeout requirements and the items below.

L. For variable-air-volume systems, develop and implement a plan to simulate diversity.

M. Check airflow patterns from the outside-air louvers and dampers and the return and exhaust-air dampers, through the supply-fan discharge and mixing damper. Report any issues with stratification, poor mixing or short circuiting from one air stream to the other.

N. Check for airflow blockages.

O. Check for proper sealing of air-handling unit components. Report all issues in balancing report.

P. Check for proper sealing of air duct systems. Minor issues shall be reported in the balancing report. If a major issue is found, stop balancing work and report issue to the Engineer and Construction Manager.

Q. The report shall include, but not be limited to, fan curves, both actual and design fan cfm, rpm, brake HP, entering and leaving static pressures, motor data, voltage and amperage and drive information. System air flows by device, terminal, branch and system shall be reported.

In addition, a sketch shall be provided for each air system balanced or surveyed, depicting exact location that fan static pressure and fan CFM readings were taken, relative to fan inlet and discharge, and what duct accessories were in place near the reading location and between the reading location and the fan. The sketch shall also depict elbows and other duct transitions in place near the reading location and between the reading location and the fan. Air handling unit sketches shall depict all air path components with-in the unit, and static pressure readings across each item. Balance reports will be rejected without this information.

R. Mark equipment and balancing device setting with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-controls levers, and similar controls and devices, to show final setting.

3.2 Water Balance

A. Chilled water and heating water circulating system, when installation is completed, shall be set in operation for balancing. Water flow thru each pump, chiller, coil, heat exchange device, balancing valve shall be determined by pressure differential gauging or direct reading. Automatic Flow Controllers at all air handling unit coils shall have flows verified via differential pressure, and 100% of all other automatic flow controllers shall be documented as well. Automatic flow controller documentation shall include Valve Model Number, shop drawing Dp Range and GPM, and actual Differential Pressure reading.

Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Flows shall be balanced to quantities listed on the drawings within plus or minus 5 percent.

B. Check and compare expansion tank set-up data to design requirements for proper operation. Report any deviations to the Engineer and the Construction Manager for corrective action.

C. Check makeup-water-station pressure settings for adequate pressure.

D. Check flow-control valves and set to indicated flow.

E. Verify air has been vented from system. Check air vents for a forceful liquid flow exiting from vents when manually operated.

F. Obtain job specific pump curves for each pump, new and existing, and include in report. Verify pump data - pump-motor brake horsepower and impeller size on nameplate data on the pump to design submittals.

G. Pump tests shall show full flow and dead head conditions. Do not throttle valves on the pump discharge. Pump flow control valves shall not be closed more than fifty percent. Pump flow control valves, which require more than fifty percent closure shall be reported to the engineer for evaluation of valve sizing and selection. Automatic valves shall be fully open during testing of the unit associated with the control valve.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads and systems' pressures and temperatures including outdoor air temperature.

I. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

J. Water Coils: Record water flow rate and water pressure drop.

K. Measure indoor wet and dry-bulb temperatures periodically for 2 successive eighth-hour days, in each separately controlled zone to prove correctness of final temperature settings.

L. The report shall include, but not be limited to, pump curves, both actual and design water quantities, pressures in and out of each device, pump motor data, operating voltage and amperage and pump curves.

M. Mark equipment and balancing device setting with paint or other suitable, permanent identification material, including valve-control positions, valve position indicators and similar controls and devices, to show final setting.

3.3 After completion of the balancing work, a full report shall be prepared in pencil and two copies (only) submitted to the Engineer for preliminary review. After review, additional balancing, adjustments, drive replacements, readings and recordings deemed necessary shall be done and the report revised. Six typed copies of the final report shall be submitted to the Engineer for review and approval. An approved copy of the report shall be included in each set of operating and maintenance manuals.

3.4 Final Report contents: In addition to certified field report data, include the following:

A. Table of Contents with total number of pages defined for each section of the report.

B. Summary of Contents - include the following:

1. Indicated versus final performance.
2. Notable characteristics of systems.
3. Description of system operation sequence if it varies from the contract documents.

C. Nomenclature sheets for each item of equipment.

D. Notes to explain why certain final data in the body of reports varies from indicated values.

E. Pump Curves.

F. Fan Curves.

G. Manufacturers' test data.

H. System component diagrams including schematic layouts of air and hydronic equipment. Present each in single-line format with data points indicated.

3.5 Inspection after testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance reading documented in the final report. Submit random sampling percentages and results.

3.6 Seasonal Testing: If initial balancing procedures were not performed during near peak summer and winter conditions, perform additional testing, inspecting and adjusting during near peak summer or winter conditions.

3.7 10 Month Warranty Walk: Perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to report unusual conditions with recommendation of adjustments. Allow two (2) days for this work.

END OF SECTION

23 07 13 DUCT INSULATION

PART 1 - GENERAL

1.1 All interior and exterior supply air, mixed air, and intake outside air ductwork and plenums shall be insulated unless specifically noted as “uninsulated” in the Duct Construction Schedule on the drawings, including ductwork in crawl spaces, attics, and buried under slab.

1.2 All interior and exterior return air ductwork and plenums shall be insulated unless specifically noted as “uninsulated” in the Duct Construction Schedule on the drawings, including ductwork in crawl spaces, and attics (when duct is above the roof insulation).

1.3 Unless noted otherwise below, exhaust and relief air ductwork shall be insulated from 24” upstream of the auto/backdraft damper to the point of exterior wall/roof penetration. Exterior exhaust air ductwork shall be insulated when noted on the Duct Construction Schedule.

1.4 Equipment and devices, accessories and stiffeners in insulated ductwork shall also be insulated. This includes but is not limited to external duct bracing and stiffeners, air control dampers and valves. The backside of supply air diffusers shall also be insulated to prevent condensation, except if the air device is internally lined or factory insulated.

1.5 Ductwork shall not be internally lined, unless shown otherwise for return or exhaust.

1.6 Jacketing shall be provided on insulation located outside for weather protection.

1.7 Composite insulation assemblies shall meet UL 723 or ASTM E84 requirements and not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, and “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84. Identification of manufacturer, thermal resistance (R-value), flame spread and smoke-development shall be clearly marked on the exterior of the insulation at intervals as required by code.

1.8 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.9 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage, in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Insulation shall be manufactured by Johns Manville, Owens Corning, Certainteed, Knauf, Manson, or as listed below. Insulation for duct systems required to be insulated shall have a minimum installed R-value of 4.2 (at a 75 degrees F mean rating temperature).

2.2 Insulation on concealed ductwork shall be fiberglass blanket insulation with factory applied reinforced foil and kraft paper vapor barrier jacket, minimum 1.50 inches thickness and 0.75 inch

p.c.f. density, formaldehyde-free or GreenGuard Certified for low formaldehyde and VOC emissions.

2.3 Ductwork located outdoors shall be jacketed with 16 mil heavy duty laminate surface. The laminate surface shall be white and carry a 10 yr. U.V. warranty. Slope jacket as required to keep water from pooling.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of ductwork and fittings has been completed prior to installing insulation.

3.3 Installation

A. Installation shall be done by tradesmen specializing in this work in strict accordance with manufacturer's recommendations.

B. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices. External duct stiffeners and bracing shall be insulated same as for duct.

C. Blanket insulation shall be wrapped tight to the duct. Insulation shall be secured to ducts 20 inches wide and greater with weld pins and fasteners, 18 inches on center maximum. Adhesive shall be applied to the duct as an aid to installation and adhesion. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3 inches wide FSK pressure sensitive tape.

D. Board insulation with factory applied jacket shall be secured to the duct with weld pins and fasteners, 12 inches on center maximum. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3 inches wide ASJ pressure sensitive tape.

E. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. All staples used on cold insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

F. External insulation on supply located outdoors shall be weatherprotected with field applied metal jacket. Tops of ducts shall be pitched to drain, and the jacket shall be firmly attached and secured, and over-lapping joints and seams shall be silicon caulked watertight. Longitudinal seams shall be located on the bottom.

G. Externally insulate the backsides of supply air devices that are mounted in ceilings and not internally insulated.

3.4 Protection

A. Advise as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.6 Reinsulate ductwork where existing insulation has been damaged or removed in the performance of work in this project.

END OF SECTION

23 07 16 HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 Insulation shall be provided on equipment as specified below.

1.2 The following HVAC equipment shall be insulated:

A. Water chiller surfaces not factory insulated which, in operation, will be cold (evaporator tank heads, piping, etc.). Refer to the chiller paragraph for factory insulation requirements. 1 inch thickness closed cell elastomeric.

B. Chilled water pump casings.
1.50 inch thickness closed cell elastomeric.

C. Hot water pump casings.
1.50 inch thickness closed cell elastomeric.

1.3 Composite insulation assemblies shall not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84

1.4 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.5 Delivery, Storage and Handling

A. Materials on-site shall be in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage, in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Insulation shall be manufactured by Johns Manville, Owens Corning, Certainteed, Knauf, Manson, or as otherwise specified below.

2.2 Closed cell elastomeric insulation for systems 6 inches and smaller and operating at 200 degrees F and below shall be tubular closed cell pipe insulation, pre-slit longitudinally. Polyolefin insulation is not acceptable. Insulation shall be manufactured without the use of CFC’s, HCFC’s or HFC’s. It shall meet ASTM C534 and also be formaldehyde free, low VOC, dust free, resistant to mold and mildew, and shall be 25/50 rated per ASTM E84. Thermal conductivity (k) shall be maximum 0.28 at 75 degrees F mean rating temperature.

Closed cell elastomeric insulation shall be Armacell AP/Armaflex-SS, K-Flex USA Insul-Tube or Aeroflex USA Aerocel-SSPT. For systems operating at 180 degrees F or less, insulation shall utilize a self-sealing pressure sensitive closure system. Butt joints shall be sealed with Armaflex 520 BLV low VOC adhesive, or equal. For systems operating between 180 degrees F and 200

degrees F, all joints and seams shall be sealed with Armaflex 520 BLV low VOC adhesive, or equal.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.3 Installation

A. Installation shall be done by tradesmen specializing in insulation work in strict accordance with manufacturer's recommendations.

B. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices.

C. Install insulation on piping subsequent to installation of heat tracing and acceptance tests.

D. Closed cell elastomeric insulation shall be held in place with adhesive. All joints shall be sealed with a vapor tight mastic. Insulation on removable chiller water boxes and heads shall be contained in a galvanized steel metal protective housing designed for easy removal.

E. Provide removable insulation sections to cover parts of equipment which must be opened periodically or maintenance, such as vessel covers, fasteners, flanges, frames and accessories.

F. Items such as manholes, handholds, clean cuts, ASTM stamp, and manufacturer's nameplates, may be left uninsulated unless omitting insulation would cause a condensation problem. When such is the base, appropriate tagging shall be provided to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

G. Aluminum protective jacket, where specified above, shall be 0.016 inch thick sheet wrapped around the item of equipment / tank / breeching and secured with bands. Finish cement and lagging cloth may be omitted where the jacket is applied.

3.4 Protection

A. Advise as to requirements for protection of the installation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

END OF SECTION

23 07 19 HVAC PIPE INSULATION

PART 1 - GENERAL

1.1 Piping systems shall be insulated as described below in their entirety, including pipe, fittings, unions, flanges, mechanical joint couplings, pump casings, air and/or dirt separators, valves, devices, specialties and all related items and equipment unless otherwise noted. Maintain access to covered P/T test ports, strainer caps, air vents, and similar accessories thru the use of removable and reusable caps, plugs and fittings.

1.2 Composite insulation assemblies shall not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

1.3 The following HVAC piping shall be covered with insulation of thickness listed, to meet or exceed ASHRAE 90.1, latest publication:

Pipe System	.75” and smaller	1.0” to 1.25”	1.50” to 3”	4” to 6”	8” and larger
Hot water, 141°F to 200°F[1]	1.5”	1.5”	2”	2”	2”
Chilled water [2], 40°F and above	0.50”	1”	1”	1.50”	1.50”
Refrigerant suction	1”	1.50”	1.50”	1.50”	1.50”
Refrigerant hot gas	1”	1”	1”	1”	1”
Refrigerant liquid [4]	1”	1”	1”	1”	1”
Cooling condensate drainage [3]	0.50”	0.50”	0.50”	0.50”	0.50”

Notes:
(1) For piping 1.50” and smaller located in vertical partitions within conditioned spaces, insulation thickness may be reduced by 1”, but resultant insulation thickness shall be no less than 1” thick. Indoor steam vent piping from receivers, flash tanks, deaerators, and other normally active vented equipment shall be insulated with 1.5” thick insulation. Boiler surface blowdown piping with-in 7 ft of the floor shall be insulated with 1” thick insulation for personnel protection.
(2) Chilled water - including glycol solution as well as clear water.
(3) Cooling condensate drainage – from cooling coil drain pans, associated floor drain sumps, traps and horizontal above ground piping to vertical stack (coordinate with plumbing).
(4) Insulate refrigerant liquid line when recommended or required by equipment manufacturer (such as for variable refrigerant volume / flow systems).

1.4 Insulation on HVAC systems is to be omitted on:

A. Unions in hot water piping.

B. Strainers, control valves, balancing valves, and automatic flow controllers in hot water piping 1” and smaller.

C. Hot water piping in cabinetry of unit heaters, convectors and thru-wall A.C. units.

D. Blow-down piping and safety relief valve discharge piping.

1.5 Insulation for hot water piping connecting to duct coils and air terminal unit coils shall include a vapor barrier maintained from the coil to 6" from the coil.

1.6 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.7 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Unless specified otherwise, pipe insulation shall be factory molded tubular fiberglass with "all service" jacket having an integral vapor barrier as manufactured by Johns Manville, Owens Corning, Knauf, Manson or as otherwise specified below. Longitudinal joints of the jacket shall be overlapping with factory applied adhesive. In lieu of the factory adhesive, staples on 6 inches centers may be used with vapor barrier mastic applied to seal both the joint and staple holes. Butt joints shall be sealed with 3 inches wide ASJ pressure sensitive tape. Insulation shall be GreenGuard Certified for low formaldehyde and VOC emissions. Thermal conductivity (k) shall be as specified below:

Maximum Conductivity k BTU in / (h x ft^2 x °F)	Mean Rating Temp degrees F
0.34	250
0.32	200
0.30	150
0.29	125
0.28	100

2.2 Chilled water, refrigerant piping and cooling condensate systems shall be insulated with closed cell elastomeric. Fiberglass is not permitted. Outdoor piping shall be jacketed as described below.

2.3 At the Contractor's option, insulation on above grade hot water piping systems (below 200 degrees F and indoor geothermal) systems may be closed cell elastomeric type in lieu of fiberglass. Minimum thicknesses as listed in 1.3 above shall still apply.

2.4 Closed cell elastomeric insulation for above grade use on systems operating at 200 degrees F and below and 6 inches or smaller pipe sizes shall be tubular closed cell pipe insulation, pre-slit longitudinally. Polyolefin insulation is not acceptable. Insulation shall be manufactured without the use of CFC's, HCFC's or HFC's. It shall meet ASTM C534 and also be formaldehyde free, low VOC, dust free, resistant to mold and mildew, and shall be 25/50 rated per ASTM E84. Thermal conductivity (k) shall be maximum 0.27 at 75 degrees mean rating temperature.

Closed cell elastomeric insulation shall be Armacell AP/Armaflex SS, K-Flex USA "Insul-Tube" or Aero Flex USA "Aerocel-SSPT". For systems operating at 180 degrees F or less, insulation shall utilize a self-sealing pressure sensitive closure system. Butt joints shall be sealed with Armaflex

520 BLV low VOC adhesive or equal. For systems operating between 180 degrees F and 200 degrees F, all joints and seams shall be sealed with Armaflex 520 BLV low VOC adhesive or equal.

For indoor systems, use shall be restricted to those systems requiring 2 inch thickness or less (due to 25/50 ASTM E-84 requirements).

Unless jacketed, for insulation located outside field paint with minimum 2 coats of an appropriate paint as recommended by the insulation manufacturer to prevent solar ultra-violet deterioration.

2.5 Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with any of the following (except when removable insulation covers are specified):

A. For fiberglass insulation;

1. Factory molded fitting insulation cover with PVC one-piece fitting cover;
2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover;
3. Fiberglass blanket insulation, held in place and covered with PVC one-piece fitting cover.
4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.

B. For closed cell elastomeric insulation systems:

1. Miter cutting of tubular insulation using special tools and mitering devices; or
2. Oversized pipe insulation overlapped and shaped to conform to fitting, valve or device.

2.6 Hangers on insulated horizontal piping are to be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:

A. Pipe 2 inches and smaller Equal to Anvil Fig. 168, 18 ga. sheet metal rib-lock shield with belled ends, 12 inches long.

B. Pipe 2.50 inches and larger;
Pipe service temperatures 210 degrees F and below: 360 degrees insulated saddles equal to Buckaroos Tru-Balance with phenolic foam insulation, integral zero-perm vapor barrier, and sheetmetal rib-lock shield with belled ends. For piping systems specified to be insulated with elastomeric pipe insulation, equal to Armafix IPH 25/50 flame / smoke rated insulation pipe hangers with polyurethane inserts and 30 mil aluminum jacket, insulation wall thickness shall be minimum 1”. If required service insulation is specified to be greater than 1”, transition to required thickness within 2” of either side of IPH.

Pipe service temperatures between 210 degrees F and 1000 degrees F, including steam supply and steam condensate piping; minimum 12 inches long, 360 degrees insulated saddles equal to Buckaroos Tru-Balance with 12 pcf calcium silicate insulation; integral vapor retarder, and sheetmetal rib-lock shield with belled ends.

C. Insulation saddles (shields) shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.7 For systems specified to have protective jacketing, jacketing shall be VentureClad 1577 CW series self-adhesive laminate, or equal by Foster Products. Finish and Color shall be Embossed White (19.5 mils).

2.8 Jacketing for refrigerant piping located outdoors shall be a white removable PVC plastic pipe insulation cover as manufactured by AIREX E-flex Guard. The covers shall be flexible, UV and

weather resistant, with full length Velcro fastening system for easy removal and reattachment. The system shall be installed in strict accordance with the manufacturer's instructions.

2.9 Mechanical joint fittings and couplings shall be considered as a part of the line and shall be insulated. Bidders on the insulation work are cautioned to verify during the bidding period the extent of this work.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

1. Due to condensation issues, fiberglass insulation shall not be installed until building is covered and conditioned.

C. Ensure that pressure testing of piping and fittings has been completed prior to installation.

3.3 Installation

A. Installation shall be done by tradesman specializing in insulation work in strict accordance with manufacturers' recommendations. Installers shall be factory trained and certified for the insulation systems being installed. Submit credentials upon request.

B. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices.

C. Install insulation on piping subsequent to installation of heat tracing and acceptance tests.

D. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal, including over staples.

E. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic. Except in ceiling spaces, PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.

F. Insulation on cold service piping shall be run thru floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to the 23 05 07 Piping Materials and Methods for special considerations which must be given at fire rated wall and floor penetrations. Refer to Section 23 05 29 Hangers and Supports for HVAC Piping for non-compressible insulation or blocking material and sheet metal saddles required at pipe hangers. Refer to Section 23 05 23 General Duty Valves for HVAC Piping for valves requiring extended shaft necks. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.

G. Provide removable insulation sections to cover parts of equipment which must be opened periodically or maintenance, and for cooling condensate piping clean-outs.

H. Items such as ASME stamp and manufacturers' nameplates, may be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of those items. Provide neatly beveled edges at interruptions of insulation.

I. Self-adhesive laminate jacketing shall be installed in strict accordance with manufacturer's instructions.

3.4 Protection

A. Advise as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.6 Reinsulate piping where existing insulation has been damaged or removed in the performance of work in this project.

END OF SECTION

23 09 23 BUILDING AUTOMATION SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 Overview

A. Contractor is responsible to review the existing system, provide controls for new equipment and integrate existing systems and new systems into the new control system. Existing equipment shall have the existing sequences pulled into the new system. New graphics shall be provided for the entire building (new and existing equipment).

B. Existing control documentation is included as reference only,

C. Furnish all labor, materials and equipment necessary for a complete and operating Building Automation System (BAS), utilizing direct digital controls and electric actuation as shown on the drawings and as described herein. Drawings are diagrammatic only.

D. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed over the control system network, the Owner's local area network, and remotely over the Internet (through the Owner's LAN).

E. Performance Monitoring: The BAS will provide the specified performance monitoring functionality, including required monitoring points and performance metrics, improved through system accuracy, data acquisition and data management capabilities, and required graphical and data displays.

F. The intent and requirement of this specification and related sections is to provide a fully integrated, open, interoperable, peer-to-peer, networked, and distributed BAS. The following communication protocols are acceptable:

1. ANSI/ASHRAE Standard 135 BACnet - A Data Communication Protocol for Building Automation and Control Networks
2. MODBUS Application Protocol V1.1b (applicable to factory packaged equipment controllers only)
3. Tridium Niagara Framework Protocol
4. Internet Engineering Task Force RFC 7540 Hypertext Transfer Protocol HTTP/2

G. The BAS shall be comprised of:

1. Communications Network
2. Enterprise Network Server
3. Embedded Controller/Web Server(s)
4. Graphical User Interface
5. Equipment controllers (B-AAC, B-ASC, MEC)
6. Sensors (refer to Section 23 09 25)
7. Controlled devices (refer to Section 23 09 25)

H. Software License Agreement

1. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract, and shall give him and their authorized agent full access to all features and functions of the installed BAS. Such license shall grant use of all programs and application software to Owner and their authorized agent as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

2. It is the Owner's express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project. In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the Enterprise Network Server, Embedded Controller/Web Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner. The owner shall determine which organizations to be named in the SI organization ID ("orgid") of all software licenses. All NiagaraAX or Niagara 4 software licences shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*"; "accept.wb.in=*"; "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier, by Tridium Inc.

I. All Embedded Controller/Web Servers shall be accessed via a single connection to the Enterprise Network Server. In this configuration, each Embedded Controller/Web Server can be accessed from a PC using Remote Desktop Connection Client User Interface and from a PC using Web Browser Client User Interface.

J. Local connections shall be via an Ethernet LAN. Remote connections shall be via Owner provided full-time, high-speed ISP connection for remote site access (i.e., T1, ADSL, cable modem) and IPv6 compliant. The owner shall be responsible for all monthly internet access fees and connection charges.

K. The basic control system includes all sensors, controllers, instruments, valves, actuators, devices, installation and service for a complete and functional control system. All control devices (valves, dampers, actuators, etc.) and associated power and control wiring shall be included. Refer to Section 23 09 25 Instrumentation and Control Devices for HVAC and Section 23 09 47 Control Power and Wiring for HVAC. The BAS shall be designed to allow easy field adjustment of all set points and parameters.

L. Provide for future system expansion to include monitoring of the access, intrusion detection, fire alarm, and lighting control systems.

M. Controls Contractor to provide 1 portable workstation.

1.2 Provider Requirements

A. Manufacturer Qualifications

1. All products used in the installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. The installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be made available for at least 10 years after completion of this contract.

B. Installer Qualifications

1. Installing Contractor shall have an established working relationship with Control System Manufacturer of not less than 5 years.
2. Installing Contractor and their Sub-Contractors shall have successfully completed manufacturer's control system training. Provide certification of completed training, including hours of instruction and course outlines, within 10 days after bid date.

3. Installing Contractor shall have an office within 75 miles of the project site and provide 24 hour response in the event of a customer call, 7-days per week, 365 days per year.

1.3 Approved Control System Manufacturers and Installing Contractors

A. Manufacturers: Subject to compliance with requirements, provide systems, equipment and installation by one of the following:

1. Grantham Company, Open Control Systems (Envelop), Jackson Systems, and Siemens.

B. All systems shall be Jace 8000 Licensed open.

C. Field verify prior to bid the required Supervisor integration requirements per job site.

1.4 Codes and Standards

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions of the following codes and standards:

1. National Electric Code (NEC)
2. Indiana Building Code (IBC) and Indiana Mechanical Code (IMC)
3. National Fire Protection Association (NFPA)
4. ANSI/ASHRAE Standard 55 Thermal Environmental Conditions For Human Occupancy
5. ANSI/ASHRAE Standard 62 Ventilation For Acceptable Indoor Air Quality
6. ANSI/ASHRAE Standard 90.1 Energy Standard For Buildings Except Low-Rise Residential Buildings
7. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Networks
8. Underwriters Laboratories: Products shall be UL-916-PAZX Listed

1.5 The following sections constitute related work:

A. Section 23 09 25 – Instrumentation and Control Devices for HVAC

B. Section 23 09 47 – Control Power Wiring for HVAC

C. For Points Lists refer to drawings.

1.6 System Performance

A. Performance Standards. System shall conform to the following minimum standards over network connections:

1. Graphic Display. A graphic with 20 dynamic points/objects shall display with current data within 10 seconds.
2. Graphic Refresh. A graphic with 20 dynamic points/objects shall update with current data within 8 seconds.
3. Object Command. Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.
4. Object Scan. Data used or displayed at a controller or user interface shall have been current within the previous 6 seconds.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the user interface within 45 seconds

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 second. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute BAS PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciations. Each user interface on the network shall receive alarms within 5 seconds of other user interfaces.
9. Reporting Accuracy. System shall report values with the minimum end-to-end accuracy listed in Table 1 of Section 23 09 25 Instrumentation and Control Devices.
10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2 of Section 23 09 25 Instrumentation and Control Devices.

1.7 Submittals

A. Refer to Section 23 05 01 – Basic HVAC Requirements /and Division 1.

B. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as 11 inches x 17 inches prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Damper and valve schedules and data sheets may be submitted separately to improve product delivery dates. Provide submittals within 12 weeks after contract award, including the following:

1. BAS Hardware
   a. Complete bill of materials indicating quantity, manufacturer, model number, and other relevant technical data.
   b. Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation and maintenance instructions for items listed below and for other relevant items not listed below:
      1) DDC (controller) panels
      2) Transducers and transmitters
      3) Sensors (including accuracy data)
      4) Actuators
      5) Valves
      6) Dampers
      7) Relays and switches
      8) Control panels
      9) Power supplies
      10) Batteries
      11) User interface equipment
      12) Wiring
   c. Wiring diagrams and layouts for each control panel. Show all termination numbers.
   d. Floor plan schematic diagrams indicating field sensor, controller and power supply locations.
2. Network and User interface Hardware and Software
   a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
   b. Manufacturer's description and technical data, such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:

1) Central Processing Unit (CPU)
2) Monitors
3) Keyboards
4) Power supply
5) Battery backup
6) Interface equipment between CPU and control panels
7) Routers
8) Repeaters
9) Operating System software
10) User interface software
11) Color graphic software
12) Third-party software

c. Schematic diagrams of control, communication, and power wiring for central system installation. Label cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to control system.
d. List of color graphics to be provided. Provide a conceptual layout of pictures and data for each graphic, showing or explaining which other graphics can be directly accessed.

3. Controlled Systems
   a. Riser diagrams showing control network layout, communication protocol, and wire types.
   b. Schematic diagram of each controlled system. Label control points/objects with point/object names. Graphically show all locations of control elements.
   c. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
   d. Instrumentation list for each controlled system. List each control system element in a table format. Show element name, type of device, manufacturer, model number, and product data sheet number.
   e. Mounting, wiring, and routing plan view drawing in 0.25 inch scale. Take into account HVAC, electrical and other systems' design and elevation requirements. Show locations of concrete pads and bases and special wall bracing for panels to accommodate this work.
   f. Complete description of control system operation including sequences of operation. Include and reference a schematic diagram of system.
   g. Point/object list for each system controller including inputs and outputs (I/O), point/object numbers, controlled device associated with each I/O point/object, and location of I/O device. Indicate alarmed and trended points/objects.
4. Description of process, report formats, and checklists to be used in Part 3: "Control System Demonstration and Acceptance."
5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of BACnet controller (B-BC, B-AAC, B-AVAVC, B-ASC) and user interface (B-OWS).
6. Instrumentation and Data Point Summary Table. Contractor shall submit in table format with the following information for each instrument and data point. The table is to be reviewed and approved by the owner's representative prior to hardware and software installation and programming.
   a. Point name
   b. Point description: provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location
   c. Expected range (upper and lower limit)
   d. Instrumentation (as applicable): manufacturer, model number, range, and accuracy specification
   e. Type
      1) AI: analog input
      2) BI: binary input
      3) NAI: network analog input

4) NBI: network binary input
5) P: programmed (e.g., soft or virtual point in control sequence such as a PID input or output)
6) C: calculated value; a soft or virtual point. If calculated value, provide logic diagrams or code and any constants used in formula. If time-based integrated values are required, provide time periods: minutes, daily, weekly, monthly, and yearly. Also indicate if it is a running average.

f. Input resolution
g. Graphic display resolution
h. Data trend interval
i. Number of samples stored in local controller before transfer to host computer/server database
j. Data point address

C. Schedules

1. Provide a Schedule of work within one month of contract award indicating:
   a. Intended sequence of work items
   b. Start date of each work item
   c. Duration of each work item
   d. Planned delivery dates for ordered material and equipment, and expected lead time
   e. Milestones indicating possible restraints on work by other trades or situations
2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

D. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

1. Project Record Drawings.
   a. As-built versions of the submittal shop drawings provided as 11 inches x 17 inches prints.
   b. Submittals to include complete electrical point-to-point wiring diagrams, component layouts, system and equipment component sequences of operation, start-up and checkout procedures. Include a list of all unit default safety and control settings, whether fixed or adjustable, as shipped from the factory. Where field modifications are required to meet the specification, provide all modification labor and materials, and submit a complete, detailed, step-by-step procedure for the modifications.
2. Testing and Commissioning Reports and Checklists. Completed versions checklists and trend logs used to meet requirements of Part 3: “Control System Demonstration and Acceptance.”
3. Operation and Maintenance (O & M) Manual.
   a. As-built versions of the submittal product data.
   b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
   c. User’s manual with procedures for operating control systems: logging on and off, handling alarms, producing point/object reports, trending data, overriding computer control, and changing setpoints and variables.
   d. Programming manual or set of manuals with description of the programming language and syntax of statements for algorithms and calculations used of point/object database creation and modification, of program creation and modification, and editor use.
   e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points/objects, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

f. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
g. Graphic files, programs and database on magnetic or optical media.
h. List of recommended spare parts with part numbers and suppliers.
i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
j. Complete original-issue copies of furnished software, including operating systems, custom programming language, user interface software, and graphics software.
k. Licenses, guarantee, and warranty documents for equipment and systems.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

4. Training Materials: Provide course outline and manuals for each class at least six weeks before the first class. Engineer will modify course outlines and manuals if necessary to meet Owner's needs. Engineer will review and approve course outlines and manuals at least three weeks before first class.

1.8 Warranty

A. Warrant all work as follows:
1. Warrant labor and materials for specified BAS free from defects for a period of 12 months after final acceptance. BAS failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. Respond during Owner's business hours within 24 hours of Owner's warranty service request.
2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
3. If Engineer determines that equipment and systems operate satisfactorily at the end of the final start-up, testing, and commissioning phase, Engineer will certify in writing that BAS operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. Provide updates to user user interface software, project-specific software, graphic software, database software, and firmware which resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above mentioned items. Do not install updates or upgrades without Owner's written authorization.

1.9 Ownership of Proprietary Material

A. Project specific software and documentation shall become Owner's property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application programming code
5. Documentation

PART 2 - PRODUCTS

2.1 Materials

A. The equipment specified shall be provided as defined herein, shown on the drawings and as required to accomplish the sequences of control.

B. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner or Owner's Representative. Spare parts shall be available for at least five-years after completion of this contract.

C. Contractor to provide 1 portable workstation.

2.2 BACnet Communications

A. Control products, communication media, connectors, repeaters, hubs and routers shall comprise a BACnet BAS. Controllers and user interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Each controller shall have a communication port for connections to an user interface.

C. Project drawings indicating remote buildings or sites to be connected to the Enterprise network shall allow for communication with each controller on the network as specified in Paragraph D.

D. Network user interface and value passing shall be transparent to network architecture.

1. A user interface connected to the BAS shall allow the user to interface with networked controllers as if directly connected. BAS information such as data, status, reports, system software, and custom programs, shall be viewable and editable from the user interface.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be available on the network. Program and test all cross-controller links required to execute specified BAS operation. An authorized user shall be able to manage, maintain, and access the BAS network of controllers.

E. Workstations, Building Control Panels and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clock daily from an user designated device via the network. The system shall automatically adjust for daylight saving and standard time as applicable.

F. System shall be expandable to at least twice the required data points with additional controllers, associated devices, and wiring. Expansion shall not require user interface hardware additions or software revisions.

G. Switches shall be one of the following: WS-C3560CX-8PC-S, CISCO SYSTEMS (CISCOPRO), Cisco Catalyst 3560-CX 8 Port PoE IP Base) and (CAB-TA-NA, CISCO SYSTEMS (CISCOPRO), provided to the owner's IT department for programming.

2.3 Enterprise Network Server

A. The Enterprise Network Server shall support all Embedded Controller/Web Servers connected to the owner's network whether local or remote.

B. The Enterprise Network Server Software shall provide the following functions, at a minimum:

1. Global Data Access: The Enterprise Network Server shall provide complete access to distributed data defined anywhere in the system.
2. Distributed Control: The Enterprise Network Server shall provide the ability to execute global control strategies based on control and data objects in any Embedded Controller/Web Server in the network, local or remote.
3. The Enterprise Network Server shall include a master clock service for its subsystems and provide time synchronization for all Embedded Controller/Web Servers.

4. The Enterprise Network Server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
5. The Enterprise Network Server shall provide scheduling for all Embedded Controller/Web Servers and their underlying field control devices.
6. The Enterprise Network Server shall provide demand limiting that operates across all Embedded Controller/Web Servers. The Enterprise Network Server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
7. The Enterprise Network Server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Embedded Controller/Web Servers. Systems not employing this prioritization shall not be accepted.
8. Each Embedded Controller/Web Server supported by the Enterprise Network Server shall have the ability to archive its log data, alarm data and database to the Enterprise Network Server, automatically. Archiving options shall be user-defined including archive time and archive frequency. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. The server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2 and HTTP/HTML/XML, CSV or text formats. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.
9. The Enterprise Network Server shall provide central alarm management for all Embedded Controller/Web Servers supported by the Enterprise Network Server. Alarm management shall include:
    a. Routing of alarms to display, email, and pagers
    b. View and acknowledge alarms
    c. Query alarm logs based on user-defined parameters
10. The Enterprise Network Server shall provide central management of log data for all Embedded Controller/Web Servers supported by the Enterprise Network Server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
    a. Viewing and printing log data
    b. Exporting log data to other software applications
    c. Query log data based on user-defined parameters

C. The Enterprise Network Server hardware platform shall have the following minimum requirements:

1. Processor: Intel Xeon x64 (or better), compatible with dual- and quad-core processors
2. Operating System: Windows 10, 64-bit Windows 8.1 Enterprise, Windows Server 2012 R2 Standard, RHEL-7
3. Memory: 8 GB
4. Hard Drive: 1 TB
5. Display: Video card capable of displaying 1024 x 768 pixel resolution or greater
6. Network Support: NIC card rated for at least 1 Gigabit or 10 Gigabit Ethernet

2.4 Embedded Controller/Web Server (EC/WS)

A. Embedded Controller/Web Server(s) shall manage communications between the BACnet Advanced Application Controllers (B-AAC), BACnet Advanced VAV Controller (B-AVAVC), BACnet Application Specific Controllers (B-ASC), and Mechanical Equipment Controllers (MEC) which are connected to its communications trunks, manage communications between itself and other Embedded Controller/Web Servers and with Enterprise Network Server that are part of the BAS, and perform control and operating strategies for the system based on

information from any controller connected to the BAS. All hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted “safe boot” technology.

B. The communication protocols utilized for peer-to-peer communications between Embedded Controller/Web Servers and with Enterprise Network Server will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between Embedded Controller/Web Servers is not allowed.

C. The EC/WS shall employ a device count capacity license model that supports expansion capabilities.

D. The EC/WS shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:

1. BACnet
2. Lon
3. MODBUS
4. SNMP
5. KNX

E. The EC/WS shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of LonWorks, BACnet, and MODBUS controller data
7. Network management functions for all EC/WS, B-AAC, B-AVAVC, and B-ASC devices.

F. The EC/WS shall provide the following hardware features as a minimum:

1. Two 10/100 Mbps Ethernet ports
2. Two Isolated EIA-485 ports with biasing switches
3. 1 GB RAM
4. 4 GB Flash Total Storage / 2 GB User Storage
5. Wi-Fi (Client or WAP)
6. USB Flash Drive
7. High-Speed Field Bus Expansion
8. -20 to 60 degree C Ambient Operating Temperature
9. Integrated 24 VAC/DC Global Power Supply
10. MicroSD Memory Card employing Encrypted Safe Boot Technology

G. The EC/WS shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

H. The EC/WS shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.

I. The EC/WS shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.

1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
   a. Alarm
   b. Return to normal

c. To default

2. Alarms shall be annunciated in any of the following manners as defined by the user:
   a. Screen message text
   b. Email of complete alarm message to multiple recipients
   c. Pagers via paging services that initiate a page on receipt of email message
   d. Graphics with flashing alarm object(s)

3. The following shall be recorded by the SNC for each alarm (at a minimum):
   a. Time and date
   b. Equipment (air handler #, access way, etc.)
   c. Acknowledge time, date, and user who issued acknowledgement

J. Programming software and all controller "Setup Wizards" shall be embedded into the EC/WS.

K. The EC/WS shall support the following security functions:

1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted
2. Role-Based Access Control (RBAC) for managing user roles and permissions
3. Require users to use strong credentials
4. Data in Motion and Sensitive Data at Rest be encrypted
5. LDAP and Kerberos integration of access management

L. The EC/WS shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:

1. Metadata: Descriptive tags to define the structure of properties
2. Tagging: Process to apply metadata to components
3. Tag Dictionary

M. The EC/WS shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (B-AAC, B-AVAVC, B-ASC, VFD…) shall have an associated template file for reuse on future project additions.

N. The EC/WS shall be provided with a 5 Year Software Maintenance license. Labor to implement not included.

2.5 Graphical User Interface

A. All Embedded Controller/Web Servers shall be accessed via a single connection to the Enterprise Network Server. In this configuration, each Embedded Controller/Web Server can be accessed from a PC using Thin-Client Remote Desktop Connection User Interface and/or a PC using Thin-Client Web Browser User Interface.

B. The Thin-Client Remote Desktop Connection User Interface shall use any of the current versions of Windows Server with Remote Desktop Services and shall allow the Enterprise Server to host multiple, simultaneous client sessions. Remote Desktop shall use Remote Desktop Services technology to allow a single session to run remotely. A user shall connect to a Remote Desktop Session Host (RD Session Host) server by using Remote Desktop Connection (RDC) client software. Thin-client hardware devices running an embedded Windows-based operating system shall run the RDC client software to connect to the RD Session Host Enterprise Server.

C. The Thin-Client Web Browser User Interface shall use any of the current versions of Microsoft Internet Explorer, Microsoft Edge, Mozilla Firefox, or Google Chrome browsers from any computer. The thin-client web browser shall be operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary user interface and configuration programs or browser plug-ins. Communication between the Thin-Client Web Browser User Interface and the Enterprise Network Server shall offer, at a minimum, encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

D. Software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote connected user interfaces.

F. The user interface shall be completely interactive and shall provide a HTML5 experience that supports the following features as a minimum:

1. Trending.
2. Scheduling.
3. Electrical demand limiting.
4. Duty Cycling.
5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
7. Tree Navigation.
8. Parameter change of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of users.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

G. Software Components: All software shall be the most current version. All software components of the BAS software shall be provided and installed as part of this project. BAS software components shall include:

1. Server Software, Database and Graphical User Interface.
2. 5 Year Software Maintenance Agreement. Labor to implement shall be included.
3. Embedded System Configuration Utilities for future modifications to the system and controllers.
4. Embedded Graphical Programming Tools.
5. Embedded Direct Digital Control software.
6. Embedded Application Software.
7. Embedded Native Function-block programming software and all controller “Setup Wizards”.

H. Login: On launching the user interface and selecting the appropriate domain name or IP address, the user shall be presented with a login page that will require a login name and

strong password. Navigation in the system shall be dependent on the user's role-based application control privileges.

I. Web Page Navigation: Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven user interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for user access, reports and reporting actions for events.

J. Tree Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the user to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.

1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
2. Groups View shall display Scheduled Groups and custom reports.
3. Configuration View shall display all the configuration categories (Users, Schedule, Event, Reporting and Roles).

K. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:

1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web-browser. User shall have ability to save custom dashboards.
3. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
4. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the user to depress an 'accept/cancel' button.
5. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
6. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
7. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
8. Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
9. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

L. Color Graphics: The GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector

scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI user interface software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability. .
5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
   a. Each piece of equipment monitored or controlled including each terminal unit.
   b. Each building.
   c. Each floor and zone controlled.

M. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the GUI, a user (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further user intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
   a. Types of schedule shall be Normal, Holiday or Override.
   b. A specific date.
   c. A range of dates.
   d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
   e. Wildcard (example, allow combinations like second Tuesday of every month).
2. Schedule Categories: The system shall allow users to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, users shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the user shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the user schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or

any other equipment required to maintain the specified comfort and environmental conditions within the room.

5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the user (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

N. Alarms:

1. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
2. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.
3. Alarm Reactions. The operator shall be able to determine (by object) what, if any, actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day.
4. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
5. Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
   a. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An user shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
   b. Alarm Categories: The user shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the user to easily sort through multiple events displayed.
   c. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
   d. Alarm Areas: Alarm Areas enable an user to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an user to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
   e. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
   f. Alarm Configuration: Users shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their

respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.

g. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
h. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an user defined period.
i. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Users shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
    1) Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
    2) Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
    3) File Write: The ASCII File write reporting action shall enable the user to append user defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the user. The user may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
    4) Write Property: The write property reporting action updates a property value in a hardware module.
    5) SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
    6) Run External Program: The Run External Program reporting action launches specified program in response to an event.
j. There shall be 4 levels of alarm
    1) Level 1: Life-safety message
    2) Level 2: Critical equipment message
    3) Level 3: Urgent message
    4) Level 4: Normal message
k. Maintenance Mode. Operators shall have the ability to put any device in/out of maintenance mode.
    1) All 1) All alarms associated with a device in maintenance mode will be suppressed except life safety alarms.
    2) If a device is in maintenance mode, issue a daily Level 3 alarm at a scheduled time indicating that the device is still in maintenance mode.
l. Entry Delays. All alarms shall have an adjustable delay time such that the alarm is not triggered unless the alarm condition is TRUE for the delay time. Default entry delays are as follows:
    1) Level 1 alarms: 1 seconds
    2) Level 2 alarms: 10 seconds
    3) Level 3 alarms: 1 minutes
    4) Level 4 alarms: 5 minutes
m. Exit Hysteresis
    1) Each alarm shall have an adjustable time-based hysteresis (default: 5 seconds) to exit the alarm. Once set, the alarm does not return to normal until the alarm conditions have ceased for the duration of the hysteresis.
    2) Each analog alarm shall have an adjustable percent-of-limit-based hysteresis (default: 0% of the alarm threshold, i.e., no hysteresis; alarm exits at the same value as the alarm threshold) the alarmed variable required to exit the alarm. Alarm conditions have ceased when the alarmed variable is below the triggering threshold by the amount of the hysteresis.

n. Latching. Any alarm can be configured as latching or nonlatching. A latching alarm requires acknowledgment from the operators before it can return to normal, even if the exit deadband has been met. A nonlatching alarm does not require acknowledgment. Default latching status is as follows:
   1) Level 1 alarms: latching
   2) Level 2 alarms: latching
   3) Level 3 alarms: nonlatching
   4) Level 4 alarms: nonlatching

o. Postexist. Suppression Period. To limit alarms, any alarm may have an adjustable suppression period such that, if the alarm is triggered, its postsuppression timer is triggered and the alarm may not trigger again until the postsuppression timer has expired. Default suppression periods are as follows:
   1) Level 1 alarms: 0 minutes
   2) Level 2 alarms: 5 minutes
   3) Level 3 alarms: 24 hours
   4) Level 4 alarms: 7 days

p. For both latching and nonlatching alarms, the operators may acknowledge the alarm. Acknowledging an alarm clears the alarm, the exit deadband, and suppression period. A device can go right back into alarm as soon as the entry delay elapses.

O. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

1. Viewing Trends: The user shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
4. Dynamic Update. Trends shall be able to dynamically update at user-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The user shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
8. Group Trend Time Series Plots
   a. Provide user-selectable Y points.
   b. Provide user-editable titles, point names, and Y axis titles.
   c. Individual trended points shall be able to be grouped in groups of up to four points per plot with up to four plots per page.
9. X-Y Trend Plots
   a. User- selectable X and Y trend inputs.
   b. User- editable titles, point names, and X and Y axis titles.
   c. User- selectable time period options:
      1) A 1-day 24-hour period;

2) A 1-week 7-day period;
3) A 1-month period, with appropriate days for the month selected; or (4) a 1-year period.
4) The user shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.

d. User- selectable display of up to 6 plots per screen in 2 columns.

P. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archivable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the Enterprise Server hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.

Q. Custom Reports. Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

R. Security Access: Systems that access from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:

1. Roles: Roles shall reflect the actual roles of different types of users. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
   a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Users, Roles and Privileges, Alarm/Event Template and Reporting Action.
   b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
   c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.

S. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same user defined HVAC Role) to different areas of the system.

T. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

U. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each

logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

V. Graphic Sequence: The clarity of the graphic sequence shall be such that the user has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the user with an understandable and exact representation of each sequence of operation.

W. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:

1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.

X. Live Graphical Programs: The Graphic Programming software shall support a ' live' mode, where all input/output data, calculated data and set points shall be displayed in a ' live' real-time mode.

2.6 BACnet Advanced Application Controller (B-AAC)

A. General. Provide an adequate number of BACnet Advanced Application Controllers (B-AAC) to achieve the performance specified in the Part 1 Article on “System Performance”. B-AAC shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. The controller platform shall provide options and advanced system functions, programmable and configurable, that allow standard and customizable control solutions required in executing the "Sequence of Operation". All local level application programs shall be installed on individual controllers in non-volatile memory. Control systems that utilize ‘canned’ programs or programmable read only memory (PROM) level application programming are not acceptable. Each of these panels shall meet the following requirements.

1. The B-AAC shall have sufficient memory to support its operating system, database, and programming requirements.
2. Data shall be shared between networked B-AACs.

3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
4. Controllers that perform scheduling shall have a real-time clock.
5. The B-AAC shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall
   a. Assume a predetermined failure mode,
   b. Generate an alarm notification.
6. The B-AAC shall communicate with other BACnet devices on the network using protocol specific services.
7. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
8. Provide documentation for each device, with the following information:
   a. BACnet Device; MAC address, name, type and instance number,
   b. BACnet Objects; name, type and instance number.

B. Communication

1. Each B-AAC shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
2. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable user's terminal.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32 degrees F to 150 degrees F and 10 to 90 percent RH.
2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F.

D. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable user terminal.

E. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

F. Memory. The B-AAC shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

G. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

H. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.

2.7 BACnet Advanced Variable Air Volume Controller (B-AVAVC)

A. General. Provide an adequate number of BACnet Advanced Variable Air Volume Controller (B-AVAVC) to achieve the performance specified in the Part 1 Article on “System Performance”. B-AVAVC shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. The controller platform shall provide options and advanced system functions, programmable and configurable, that allow standard and customizable control solutions required in executing the "Sequence of Operation". All local level application programs shall be installed on individual controllers in non-volatile memory. Control systems that utilize ‘canned’ programs or programmable read only memory (PROM) level application programming are not acceptable. Each of these controllers shall meet the following requirements.

1. The B-AVAVC shall have sufficient memory to support its operating system, database, and programming requirements.
2. Data shall be shared between networked B-AVAVCs.
3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
4. Controllers that perform scheduling shall have a real-time clock.
5. The B-AVAVC shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
   a. Assume a predetermined failure mode,
   b. Generate an alarm notification.
6. The B-AVAVC shall communicate with other BACnet devices on the network using protocol specific services.
7. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
8. The controller shall have Significant Event Notification, Periodic Update capability and Failure Detect when network inputs fail to be detected within their configurable time frame.
9. Provide 9. Provide documentation for each device, with the following information:
   a. BACnet Device; MAC address, name, type and instance number,
   b. BACnet Objects; name, type and instance number.
   c. The controller shall have an internal velocity pressure sensor.
   d. The controller shall have an integrated or remote actuator.

B. Communication

1. Each B-AVAVC shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
2. Each B-AVAVC shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable user’s terminal.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 32 degrees F to 150 degrees F and 10 to 90 percent RH.
2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The B-AVAVC shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

G. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.

2.8 BACnet Application Specific Controller (B-ASC)

A. General. BACnet Application Specific Controllers (B-ASCs) are microprocessor-based BAS controllers which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user-programmable, but are customized for operation within the confines of the equipment they are designed to serve. B-ASCs may not be used for complex sequences of operation. B-ASCs shall communicate with other BACnet devices on the network using the Read (Execute) Property service as defined in Clause 15.5 of ASHRAE Standard 135. Each B-ASCs shall be certified or listed for compliance to the BACnet standards.

1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network
2. Each B-ASC will contain sufficient I/O capacity to control the target system.
3. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
4. Provide documentation for each device, with the following information:
   a. BACnet Device; MAC address, name, type and instance number,
   b. BACnet Objects; name, type and instance number.

B. Communication

1. Each controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol. Each network of controllers shall be connected to one building controller.
2. Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable user's tool. This connection shall be extended to a space temperature sensor port where shown and allow access to the entire network.
3. Each controller shall have a secondary sub network for communicating sensors or I/O expansion modules.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32 degrees F to 150 degrees F and 10 to 90 percent RH.
2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.

F. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

G. Transformer. Power supply for the ASC must be rated at a minimum of 125 percent of ASC power consumption and shall be of the fused or current limiting type.

H. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.

2.9 MODBUS System Integration

A. The BAS shall support the integration of device data from MODBUS RTU, ACSII, or TCP control system devices. The connection to the MODBUS system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

1. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the MODBUS system data into the FPMS. Objects provided shall include at a minimum:
2. Read/Write MODBUS AI Registers
3. Read/Write MODBUS AO Registers
4. Read/Write MODBUS BI Registers
5. Read/Write MODBUS BO Registers

B. All scheduling, alarming, logging and global supervisory control functions, of the MODBUS system devices, shall be performed by the Network Area Controller.

C. The BAS supplier shall provide a MODBUS system communications driver. The equipment system vendor that provided the equipment utilizing MODBUS shall provide documentation of the system's MODBUS interface and shall provide factory support at no charge during system commissioning.

2.10 Input/Output Interface

A. Hardwired inputs and outputs may tie into the BAS through building, advanced application, or application specific controllers.

B. All input and output points shall be protected such that shorting of the point to itself, to another point, or to ground, shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 volts of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low-voltage (0-10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with – and field configurable to – commonly available sensing devices.

F. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and advanced application controllers shall have three-position (On/Off/Auto) override switches, and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC signal or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or advanced application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4 percent of range per year.

H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct mounted heating coils, zone dampers, radiation, etc.) Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of user tracking.

I. Input/Output points shall be universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.

J. System Capacity. The system size shall be expandable to at least twice the number of input/output objects/points required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The user interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

K. Each controlled device or function shall be a separate output of the digital controller (i.e., Economizer, Heating Valve, Cooling Valve are three (3) separate output points). When a points' list is provided the greater number of points and their configuration shall govern. Multiplexers or programmable logic controllers utilized with digital controller input and output points to expend the digital controller I/O capabilities will not be allowed.

2.11 Surge protection and battery back-up shall be provided at all control panels and workstations.

PART 3 - EXECUTION

3.1 Examination

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor's work and the plans and the work of others, then report these discrepancies to the Engineer and obtain written instructions for any changes necessary to accommodate the

temperature control work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect to report such discrepancies shall be made by and the costs borne by this Contractor.

3.2 Protection

A. Protect all work and material from damage by their work or employees, and shall be liable for all damage thus caused.

B. The installing contractor shall be responsible for their work and equipment until finally inspected, tested, and accepted. Protect any material that is not immediately installed. Close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 Coordination

A. Site

1. Where the temperature control work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If temperature control work is installed before coordinating with other trades, so as to cause any interference with work of other trades, the temperature control work shall be re-worked to correct the condition without extra charge.
2. Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.

B. Test and Balance

1. Furnish all tools necessary to interface to the control system for test and balance purposes.
2. Provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
3. In addition provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

C. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated as follows:

1. All communication media and equipment shall be provided as specified in Part 2: “Communication” of this specification.
2. Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
3. Coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.

D. Revise equipment tagging and nomenclature, room numbering, etc. to reflect as-built conditions or an Owner’s preference for integration into their existing naming numbering convention.

3.4 Field Quality Control

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

B. Continually monitor the field installation for code compliance and quality of workmanship.

C. Have work inspected by authorities having jurisdiction over the work.

3.5 Controllers

A. Provide a separate controller for each AHU, terminal unit, fan coil, and other unitary equipment and HVAC systems. A DDC controller may control more than one system provided that all points/objects associated with the system are assigned to the same DDC controller. Points/objects used for control loop reset such as outside air or space temperature are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15 percent spare I/O point/object capacity for each point/object type found at each location. If input /objects are not universal, 15 percent of each type is required. If outputs are not universal, 15 percent of each type is required. A minimum of one spare is required for each type of point/object used.

1. Future use of spare capacity shall require providing the field device, field wiring, point/object database definition, and custom software. No additional controller boards or point/object modules shall be required to implement use of these spare points.

3.6 Programming

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25 percent of available memory free for future use.

B. Point/object Naming: System point/object names shall be modular in design, allowing easy user interface without the use of a written point/object index. Use the following naming convention:
AAABBBCCCDDDEEE where:

AAA is used to designate the location of the point/object within the building such as mechanical room, wing, or level, or the building itself in a multi-building environment.

BBB is used to designate the mechanical system with which the point/object is associated (e.g., A01, HTG, CLG, LTG).

CCC represents the equipment or material referenced (e.g., SAF for supply air fan, EXF for exhaust fan, RAF for return air fan).

D or DD or DDD may be used for clarification or for identification if more than one of CCC exists (e.g., SAF10, EXF121).

EE represents the action or state of the equipment or medium (e.g., T for temperature, RH for humidity, CO for control, S for status, D for damper control, I for current).

C. Software Programming

1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided. Imbed into the control program

sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

a. Text-based:
   1) must provide actions for all possible situations
   2) must be modular and structured
   3) must be commented
b. Graphic-based
   1) must provide actions for all possible situations
   2) must be documented
c. Parameter-based
   1) must provide actions for all possible situations
   2) must be documented

2. After submittal and review of control software, offer to schedule a meeting with the Engineer and Commissioning Agent (CxA) to review system function.

D. Graphical User Interface

1. Standard Graphics. Provide graphics for all controlled systems and floor plans of the building. Point/object information on the graphic displays shall dynamically update. Show on each graphic all input and output points/objects for the system. Also show relevant calculated points/objects such as setpoints.
2. Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point/object show.
3. Provide all the labor necessary to install, initialize, start up, and troubleshoot all user interface software and their functions as described in this section. This includes any operating system software, the user interface database, and any third-party software installation and integration required for successful operation of the user interface.
4. Provide graphic representation of each system. Graphic shall have a link to its respective approved as-built sequence of operation in portable document format (pdf) or hypertext markup language format (html).
5. Provide graphic representation of each control device component (sensor, controller, controlled device). Each control device component graphic representation shall have a cursor-hover-over pull-down box with links to the manufacturer’s data sheet, installation instructions, maintenance instructions, and programming instructions literature in portable document format (pdf) or hypertext markup language format (html). Also, provide a link to an active trend of sensor and controlled device components.
6. Provide graphic representation of each equipment component (pump, boiler, chiller, air handling unit, etc.). Each equipment component shall have a cursor-hover-over pull-down box with links to the manufacturer’s data sheet, installation, maintenance, and programming literature in portable document format (pdf) or hypertext markup language format (html). For equipment components with factory mounted controllers provide an additional link to a graphic representation of all equipment controller data available via the respective communication protocol interface in tabular format.
7. The ATC Contractor shall initially prepare and be responsible for a Graphical User Interface Development Plan. The plan shall describe the process for the development of the GUI.
8. GUI Scope Meeting: Within 45 days from execution of the Contract, participate in a scope meeting with the GUI Development Team chaired by the ATC Contractor. The purpose of the meeting includes a review of the GUI Development Plan with discussions of development schedule, graphical requirements, and assignments of responsibilities.
9. GUI Coordination Meetings: The GUI Development Team members will meet on a predetermined and approved basis (by the Owner) to review progress on the GUI work, coordinate scheduling conflicts, and to discuss strategies and processes for upcoming tasks. The meetings will be chaired by the ATC Contractor. Allow for 80 hours of meeting time.

10. GUI Development Meeting Minutes: The ATC Contractor shall prepare minutes of the initial scope and progress meetings, and shall include a copy of the agenda, and identify location and date of the meeting, and individuals in attendance. Minutes shall be distributed to members of the GUI Development Team.
11. GUI Development Team: Members of the GUI Development Team shall include, but not be limited to the Owner, ATC Contractor, and such parties designated by the Owner or ATC Contractor.

3.7 Control System Checkout and Testing

A. Start-up Testing: All testing listed in this article shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's Representative is notified of the system demonstration.

1. Upon completion of the control system, adjust all components of the system. Make all adjustments in the control system required and as directed by the balancer to achieve the desired air balance quantities. All instruments shall be carefully calibrated and each control function shall be demonstrated to function properly, to the satisfaction of the Engineer and the Owner. Provide a complete instruction manual covering the function and operation of all components. At the time of demonstration, each function shall be simulated to ensure that controls respond properly to all signals, and the Owner shall be instructed in the proper operation of the system.
2. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
3. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
4. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations.
5. Verify that all binary output devices (relays, solenoid valves, two position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
6. Verify that all analog output devices (transducers, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Check all control valves and automatic dampers to ensure proper action and closure. Make any necessary adjustments to valve stem and damper blade travel.
7. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.
8. Alarms and Interlocks
    a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
    b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
    c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
9. Each unit and associated controls, safeties and wiring shall be checked out, started and adjusted by a factory trained service technician. Submit a startup report including a list of all unit safety and control settings, whether fixed or adjustable, as field checked and setup per the specified design conditions five days after unit startup. Submit service technician certification upon request.

3.8 Control System Demonstration and Acceptance

A. Demonstration

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the temperature controls have been completed, started up and performed its own tests.
2. The tests described in this section are to be performed in addition to the tests that are performed as a necessary part of the installation, startup, and debugging process and as specified in the “Control System Checkout and Testing” Article in Part 3 of this specification. The Engineer may be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1: “Submittals.” The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. Provide at least two persons equipped with two way communication, and demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point/object and system. Provide and operate any test equipment required to prove the proper operation.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1: “System Performance.
7. Demonstrate compliance with Sequences of Operation through all modes of operation.
8. Demonstrate complete operation of User Interface.
9. Additionally, the following items shall be demonstrated:
   a. Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48 hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date, and any necessary repairs or revisions to the hardware or software to successfully complete all tests shall be made.

B. Acceptance

1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: Submittals.

C. During the first year of operation, after acceptance by the Owner, provide complete service to adjust or assist the Owner in adjusting the equipment to obtain optimum performance from the control equipment and from the heating and air conditioning systems in general. This shall be done without additional expense to the Owner. This work shall include revisions to DDC software programs and controller, and all PC front end software upgrades. All software shall be provided to the Owner in disk form, including back-ups of final field programs.

3.9 Cleaning

A. Clean up all debris resulting from its activities daily. Remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.10 Training

A. Provide a minimum of three onsite training classes 8 hours in length during the construction period for personnel designated by the owner.

B. Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be 8 hrs. in length and must be coordinated with the building Owner.

C. Training session to be recorded. Recording to be turned over to Owner

D. Train the designated staff of Owner's Representative and Owner to enable them to:

1. Day-to-day Users:
   a. Proficiently operate the system
   b. Understand control system architecture and configuration
   c. Understand DDC system components
   d. Understand system operation, including DDC system control and optimizing routines (algorithms)
   e. Operate the user interface and peripherals
   f. Log on and off the system
   g. Access graphics, point/object reports, and logs
   h. Adjust and change system setpoints, time schedules, and holiday schedules
   i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
   j. Understand system drawings, and Operation and Maintenance manual
   k. Understand the job layout and location of control components
   l. Access data from DDC controllers
   m. Operate portable user's terminals
2. Advanced Users:
   a. Make and change graphics on the user interface
   b. Create, delete, and modify alarms, including annunciation and routing of these
   c. Create, delete, and modify point/object trend logs, and graph or print these
   d. Create, delete, and modify reports
   e. Add, remove, and modify system's physical points/objects
   f. Create, modify, and delete programming
   g. Add panels when required
   h. Add user interface stations
   i. Create, delete, and modify system displays — both graphical and otherwise
   j. Perform BAS system field checkout procedures
   k. Perform DDC controller unit operation and maintenance procedures
   l. Perform user interface and peripheral operation and maintenance procedures
   m. Perform BAS system diagnostic procedures
   n. Configure hardware including PC boards, switches, communication, and I/O points/objects
   o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
   p. Adjust, calibrate, and replace system components
3. System Managers/Administrators:
   a. Maintain software and prepare backups

b. Interface with job-specific, third-party user software
c. Add new users and understand password security procedures

E. Provide course outline and materials as per “Submittals” Article in Part 1 of this specification. The instructor(s) shall provide one copy of training material per student.

F. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

G. Classroom training shall be done using a network of working controllers representative of the installed hardware.

3.11 Outdoor temperature and humidity sensors shall be mounted on the north face of the building unless otherwise approved by the Engineer. Exact location shall be approved by the Architect.

3.12 In addition to the adjustments and fine tuning, include as a part of this contract the equivalent of five (5) man days of service technician and/or programming time for work as may be specified by the Engineer.

END OF SECTION

23 09 25 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 This section describes all sensors, controllers, instruments, valves, actuators, devices, for use with the control system specified in Section 23 09 23 Building Automation System (BAS) for HVAC. All control devices (valves, dampers, actuators, etc.) shall be included.

1.2 Refer to the HVAC Drawings, Section 23 09 23 Building Automation System (BAS) for HVAC, drawings for Sequences of Operations, for sensor and device requirements.

1.3 All products used in the installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be available for at least 10 years after completion of this contract.

1.4 System shall conform to the following minimum standards over network connections:

A. Reporting Accuracy. System shall report values with the minimum end-to-end accuracy listed in Table 1.

B. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

TABLE 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5ºC [±1ºF]
Ducted Air	±0.5ºC [±1ºF]
Outside Air	±1.0ºC [±2ºF]
Dewpoint	±1.5ºC [±3ºF] (-76 to 176ºF scale)
Water Temperature	±0.5ºC [±1ºF]
Delta-T	±0.15ºC [±0.25ºF]
Relative Humidity	±5% RH (0 – 90% scale)
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized space)	±3% of full scale
Air Pressure (ducts)	±25 Pa [±0.1" w.g.]
Air Pressure (space)	±3 Pa [±0.01" w.g.]
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power factor)	±1% of reading
(see Note 3)	
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO2)	±50 ppm

Notes:
(1) Accuracy applies to 10 percent - 100 percent of scale.
(2) For both absolute and differential pressure.
(3) Not including utility supplied meters.

TABLE 2: Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa [±0.2" w.g.]	0-1.5 kPa [0-6" w.g.]
	±3 Pa [±0.01" w.g.]	-25 to 25 Pa [-0.1 to 0.1" w.g.]
Airflow	±10% of full scale	
Space Temperature	±1.0ºC [±2.0ºF]	
Duct Temperature	±1.5ºC [±3.0ºF]	
Humidity	±5% RH	
Fluid Pressure	±10 kPa [±1.5 psi]	0-1 MPa [1-150 psi]
	±250 Pa [±1.0" w.g.]	0-12.5 kPa [0-50" w.g.] differential
Differential Enthalpy	±5 kJ/kg [±3 Btu/lb]	35 – 63 kJ/kg [20-36 Btu/lb]

PART 2 - PRODUCTS

2.1 Actuators And Operators

A. Electronic Actuators

1. Actuators shall include electronics to receive the digital controllers analog position signal and maintain the position through the use of positive position feedback. Torque of the actuator shall be the working pressures of the system for valves, the total static differential of an air system, plus 30 percent safety factors. Actuator shall be UL or other approved testing agency listed. Actuators shall be manufactured by Belimo Air Controls or approved equal.
2. Electronic actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
3. Unless noted otherwise as “floating point control”, mechanical fail safe shall incorporate a spring-return mechanism to return to the device to its “normal” position on loss of power. Electronic fail safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors with a visual indication of the fail safe status on the actuator face with the power fail position field adjustable between 0 to 100 percent in 10 degree increments, an adjustable 0 – 10 second operational delay, and capable of changing the fail-safe position through an integrated switch without removing the mounted actuator.
4. All rotary spring-return actuators shall be capable of both clockwise and counter-clockwise spring-return operation. Linear actuators shall spring-return to the retracted position.
5. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
6. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not require more than 11 VA.

7. All actuators shall have an external manual gear release to allow manual positioning of the device when the actuator is not powered. Spring-return actuators with more than 7 N•m [60 in-lb] torque capacity shall have a manual crank for this purpose.
8. Actuators shall be provided with a raceway fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
9. Actuators shall be designed for a minimum of 60,000 full-stroke cycles at the actuator's rated torque.

2.2 Sensors And Transmitters

A. Any temperature or humidity sensing device mounted on an exterior wall shall be fitted with an insulated sub-base.

B. Binary Temperature Devices

1. Low-voltage space thermostats shall be 24 V, bimetal-operated type, concealed setpoint adjustment, 55 degrees F to 85 degrees F setpoint range, 2 degrees F maximum differential, and vented ABS plastic cover. Provide subbase with manual or automatic switching as required to perform the specified functions. Thermostats shall be single or multi-stage or modulating output as required to perform the functions specified.
2. Line-voltage space thermostats shall be bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, UL listed for electrical rating, concealed setpoint adjustment, 55 degrees F to 85 degrees F setpoint range, 2 degrees F maximum differential, and vented ABS plastic cover. Provide subbase with manual or automatic switching as required to perform the specified functions. Thermostats shall be single or multi-stage or modulating output as required to perform the functions specified.
3. Low-limit thermostats (freezestats). Low-limit airstream thermostats shall be UL listed, vapor pressure type or electronic type, with an element 20 ft. minimum length. Element shall cover the face of the coil at 1 ft. centers in a horizontal serpentine fashion and shall respond to the lowest temperature sensed by any 1 ft. section. When one freezestat cannot meet this requirement provide multiple freezestats. Unless noted otherwise, low-limit thermostats shall be manual reset type. For outdoor units and for indoor units where the freezestat controller is mounted more than 6 ft. above the floor, the low-limit thermostat shall be auto reset type with manual reset of its electrical circuit. Freezestats shall be supplied as DPST with one (1) set of normally closed contacts wired directly to fan circuit and one (1) set of normally open contacts to provide an alarm to the BAS.

C. Temperature Sensors
1. Temperature sensors shall be thermistors and be suitable for the application. Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degree F cumulative. A/D conversion resolution error shall be kept to 0.1 degree F. Total error for a thermistor circuit shall not exceed 0.5 degree F.
2. Duct sensors shall be single point or averaging as shown or specified. Averaging sensors shall be a minimum of 5 feet in length per 10 sq. ft. of duct cross section. Mixed air and discharge air sensors shall be averaging type.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
4. Space sensors shall be equipped with setpoint adjustment, occupancy mode override switch, display, and communication port. Thermostat cover shall be rectangular high impact ABS plastic (or equal) in a neutral cover.
5. Provide matched temperature sensors for differential temperature measurement.

6. Outdoor temperature sensors shall be platinum type and have a minimum accuracy of ± 0.5 degrees F from -40 degrees F to 140 degrees F and a measuring range from -20 degrees F to 120 degrees F. Outdoor temperature sensors shall be mounted on the north side of the building within a ventilated enclosure that protects the sensor from thermal building mass biasing, solar radiation and precipitation without affecting performance.

D. Humidity Sensors

1. Duct and room sensors shall have a sensing range of 20 percent to 80 percent. Accuracy shall be ± 3 percent of range. Accuracy shall be as stated in paragraph 1.4.
2. Duct sensors shall be provided with a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 0 percent to 100 percent RH. Accuracy shall be ± 5 percent of range. Accuracy shall be as stated in paragraph 1.4. They shall be suitable for ambient conditions of -40 degrees F to 170 degrees F. Outdoor humidity sensor shall be within a ventilated enclosure that protects the sensor from thermal building mass biasing, solar radiation and precipitation without affecting performance.
4. Humidity sensor's drift shall not exceed 1 percent of full scale per year.

E. Flow Switches

1. Flow-proving switches shall be either paddle or differential pressure type, as specified or as appropriate for the application.
2. Paddle type switches (water service only) shall be UL Listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA enclosure suitable for location.
3. Differential pressure type switches (air or water service) shall be UL Listed, SPDT snap acting, pilot duty rated (125 VA minimum), NEMA enclosure suitable for location, with scale range and differential suitable for intended application, or as specified.

F. Relays

1. Control relays shall be UL Listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200 percent (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA enclosure suitable for location when not installed in local control panel.

G. Override Timers

1. Override timers shall be electronic UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated type with LCD display unless otherwise specified.

H. Current Transformers

1. AC current transformers shall be UL/CSA recognized and completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for ±1 percent accuracy at 5 A full scale output.
3. Transformers shall be split-core type for installation on new or existing wiring.

I. Voltage Transmitters

1. AC voltage transmitters shall be self-powered single loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
2. Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with ±1 percent full-scale accuracy with 500 ohm maximum burden.
3. Transmitters shall be UL/CSA recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.

J. Voltage Transformers

1. AC voltage transformers shall be UL/CSA recognized, 600 VAC rated, complete with built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4 to 55 degrees C [40 to 130 degrees F] and shall provide ±0.5 percent accuracy at 24 VAC and a 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic material.

K. Surge and Transient Protection

1. Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.
2. Power Line Surge Protection
    a. Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:
        1) The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.
        2) The device shall react within 5 nanoseconds and automatically reset.
        3) The voltage protection threshold, line to neutral, shall be no more than 211 volts.
        4) The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.
        5) The primary suppression system components shall be pure silicon avalanche diodes.
        6) The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.
        7) The device shall have an indication light to indicate the protection components are functioning.
        8) All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.
        9) The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.
        10) The device shall comply with IEEE C62.41, Class "B" requirements and be tested according to IEEE C62.45.
        11) The device shall be capable of operating between -20 degrees F and +122 degrees F.
3. Telephone and Communication Line Surge Protection
    a. Provide surge and transient protection for DDC controllers and BAS network related devices connected to phone and network communication lines, in accordance with the following:
        1) The device shall provide continuous, non-interrupting protection, and shall automatically reset after safely eliminating transient surges.
        2) The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology.
        3) The device shall be installed at the distance recommended by its manufacturer.

4. Controller Input/Output Protection
   a. Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

L. Current Switches and Relays

1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the BAS.
2. Current relays for fan or pump proof shall be fully adjustable from 1.5 amps to 150 amps and shall have L.E.D. indicators. Form "A" (normally open) relays shall not be polarity sensitive. Current relays shall accommodate variable frequency drive outputs down to 6 HZ without contact chatter. Motor loads of less than 1.5 amps shall be multi-wound around current relay to increase "sensed" amperage to minimum setpoint for activation.

M. Pressure transducers

1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.
3. Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 1 - 5vdc or 4 to 20 mA output, required mounting brackets, and block and bleed valves.
4. Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 1 – 5vdc or 4 to 20 mA output, required mounting brackets, and five-valve manifold.
5. Air velocity pressure sensors shall use differential pressure to determine airflow rate and have repeatability within 1 percent of reading and an accuracy of ± 5 percent of range. The velocity range shall be from 0 to 3250 FPM.

N. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as shown.

O. Airflow measuring stations shall be provided on supply and exhaust fan of air handling units, as shown on the drawings and specified herein, utilizing electronic air flow traverse probes and transmitters designed to continuously monitor duct airflow volume or fan inlet volume as dictated by the application. Each airflow measurement system shall consist of single or multiple probes with velocity measuring sensors and elements designed and built to comply with accepted practice for traversing as defined in the most current ASHRAE Handbook of Fundamentals. The minimum number of sensing points on each element, and the quantity of elements utilized at each installation, shall comply with ASHRAE Standard 111 for equal area traversing. Sensors may utilize the principles of thermistor technology with temperature compensation, high precision pitot tube technology, or vortex shedding provided that the performance specified below can be achieved. Signal amplifying sensors requiring flow corrections for field calibration are not acceptable.

Fan inlet airflow stations for supply and return and exhaust air shall include flow transducers with minimum .25 percent full-scale accuracy signal processors. The minimum accuracy shall be 2.0 percent of reading or better thru a velocity range of 500-8000 fpm.

P. Heat Tracing System

1. All outdoor piping associated with the air-cooled chillers shall be heat traced for freeze protection. The system shall be engineered by Raychem, Delta-Therm, or Indeeco. System shall include, but not limited to, Raychem XL-TRACE or equal self-regulating plastic insulated resistance cables having heating density as recommended by the manufacturer for the application, power distribution panel containing ground fault circuit breakers (minimum one for each chiller system), one or more electronic monitoring panels that monitors each heat trace circuit's ground fault status and the integrity of the heat trace circuit (high and low current) and shall include contacts for remote monitoring thru the B.A.S.

2. Installation shall be in strict accordance with the manufacturer's recommendations, including wrapping with insulating tape. Extend power from the emergency power panel as directed coordinated with Division 26. Provide all wiring, transformers, etc… for a complete and operational system.

Q. Local control panels

1. All indoor control cabinets shall be fully enclosed NEMA construction, suitable to the installed location, with [hinged door], key-lock latch, removable sub-panels. A single key shall be common to all field panels and sub-panels. Panels shall be unitized design for transducers, relays, gauges, etc.
2. Interconnections between internal and face-mounted devices pre-wired with color coded stranded conductors neatly installed in plastic troughs and/or tie wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power source to each local panel.
4. Provide 120V receptacle at each local panel location.

2.3 Control Valves

A. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown or specified herein or in 23 09 93.

B. All control valves shall be selected and rated for the duty imposed, sized per sizing criteria subparagraph, and in accordance with the manufacturer's published literature.

C. Valves shall be equipped with a manual positioner to allow positioning of the valve in the absence of control power.

D. Ball Valves 2.0 inches and smaller, 0.01% percent leakage rate for port connected to coil, specifically designed for modulating hydronic service and ISO 9001 compliant:

1. Body
   a. ANSI B16.5 Class 150
   b. Cast bronze or brass
   c. Threaded (FNPT) or soldered connections
2. Bonnet
   a. Brass
   b. Packing: Reinforced Teflon or carbon filled Teflon and EPDM O-ring
3. Trim
   a. Stem: Stainless Steel
   b. Ball: Stainless Steel, equal percentage flow characteristic or modified equal percentage flow characteristic.
   c. Seat: Reinforced Teflon or carbon filled Teflon

E. Globe Valves 2.0 inches and smaller

1. Body
   a. ANSI B16.15 Class 125 and 250
   b. Cast bronze or brass
   c. Threaded (FNPT), union sweat, or flared connections
2. Bonnet
   a. Brass
   b. Packing: Self-adjusting Ethylene Propylene Rubber (EPR) ring pack u-cups, Spring loaded PTFE and Elastomer V-rings, or spring loaded Teflon cone
3. Brass Trim
   a. Stem: Stainless Steel
   b. Plug: Brass, equal percentage flow characteristic or modified equal percentage flow characteristic
   c. Replaceable Seat: Brass against molded Elastometric disc, or bronze

F. Globe Valves 2.5 inches and larger

1. Body
   a. ANSI B16.1 Class 125 and 250
   b. Cast Iron with black lacquer finish
   c. Flanged connections
2. Bonnet
   a. Brass
   b. Packing: Ethylene Propylene Terpolymer (EPT) ring packs, EDPM O-ring, or spring loaded Teflon cone
3. Trim
   a. Stem: 316 Stainless Steel
   b. Plug: Brass, equal percentage flow characteristic or modified equal percentage flow characteristic
   c. Replaceable Seat: Bronze

G. Butterfly Valves 2.5 inches to 12.0 inches

1. Valves shall be equal to Type A1, A2 or A4 as listed in 23 05 23 General Duty Valves, with additional features defined below.
2. Bubble-tight shut-off.
3. 2-position control only.

H. Close-off Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

1. Water Valves:
   a. Two-way: 150 percent of total system (pump) head.
   b. Three-way: 300 percent of pressure differential between ports A and B at design flow or 150 percent of total system (pump) head, whichever is greater.

I. Sizing Criteria

1. Water Valves:

   a. When selecting control valves for a specified Cv, the control valve supplier/manufacturer shall take into account the piping geometry effect on the Cv performance value, and include with the shop drawings.
   b. Control valves shall be selected to provide minimum .25 valve authority. Submit calculations for review.

c. Two-position service: line size.
d. Two-way modulating service: minimum .25 valve authority but maximum 10 ft.hd. w.p.d. unless otherwise noted on plans.
e. Three-way Modulating Service: minimum .25 valve authority but maximum 10 ft.hd. w.p.d. unless otherwise noted on plans.

PART 3 - EXECUTION

3.1 Examination

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Examine the project drawings and specifications. If head room or space conditions appear inadequate, or if any discrepancies occur between the plans and the temperature controls work and the plans and the work of others, then report these discrepancies to the Engineer and obtain written instructions for any changes necessary to accommodate the temperature controls work with the work of others. Any changes in the work made necessary by the failure or neglect to report such discrepancies shall be made by and costs borne by this Contractor.

3.2 Installation of Sensors

A. Install all sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Mixed air temperature sensors shall be located a minimum of 12 inches in front of 1st downstream coil (to prevent false reading of M.A.T.).

F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across face area. Each bend shall be supported with a capillary clip.

G. Low limit thermostats (freezestats) shall be installed in a serpentine manner horizontally across the coil face at 1 ft. centers. Each bend shall be supported with a capillary clip. Provide minimum 1 ft. of sensing element for each 1 ft. of coil area. Freezestat controller shall be located outside of airstream and installed in strict accordance with manufacturer’s instructions. For freezestats with auto-reset (refer to para 2.2-B.3 or control sequences), provide indoor NEMA 1 panel to house latching control relay, with reset button and light on face of panel. The latching relay shall have separate contacts for latching circuit (N.O.), AHU / fan safety circuits (N.C.) and DDC alarm input (N.O.). The circuit shall be arranged to automatically reset after power failure. For outdoor units, mount panel in mechanical room. For indoor units, mount panel on or near associated AHU.

H. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells. All duct mounted sensors in externally insulated ducts shall be installed in insulated J-boxes (or J-boxes with 1 inch thick ductboard between it and duct) to afford access (and not be covered with insulation).

I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

J. Differential Air Static Pressure

1. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable), or to the location of the duct high-pressure tap and leave open to the plenum.
2. Return Duct Static Pressure: Pipe the low-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor.
3. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover at the specified location. Outdoor air pressure sensing points shall be located on each side of the building and piped together in a common manifold.
4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.3 Flow Switch Installation

A. Use correct paddle for pipe diameter.

B. Adjust flow switch in accordance with manufacturer’s instructions.

3.4 Actuators

A. Mount and link control damper actuators per manufacturer's instructions.

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.
4. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degrees available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
5. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.5 Local Control Panels

A. Local control panels shall be provided for the equipment being controlled. Panel shall be mounted in mechanical, electrical rooms or electrical closets. Mount panels on wall, columns or independent supports near each respective unit. Do not mount on the unit proper unless the unit has internal jam isolation and the control panel and unit have been designed for direct mounting.

3.6 Identification of Hardware And Wiring

A. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2 inches of termination with the DDC address or termination number.

B. Permanently label or code each point/object of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 0.50 inch letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to terminal box or valves with nameplates.

F. Manufacturers' nameplates.

G. Identifiers shall match record documents.

H. Upon completion of the project, furnish a complete set of these drawings and diagrams, framed under clear plastic, and hang on the wall of the Mechanical Equipment Room where directed.

END OF SECTION

23 09 47 CONTROL POWER AND WIRING FOR HVAC

PART 1 - GENERAL

1.1 Provide all electrical wiring, both line voltage and low voltage, which is required to perform the automatic control functions.

1.2 Where power sources are required beyond sources explicitly shown on the Division 26 drawings, these shall be provided under the Division 23 Contract. Where auxiliary contacts are required on starters to perform the required functions these, too, shall be provided under the Division 23 Contract. Where not provided under Division 26, auxiliary external relays may be provided in lieu of auxiliary contacts.

1.3 Wiring, both line and low voltage, shall comply with The National Electric Code (NEC) and shall be subject to approval of the local code enforcing authorities.

1.4 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

1.5 Install all equipment in readily accessible locations as defined by the National Electrical Code (NEC).

1.6 Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

1.7 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

1.8 Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.

1.9 All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 5 cm [2 inches] of termination with the DDC address or termination number.

1.10 Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible. Where communication wire must cross high power wire (deemed as 110VAC or greater) it must do so at right angles.

1.11 All shields shall be grounded (earth ground) at one point only to eliminate ground loops. All shield grounding shall be done at the controller location with the shield at the sensor/device end of the applicable wire being left long and “safed” off in an appropriate manner.

1.12 There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted pairs (24awg) in accordance with the manufacturer’s wiring practices.

PART 2 - PRODUCTS

2.1 Wire, conduit and installation methods shall conform to applicable provisions of Division 26 - Electrical except that wiring smaller than No. 12 and conduit smaller than 0.75 inch are permitted as appropriate for the application.

2.2 Communication wire shall meet the following requirements as a minimum. Control system manufacturers recommendations which exceed these requirements shall govern.

A. Category 6 plenum rated, 4 twisted pair, non-shielded (UTP) station cable (capable of transmission speeds up to 100 Mb/s) shall be used for control system networking. Cable shall be insulated with FEP material and sequentially marked at 2 foot intervals. Color as selected by Owner.

Gauge	24 AWG
Nominal O.D.	.17 in.
Min. Bend Radius	.5 in.
Standards/Certification	UL 444, UL 13 EIA/TIA 568, Cat. 5 PN-2841
DC Resistance	9.38 ohm/100 m
Maximum mutual capacitance of a pair @ 1 Khz	5.6 nF/100 m
Unbalanced Capacitance per pair to ground @ 1 Khz	330 pF/100 m
Impedance	100 ohm ± 15%
Structured Return Loss 10/100 Mhz	23/16 dB/100 m
Attenuation (max at 100 m)	4.1 dB @ 4 Mhz 8.2 dB @ 16 Mhz 22.0 dB @ 100 Mhz
NEXT (min. at 100 m)	53.0 dB @ 4 Mhz 44.0 dB @ 16 Mhz 32.0 dB @ 100 Mhz
Propagation Delay (min. @ 10 Mhz)	5.7 ns/m

2.3 Wiring and raceways

A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.

B. All insulated wire to be copper conductors, UL labeled for 90 degrees C minimum service.

C. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

D. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

E. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

F. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

G. Sensor and/or signal cabling for controller I/O shall be multi-conductor type, stranded copper conductors, shielded, with plenum rated outer jacket. Conductor size shall be as recommended by the manufacturer for cable length and device power consumption.

2.4 Provide an Uninterruptible Power Supply system battery backup for each controller and its respective input/output devices. Circuits for VAV DDC controllers and other unitary type controls

need not be on backup power. Uninterruptable Power Supply shall protect against blackouts, brownouts, surges and noise.

A. Uninterruptable Power Supply shall include LAN port and modem line surge protection.

B. Uninterruptable Power Supply shall be sized for a 7-minute full load runtime, 23-minute ½ load runtime, with a typical runtime of up to 60 minutes. Transfer time shall be 2 – 4 milliseconds or less.

C. Uninterruptable Power Supply shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90 percent recharge capability in 2 – 4 hours. Suppression response time shall be instantaneous. Uninterruptable Power Supply low voltage switching shall occur when supply voltage is less than 94 volts.

D. Provide a maintenance bypass switch that allows input voltage to bypass the Uninterruptable Power Supply and directly power the connected equipment if an abnormal condition prevents the Uninterruptable Power Supply from supporting the load, or if the Uninterruptable Power Supply is required to be taken out of service. Provide all software, cables, peripherals, etc. for a complete system.

PART 3 - EXECUTION

3.1 All line voltage wiring and low voltage wiring (except as stated below) shall be run in conduit. Low voltage wiring concealed above accessible ceilings may be run without conduit. Open wiring dropping into walls shall be run in conduit. Thermostats shall be installed on a single gang box and conduit shall be installed to extend into the plenum. Open wiring shall be bundled and supported at 3 ft. maximum intervals with a system of J-hooks. Open wiring in air plenums shall be rated for such use and so labeled.

3.2 Thermostats and other wall mounted sensors shall be installed on a single gang box. EMT conduit shall be installed from the wall box to the plenum; cabling within the wall shall be in conduit.

3.3 Provide electrical circuits from the nearest appropriate electrical panel to serve control panels, transformers, and other control equipment and devices. Circuits serving control panels and transformers for low voltage service shall be independent and used for no other purpose. Provide circuit wiring from the electrical panel. These circuits shall be clearly identified at the panels. Coordinate with Division 26.

END OF SECTION

23 21 13 HYDRONIC PIPING

PART 1 - GENERAL

1.1 Hydronic piping systems (hot water, chilled water, condenser water, condensate drainage, etc.) shall be as shown on the drawings and as specified herein. Systems shall include piping, valves, system specialties and accessories.

1.2 Piping systems shall conform to ANSI and State rules for pressure piping where applicable. Welders and fitters shall be fully certified for work performed.

1.3 Safety valves and all pressure vessels shall bear the appropriate ASME label.

1.4 Refer to Section 23 05 07 Piping Materials and Methods, Section 23 05 23 General Duty Valves for HVAC Piping, Section 23 05 29 Hangers and Supports for HVAC Piping and other related sections for required provisions.

PART 2 - PRODUCTS

2.1 Pipe, fittings and joints for the hydronic systems shall be as listed below and as described in Section 23 05 07 Piping Materials and Methods.

2.2 Piping for the various service shall be:

A. Hot water and chilled water (including glycol system).

1. Piping 2.5” and larger - Black Steel - Type S1.
2. Piping 4” and smaller - Copper – Type C1.

B. Cooling Condensate drainage.

1. Copper – Type C4.

2.3 General duty valves for the various services shall be as listed below and as described in Section 23 05 23 General Duty Valves for HVAC Piping:

A. Shutoff

1. Butterfly - Type A1.
2. Ball - Type B1, B3.

B. Check

1. Swing - Type C1, C2.
2. In-line Spring - Type C3, C4. Shall be used on pump discharges and in upward flow vertical locations.

Note that check valves of any type shall never be installed in downward flow positions. Revise piping layout to allow for a horizontal or vertical upwards flow position.

C. Balancing Shut-off - Type E1, E3.

D. Automatic Flow Controllers – Type F1.

2.4 Hydronic Specialties

E. Air vents shall be automatic type unless specifically noted to be manual. Air vents shall be:

1. Large capacity automatic type for installation on boiler or air removal fitting, equal to Hoffman 792 150 psig operating pressure rating. Provide a ball valve on the inlet pipe and pipe the outlet to the nearest drain.
2. Large capacity automatic type, 150 psig operating pressure rating, equal to Hoffman 78. For use on air handling unit coils and on main piping. Provide a ball valve at inlet of each vent. Pipe outlet to nearest drain point with 0.125 inch ID copper tube.
3. Small capacity manual automatic with screwdriver stop, 50 psi, equal to Hoffman 500, for use on room heating and cooling units, VAV unit heating coils and duct heating coils.
4. Manual air vent – 0.25 inch ball valve. Elbow down to facilitate catching of water during manual venting.

F. Strainers shall be 125 lb. wsp "Y" pattern cast iron construction with removable stainless steel strainer element and screwed or flanged ends. Strainer elements shall be 20 mesh for 2 inches and smaller, 0.0625 inch for 2.50 inches, 3 inches and 4 inches and 0.125 inch for larger sizes. Refer to Part 3 for blow-down valves.

G. Combination valves and devices such as Bell & Gossett Triple Duty Valve (check, balancing and shutoff) for installation on pump discharge are acceptable in lieu of individual components, furnished by pump manufacturer.

H. Pump suction diffusers for inlet condition enhancement shall be equal to that manufactured by Bell & Gossett, furnished by pump manufacturer.

PART 3 - EXECUTION

3.1 Drawings (plans, schematics and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, pipe expansion, pump sizing and other design considerations; therefore, it is imperative that piping be installed as indicated. However, deviations shall be anticipated & expected to accommodate field conditions and as such deviations shall be submitted in writing/diagram form for review by the Engineer prior to installation.

3.2 Refer to Section 23 05 01 Basic HVAC Requirements and other equipment sections for system cleaning and flushing requirements.

3.3 Refer to Section 23 05 07 Piping Materials and Methods for installation of piping and accessory devices and equipment.

3.4 Pump suction diffuser start-up strainers shall be removed after initial circulation and cleaning of the system.

3.5 For renovated systems and new systems connecting to existing it shall be anticipated that the existing systems will affect the new systems as far as cleanliness and therefore strainers shall be monitored/flushed daily, or more frequently if needed, until the systems are determined to be clean.

3.6 Air vents shall be installed at high points of piping and system, on each heating coil and cooling coil and at other locations subject to air binding. Air vents shall be installed in locations accessible for servicing. A shutoff valve or cock on the inlet and drain tubing extending from the vent discharge shall be provided for each large capacity automatic vent. The drain tube shall be extended to a drain location (floor drain, janitor sink, etc.) or, in mechanical rooms, turned down over a clear area of the floor to afford notice by maintenance personnel.

3.7 Install strainers as indicated on the drawings. Provide a nipple and ball valve in the blow down connection of each strainer 2 inches and larger.

END OF SECTION

23 21 17 GLYCOL SOLUTION SYSTEM

PART 1 - GENERAL

1.1 The chilled water piping system shall be filled with a factory mixed solution of propylene glycol and water, 30 percent by volume.

1.2 Refer to the 23 21 13 Hydronic Piping for work related to this system.

PART 2 - PRODUCTS

2.1 Propylene glycol shall be Industrial Grade quality with corrision inhibitor formulation for HVAC, , Dow Chemical Industrial Grade or equal by Protocol, Interstate Chemical or Union Carbide. The freeze protection fluid shall be factory mixed with deionized water to the desired concentration and furnished in drums. Note: because the piping system and components cannot be 100% drained after flushing and cleaning, the pre-mixed glycol solution shall account for this and be 5-10% higher in concentration than that specified, as recommended by the glycol supplier. The solution shall contain a fluorescent dye to facilitate easy leak detection.

PART 3 - EXECUTION

3.1 Before introduction of the solution, the piping shall be thoroughly cleaned and prepared in strict accordance with manufacturer's recommendations. Provide valved inlet connections, sampling valves, air vents, etc. Pump the solution into the piping, bleed air manually, circulate and test for correct concentration.

3.2 Excess solution in the specified concentration, 50 gallons minimum, shall be turned over to the Owner in sealed, opaque shipping containers placed where so directed by the Owner.

END OF SECTION

23 21 23 HYDRONIC PUMPS

PART 1 - GENERAL

1.1 Circulating pumps shall be pipe mounted and base mounted end suction centrifugal pumps as described below and as shown on the drawings.

1.2 Pumps shall be tested and rated in accordance with Hydraulics Institute standards. Pumps shall comply with and be labeled with the Department of Energy mandated Pump Energy Index (PEI). Pumps with a PEI greater than 1.0 will not be accepted. Shop drawing submittals shall include the PEI values or will be subject to rejection without further review.

1.3 Impellers shall be statically and dynamically balanced after being shaved for the specified duty.

1.4 Equipment shall carry an all-inclusive manufacturer's parts and labor warranty for a period of one (1) year(s) from date of final acceptance or date of beneficial use, as agreed to between Contractor and Engineer. The all-inclusive parts and labor warranty for ECM's and associated controllers shall be for a period of 5 years. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner, including any required replacement of fluids, glycol, or refrigerant. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer's authorized service agent.

PART 2 - PRODUCTS

2.1 Induction motors shall be "premium efficiency" series motors. Motors shall be 1750 rpm unless specifically noted otherwise. Motors shall be sized to not overload or enter into the service factor area at any point on the operating curve of the pump. Submittals shall include pump curves. Drives and couplings shall be protected with guards conforming with OSHA standards. Motors connected to VFD's shall comply with 23 05 13 Electrical Requirements for HVAC Equipment and shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer. Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment. Motor enclosure shall be selected to suit the application.

2.2 Horizontal in-line pipe mounted pumps shall be centrifugal type with horizontal motor axis as shown on the drawings. Each pump shall be bronze fitted with cast iron casing, brass or bronze impeller, oil lubricated sleeve or ball bearings, mechanical seals, flanged ends and direct connected motor with flexible connector and EC motor. Pumps shall be Bell & Gossett Series 60-ECM or equal by Armstrong, Patterson, or Grundfos/Peerless/Paco, or Taco.

2.3 Base mounted end suction pumps shall be centrifugal type with flexible coupling, motor and channel steel or cast iron base with "back pull out" design. Each pump shall be bronze fitted with cast iron casing, stainless steel or bronze impeller, grease lubricated ball bearings, mechanical seals and flanged pipe connections (except pumps 2 inches and smaller may be threaded end). Pumps shall be Bell & Gossett Series e-1510 or equal by Armstrong, Patterson, or Grundfos/Peerless/Paco, Taco.

2.4 Furnish a spare pump seal for each type and size of pump except, for split case pumps furnish a spare set of seals.

PART 3 - EXECUTION

3.1 Each base mounted pump shall be set on and secured to a concrete base. Installation of the pump, including grouting of base and alignment of pump and motor, shall conform to manufacturer's recommendations.

3.2 Pumps with E.C. Motors shall be commissioned and set-up by a factory authorized technician to meet project requirements, and interface coordinated with the B.A.S.

3.3 Provide an in-line spring actuated center guided silent type check valve in the discharge piping of each pump.

END OF SECTION

23 23 00 REFRIGERANT PIPING

PART 1 - GENERAL

1.1 Refrigerant piping and related devices shall be provided extending between indoor and outdoor split systems.

1.2 Refrigerant piping shall conform to ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition.

1.3 Pipe arrangement, devices and sizing information shown on the drawings is limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Drawings shall be submitted to the Engineer for review with the equipment shop drawings.

1.4 The equipment supplier shall provide piping installation instructions to the Installing Contractor and supervision as needed to ensure that the piping system is installed in accordance with the equipment manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 Refrigerant tubing shall be Type "ACR" hard seamless copper thoroughly cleaned and dehydrated for use with the refrigerant used. Tubing which has not been so prepared and sealed or which has been open to the atmosphere for any length of time shall not be used. All changes in direction of piping shall be made with wrought copper fittings.

2.2 Refrigerant piping may be soft copper pre-charged refrigerant tubing with compatible end connections as may appropriate for project conditions.

2.3 Refrigerant devices and specialties shall be specifically designed for refrigerant applications and of construction pressure class consistent with the duty imposed.

A. A filter-drier and moisture indicator - sight glass shall be provided in the liquid line near the condensing unit or evaporator coil.

B. A thermal expansion valve shall be provided in the liquid line at each evaporator coil if an expansion valve or device is not integral with the unit. The expansion valve shall be diaphragm type with external equalizer and external superheat adjustment.

C. A liquid line electric solenoid valve or a "hard shutoff" thermal expansion valve shall be provided where the liquid line exceeds 50 ft. in length.

D. All refrigerant access ports shall be fitted with locking-type tamper-resistant caps.

PART 3 - EXECUTION

3.1 Pipe arrangement, devices and sizing information shown on the drawings is schematic in nature, limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Exact routing, and pipe quantities and sizing shall be per manufacturer’s requirements. Refrigerant piping shall conform to

ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition. Drawings shall be submitted to the Engineer for review with the equipment shop drawings. Exact routing, and pipe quantities and sizing shall be per manufacturer's requirements.

3.2 All joints shall be brazed using silver brazing alloy while flowing an inert gas such as dry nitrogen through the piping.

3.3 Piping shall be hung from the building structure with clevis hangers and rods as described in 23 05 29 Hangers and Supports for HVAC Piping. Hangers for insulated pipe shall be oversized and a sheet metal saddle with belled ends incorporated to protect the insulation.

3.4 Each refrigerant piping system shall be 24-hour positive-pressure leak tested with dry nitrogen at 600 psi, and then 24-hour negative-pressure tested to between 200 and 500 microns, or per equipment manufacturer's requirements, whichever is more stringent. The test pressures shall be demonstrated to be maintained for at least 24 hours for each pressure test, with starting and ending pressures recorded and documented. A system shall be considered "proven-tight" when there is no more than a 40 psig loss during the positive-pressure test, and no more than a 50 micron rise for the negative-pressure test. If a test fails, triple nitrogen purge and repeat the test after the leak has been repaired. Once a system has been "proven-tight", the system shall then be purged and charged with the required amount of refrigerant per the equipment manufacturer's instructions.

END OF SECTION

23 31 13 HVAC DUCTWORK

PART 1 - GENERAL

1.1 Ducts, sheet metal plenums and associated devices, accessories and work items shall be provided as shown on the drawings and as specified hereinafter.

1.2 Ductwork, materials, construction, reinforcing and installation shall conform to SMACNA HVAC Duct Construction Standards, latest edition, and other applicable SMACNA standards. In addition, duct systems, components and accessories shall comply with applicable provisions of NFPA 90A, 90B, 96 and 255, and UL 181, 181A, and 181B, including smoke and flame ratings.

1.3 Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 Refer to the Duct Construction and Sealing Schedule on the drawings for information pertinent to the various duct systems, such as duct materials, SMACNA pressure class, seal and leakage class, external insulation, duct liner, etc.

1.5 Refer to the drawings for ductwork that is to be internally lined. Ductwork shall only be internally lined where scheduled or noted on the drawings.

1.6 Ductwork shall not be internally lined, unless shown otherwise for return or exhaust.

1.7 Refer to 23 05 05 Firestopping for requirements related to non-fire dampered ductwork penetrating fire rated walls and partitions, and to 23 07 14 Fire Barrier Wrap for ductwork requiring such products.

1.8 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Sheet metal shall be lock forming quality galvanized steel, ASTM A924/A924M and A653/A653M, G90 coating designation, 24 gauge minimum, except as otherwise noted or specified. Other materials and construction for special applications required are as shown on the drawings and specified below.

2.2 Ductwork that will remain exposed in finished areas which will be painted shall be fabricated of sheet metal with galvannealed or bonderized (phosphated) coating.

2.3 Flexible duct shall be installed as detailed on the drawings and shall not pass through any wall, floor, or ceiling. Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly.

A. Flexible air (duct) connectors for galvanized steel ductwork shall be:

Constructed of galvanized steel spiral wire mechanically locked to an airtight laminated aluminum foil, fiberglass and aluminized polyester duct fabric. Duct shall be rated at a minimum of 10 inches w.c. positive pressure and 4 inches w.c. negative pressure. Unless otherwise detailed on the drawings, length shall be limited to 4 feet for Air Terminal Units and 5 feet for Air Devices .

Insulated flexible duct shall have 1 inch thick R-4.2 fibrous glass insulation and .10 perm polyethylene vapor barrier outer jacket, equal to Flexmaster Type 5B or. Insulated duct assembly shall conform to be UL 181 and listed as Class I Flexible Air Connector.

Non-insulated flexible duct shall be equal to Flexmaster NI-55, shall conform to UL181 and be listed as Class I Flexible Air Connector.

2.4 Interior liner for acoustical and thermal insulating purposes shall be 1 inch thick elastomeric foam. The interior (airside) surface shall be coated with an acrylic polymer to protect the liner material from cuts and abrasions. The liner shall be treated with an EPA registered preservative to reduce the potential for microbial growth. The liner shall be free of formaldehyde. Noise Reduction Coefficient (NRC) for the liner shall be 0.60 or better, and the R-value shall be 3.5 or greater. Liner shall not exceed 25/50 for flame spread/smoke developed per ASTM E84. Liner shall be rated for air velocities up to 5000 feet per minute and operating temperatures up to 180 degrees F. Note that duct sizes indicated on the drawings are inside clear dimensions, and that the sheet metal dimensions are 2 inches greater in each dimension. Liner shall be Solcoustic Duct Liner as manufactured by Evonikk Industries, or AP Coilflex as manufactured by Armaflex.

2.5 Rectangular Ductwork

A. Exterior rectangular duct shall be double wall aluminum sealed for exterior use with aluminum solid liner and 2 inches thick R-7.4 fiberglass insulation, United McGill Acousti k27, weatertight and designed for exterior installation, or equal by Langdon, Semco, Tangent Air, Precision Duct or approved equal. Fittings shall be aluminum double wall insulated with aluminum solid liner, of weathertight construction designed for exterior installation. Duct sizes list on the drawings are inside clear dimensions.

B. Elbows shall have an inside radius equal to the duct width. Where 90 degrees elbows are shown to be square on the drawings, they shall be square (mitered) with turning vanes, single vane type in lengths 32 inches and less, double wall in longer vanes, installed and supported per SMACNA. Elbows less than 90 degrees shall be radiused. Non-radiused elbows less than 90 degrees, with or without turning vanes, are not permitted.

C. Square Tee fittings shall include turning vanes. The widths of the two branch ducts shall add up to the width of the main duct, and the duct depths shall remain constant. Turning vanes shall be single vane type in lengths 32 inches and less, double wall in longer vanes, installed and supported per SMACNA.

D. Offsets and transitions shall conform to SMACNA. Unless shown otherwise on plans, transition angles shall be limited to 60 degrees on converging transitions as measured on the interior, and 30 degrees on diverging transitions as measured on the interior.

E. Branch take-offs, where not detailed otherwise, shall be with a static boot (45 degrees clinch collar) per SMACNA. Straight tap take-offs are not permitted.

F. Divided flow branches shall conform to SMACNA. Bull head tees without vanes are not permitted.

G. Manufactured duct connectors similar to Ductmate Industries “25”, “35” and “45” may be used on rectangular ductwork except where welding or brazing is specifically required. Adhere strictly to manufacturer’s instructions. SMACNA duct gauge thickness and reinforcing shall be maintained when using this joining method, or the manufacturer’s requirements, whichever is more stringent. Connector components shall be constructed from same material as the duct section being connected.

2.6 Fan Transitions

A. Fan inlet – Maximum 15 degrees diverging as measured on the interior, and 30 degrees converging as measured on the interior, and first duct elbow shall be minimum 2.5 fan inlet diameters away unless shown otherwise on plans.

B. Fan Discharge -- Maximum 15 degrees diverging as measured on the interior, and 30 degrees converging as measured on the interior, and first duct elbow shall be minimum 2.5 fan inlet diameters away unless shown otherwise on plans

2.7 Round and Flat Oval Ductwork:

A. Round and flat oval duct shall be factory or shop formed spiral lock seam, United McGill Air Products "Uni Seal" or equal by Langdon, Semco, Tangent Air, Precision Duct or approved equal.

B. In lieu of the above, round duct, fittings and connectors may be Linx Industries' Lindab "Safe" (single wall) or "ISOL" (double wall) duct systems with fitting ends factory equipped with double lipped "U" profile EPDM gasket. Spiral ducts shall conform to Lindab standards and shall be calibrated to published dimensional tolerances of Lindab. Insulation R-valves and liner types shall be as specified above.

C. Construction, reinforcing, supports, etc. shall either conform to SMACNA or to the duct manufacturer's standards, whichever is more stringent.

2.8 Air device duct connections for round duct branch connections to rectangular sheet metal ducts shall be 24 gauge sheet metal, equal to Flexmaster Series FL, straight side, minimum 24 gauge with and without manual damper, as described on the drawings. When manual damper is provided it shall be minimum 22 gauge with stamped re-enforcements and include .375" square shaft and locking quadrant equal to Ventlok 639 or Rossi "Everlock", with 2" standoff and nylon bushings. Air terminal unit duct connections for round duct branch connections to rectangular sheet metal ducts shall be 24 gauge sheet metal conical type equal to Flexmaster Series CB. Connectors installed on interior lined rectangular duct shall have an integral insulation guard sleeve. Rectangular tap-to-round branch connection with static boot configuration shall be equal to Flexmaster Type STO. Similar fittings equal to Flexmaster Series DB and DC shall be used for fiberglass ductboard system. Buckley "Air Tite" fittings or similar by "Snap Rite", equal to the specified Flexmaster fittings, with neoprene gasket and adhesive facing, additionally secured with minimum four sheetmetal screws, may be used for air device duct taps to rectangular sheet metal duct which is not internally lined.

2.9 Duct sealants containing asbestos are prohibited. All duct sealants, tapes and connectors shall be listed and labeled in accordance with UL 181A, 181B or 181C as applicable to the application. Duct sealant materials shall be one or more of the following (compatible with the application):

A. Water base duct sealers and mastics equal to United McGill or Foster Products when the installation environment is above 40 degrees F.

B. Acetone based duct sealers and mastics, equal to Precision Adhesives, when the installation environment is between 0 degrees F and 40 degrees F, zero reportable V.O.C.'s.

C. Mineral impregnated fiber tape with liquid sealant duct joint sealer equal to that manufactured by Hardcast, Inc., Two Part II Sealing System, maximum V.O.C. of 135 g/l.

2.10 Duct Access Doors (Non-Grease Ducts)

A. Access doors shall be factory fabricated constructed of the same material as the ductwork (except galvanized sheet metal for fiberglass duct), complete with hinged door, cam lock latches, frame and neoprene gasket between door and frame. Doors in insulated ductwork

(internal and external) shall have double wall insulated doors. Access doors shall be 16 inches x 16 inches minimum except smaller where duct size will not permit such size.

B. Access doors and panels shall be designed to provide tight seal commensurate with the duct pressure. Apply duct sealer or rubber gasket between frame and duct. On ducts of 3 inches S.P. and higher construction class, mechanical fastening of the frame and rubber gasket shall be provided.

C. Where sufficient clearance is not available to allow the door to swing open 90 degrees, an access panel with neoprene gasket, frame, chain connected to both the panel and ductwork, and cam lock latches on all four sides shall be provided in lieu of the hinged door.

2.11 Plenum access doors shall be factory fabricated and as described for duct access doors except that doors shall be 18 inches x 48 inches (unless otherwise noted) with overlapping frame, continuous piano hinge and heavy duty latches (with lever on both outside and inside) equal to Ventfabrics "Ventlok No. 202. Two latches shall be provided except on doors 50 inches and higher three shall be provided. Frame shall be mechanically fastened to the plenum wall.

2.12 Ductwork that crosses building seismic joints or expansion joints shall be fitted with flexible connectors that will accommodate the building movement in all directions. Refer to structural drawings for required displacements. Connectors shall be manufactured by Mercer Rubber or approved equal, multiple plies and arches of elastomer-impregnated fabric or cord, EPDM construction with mounting flanges, all rated for 250 degrees F service at pressure rating consistent with the associated duct system. Refer to duct construction schedule. Grease ductwork shall not be fitted with flexible connectors.

PART 3 - EXECUTION

3.1 Duct thickness, construction, reinforcing, support and installation including cabling systems, shall conform to SMACNA HVAC Duct Construction Standards, latest edition and other applicable SMACNA standards. Cable support systems are not allowed. Duct reinforcing shall be external to the duct except that rectangular ducts of 3 inches s.p. class or greater with a dimension exceeding 48 inches may utilize internal tie-rod supports in accordance with SMACNA. Only round tubing, rods or conduit is permitted as tie-rods, utilizing the minimum diameters required by SMACNA.

3.2 Transverse joints and longitudinal seams shall be assembled with sealant to conform to SMACNA sealing requirements as indicated in the Duct Construction Schedule on the drawings. Selection of sealant materials shall be compatible with the application. Sealants shall be applied in accordance with manufacturer's recommendations, including application temperature ranges.

3.3 Attachment of hangers and straps to the structure shall be with:

A. After-set concrete inserts, in 4 inches minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

B. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment.

C. Unistrut type channel support system may be utilized. Channel shall be pre-set or attached to the structure with inserts or clamps.

D. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

E. Attachment to manufactured trusses, joists, purlins, and other engineered structural members and supports shall be done in strict accordance with the structural engineer's or manufacturer's recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural engineer or manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances. In the case of existing trusses, the structural engineer must review and approve hanger attachment methods.

3.4 Ductwork outside shall be sealed with mineral impregnated fiber tape. Ductwork shall be supported per SMACNA and as noted or detailed on the drawings. Ductwork, whether externally insulated or not, shall be jacketed as specified in 23 07 13 Duct Insulation.

3.5 Ductwork with galvannealed or bonderized coating shall be wiped clean to remove dirt, dust, oil and other contaminates in the shop before delivery to the jobsite. Care shall be taken in storage and installation to maintain cleanliness of the surfaces. Prior to painting, again wipe the surfaces clean.

3.6 Flexible air (duct) connectors shall be attached to metal duct with Panduit nylon banding straps or stainless steel clamps. Nylon banding straps shall be tightened utilizing a cable tie gun. Outer jacket of insulated flexible duct shall be closed at the ends with sealant and nylon banding straps or U.L. listed aluminum foil duct tape equal to Nashua No. 617022 with UL 181 listing printed on the face. Maximum length shall be 7 ft. with support at 4 ft. maximum spacing. Duct shall be free of sags and sharp bends. Utilize flexible duct elbow supports at all elbows. Flexible supports shall be UL listed for ceiling return air plenum use per UL 2043, UL 723 or ASTM E84, as manufactured by Titus (Flexright) or Thermaflex (Flex Flow) or approved equal. Independently supported radius'd sheet metal elbows may be used in lieu of flexible duct elbow supports when installed directly on air devices.

3.7 Flexible air (duct) connectors shall not be installed:

A. Where ductwork is exposed.

B. Thru any wall, ceiling, floor or fire rated or smoke rated assembly.

C. In the immediate vicinity of, and connecting to, air devices in fire rated ceilings where the assembly details require steel ductwork.

3.8 Interior duct liner shall be installed at time of ductwork fabrication. Liner shall be installed in strict accordance with the manufacturer's instructions and SMACNA standards. Liner shall provide full coverage of the ductwork, with all edges neatly butted together without gaps or interruptions. Adhesive shall cover at least 90 percent of the sheet metal surface. In addition, mechanical fasteners shall be utilized where required by SMACNA standards, NAIMA standards, or the liner manufacturer. Fasteners for flexible polyimide liner shall have beveled or cupped contact edges. Fasteners shall not compress the liner more than 10 percent of the liner thickness. Length of fastener pins for flexible polyimide liner shall equal liner thickness within 1/16 inch. Raw exposed liner edges resulting from shop cutting of the liner shall be treated with a sealant to protect the fibrous liner material from moisture or erosion due to air movement. Provide metal nosing at the leading edge of transverse joints at fan discharge and any joint preceded by an unlined section of ductwork. In addition, metal nosing is required at every transverse joint when the air velocity exceeds 3000 feet per minute. Repair any damage to liner coating with repair sealant/coating approved by the liner manufacturer. Protect liner and lined ductwork from dirt and moisture during fabrication, transport and storage, as well as during and following installation of the ductwork.

3.9 Duct access doors shall be provided for access to equipment, damper operators, devices and instruments inside the duct, at each fire damper, smoke damper and duct smoke detector (refer to

Electrical drawings) and where otherwise shown. A wall or ceiling access panel shall be provided where duct access is required thru a wall or inaccessible ceiling. Refer to 23 05 04 Basic HVAC Materials and Methods for such access panels.

3.10 Access door and fire damper shall be so arranged and located such that the spring catch and fusible link are accessible when the damper is closed. The door shall be sized to permit entry of arms or body in resetting of the damper. Special consideration must be given for larger dampers and spring loaded horizontal dampers.

3.11 Coordinate openings required for the passage of ductwork thru walls, partitions, floors and roofs with the General Contractor. Sleeves are not required except as stated below.

3.12 Floor sleeves for ductwork shall project 4 inches above the finished floor in equipment rooms and areas of similar usage, and shall form a waterproof seal. Exceptions shall be at locations where the opening is protected from drainage falling thru by means of concrete curbs or shaft walls. Provide 4 inch high x 4 inch wide concrete curbs with beveled edges to protect floor openings related to work in equipment rooms or an equally effective waterproofing metal curb.

3.13 Sheet metal sleeves in conjunction with fire dampers shall be placed in walls and floors to pass ductwork.

3.14 Where a fire damper is not required in a duct penetrating a fire rated wall or partition, the opening shall be fitted with a sleeve conforming to the requirements of the firestopping assembly. Refer to 23 05 05 Firestopping.

3.15 Annular spaces around ducts or duct insulation passing thru non-fired rated walls and partitions shall be closed with caulking or other compatible material to retard the passage of smoke. Annular spaces around ducts not fitted with fire dampers that pass thru non-fire rated floors shall be similarly closed.

3.16 Stored ductwork shall be blocked up off the ground and completely covered with visqueen. Open ends of both stored and erected duct shall be capped or covered with visqueen secured with duct tape before the end of each day's work to preclude contamination or entry of foreign materials. Factory made covers with elastic banding as manufactured by Duct Cap are also an acceptable means for temporary duct closure.

3.17 Where duct surfaces can be seen thru grilles, registers and diffusers, the inside of the duct shall be coated with flat black paint before the device is installed, to eliminate obtrusive appearances.

3.18 Ductwork and piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment in accordance with The National Electric Code.

3.19 Coordinate duct layout carefully with other trades to avoid conflict with structural elements, lighting and plumbing heating piping. Flattening of ductwork and offsets to fit ductwork in available space is generally shown. In the absence of such, arrange the ductwork to maintain concealment and allow ceilings and lights to be installed as intended. Do not hang ductwork until possible interference with electrical and mechanical trades have been resolved. Having ductwork fabricated and delivered in advance shall not be justification for interference with other trades.

3.20 Provide a complete set of ¼ inch = 1 foot 0 inch sheetmetal fabrication drawings. The drawings shall be used for overall coordination with the other trades. Meet with the other trades prior to developing and finalizing these drawings. The ¼ inch sheet metal drawings shall be true fabrication drawings started “from scratch” in that direct duplication of the contract drawings will not be accepted. In addition to plan layouts, fabrication drawings submitted for review shall include the following:

A. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.

B. Duct layout, indicating pressure classifications and sizes in plan view.

C. Fittings.

D. Reinforcing details and spacing.

E. Seam and joint construction details.

F. Penetrations through fire rated and other walls.

G. Terminal unit, coil, humidifier, and other air-side equipment installations.

H. Hangers and supports, including methods for building attachment, vibration isolation and duct attachment.

3.21 Provide a leak test on all ductwork located in chases and shafts, on all outdoor ductwork, and on 100 percent of ductwork on the drawings.

A. Leakage test procedures shall follow the outlines and classifications in the SMACNA HVAC Duct Leakage Test Manual. Where classifications specified exceed SMACNA standards the specified classification shall be considered the minimum standard. Negative pressure ductwork may be tested with equivalent positive pressure.

B. The leakage amount shall not exceed the allotted amount for the pressure class or the allotted

C. Leak test shall be conducted before any ceilings or shafts are enclosed.

D. A leakage test report shall be submitted certifying that the duct has been tested per SMACNA requirements and providing detailed test data and results.

E. If tested section fails to meet allotted leakage level, make modifications to bring section into compliance, and retest until acceptable leakage levels are obtained.

F. The leakage test shall be witnessed by the Air Balancer (who shall sign-off on the test results) and the Engineer or Owner’s Representative.

END OF SECTION

23 33 00 AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 Ductwork accessories specified herein shall include manual balancing dampers, backdraft dampers and filter pressure differential gauges. Refer to the drawings for scope and application.

1.2 Manual balancing dampers, in addition to those shown, which will be required to effect a positive balancing of air in the system shall be provided in the ductwork. The company or agent who is to balance the air systems shall call the HVAC Contractor's attention to requirements for additional balancing dampers which are deemed necessary.

PART 2 - PRODUCTS

2.1 Dampers and accessory items shall be constructed of galvanized steel, except those in ducts of stainless steel, aluminum, PVC coated or other such materials shall be stainless steel to maintain the intended corrosion resistance of the system.

2.2 Balancing dampers shall be single cross-blade up to 12 inches blade width and in larger sizes, multiple blade type 6 inches maximum width with opposed blade arrangement. Dampers shall have a full length continuous drive shaft and be controlled by a locking quadrant positioner with handle and minimum .375” square shaft, equal to Rossi “Everlock” or Ventlok #641 and for externally insulated ducts Rossi “Everlock” with 2” stand-off or Ventlok #644. For ductwork classified as 2” and greater, provide HiVel Ventlok Acorn Nut, End Bearing and gasket hardware.

2.3 Backdraft dampers shall be adjustable counter-balanced type with extruded aluminum frame and blades and extruded vinyl edge seals, equal to Ruskin CBD6. Backdraft dampers in stainless steel, aluminum, PVC or “wet” ductwork shall be stainless steel counter-balanced equal to Carnes FANA/FAPA.

PART 3 - EXECUTION

3.1 N/A

END OF SECTION

23 37 00 AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 Air outlet and inlet devices include grilles, registers, diffusers, louvers and special air diffusion devices associated with ceiling and lighting systems.

1.2 Refer to the schedule on the drawings for description, catalog numbers, materials, finishes, accessories, mounting and other details of the devices required.

1.3 Supply air devices in ceilings shall have their backsides externally insulated for condensation control. This external insulation shall be factory installed, minimum R-4.2 mineral fiber with foil jacket.

PART 2 - PRODUCTS

2.1 Air distribution devices other than louvers and specialty products shall be Titus, Tuttle & Bailey, Kreuger, Price, Metal Aire. All devices of a common type shall be by the same manufacturer.

2.2 Air outlet and inlet devices shall be equal to those specified by catalog number and description in the schedule on the drawings. Dampers shall be galvanized steel, unless otherwise noted, opposed blade configuration. Damper operators shall be concealed screw type. An auxiliary mounting frame shall be furnished with each grille and register except those mounted on exposed ducts or in lay in application.

PART 3 - EXECUTION

3.1 Verify & ensure compatibility of ceiling mounted devices with the ceilings and suspension systems (lay in, concealed spline, plaster, drywall, etc.). Verify with the architectural drawings.

3.2 Carefully align square and rectangular devices with the vertical and horizontal building lines. Diffusers shall be attached rigidly to the ductwork. Where connected by flexible ducts, special supports shall be provided as required, either from the ceiling suspension system or by independent suspension wires or rods from the building structure.

3.3 Externally insulate the backsides of supply air devices that are mounted in ceilings and not internally insulated. Insulation shall comply with 23 07 13 DUCT INSULATION.

3.4 Factory insulation on supply diffusers that is damaged prior to or during installing shall be repaired.

3.5 Inside of ducts behind grilles, registers and diffusers shall be painted flat black, as needed, to eliminate the sight of shiny surfaces.

END OF SECTION

23 64 20 SCROLL WATER CHILLER (AIR COOLED)

PART 1 - GENERAL

1.1 Water chiller shall be factory packaged air cooled type with scroll compressor(s), condenser fans and coils, water cooler, refrigerant piping and specialties, control panel and enclosure, designed for outdoor installation.

1.2 Ratings and construction shall be in accordance with the current ARI Standard 550/590, latest edition, ANSI B9.1 and ASME Section VIII codes. The unit shall be UL or ETL listed.

1.3 Efficient performance is mandatory. In no case shall the furnished chiller's EER be less than the minimum EER values required by ASHRAE 90.1-2019, Full Load and IPLV (Integrated Part Load Value) at standard operating conditions (as set by ASHRAE 90.1-2019 and AHRI 550/490). In addition, at the listed operating conditions as shown on the drawings, the chiller's NPLV (Non-Standard Part Load Value) shall not be less than 15.6 EER. Selections and certified test data shall be provided for BOTH the standard operating conditions and the specified conditions. A copy of an AHRI certified computerized selection shall be provided to demonstrate the performance of the unit at full load and part load conditions.

1.4 Chiller sound power value shall not exceed 92 dbA at the unit.

1.5 Chiller sound pressure value shall not exceed 65 dbA at 30 ft. from the unit.

1.6 Equipment shall carry an all-inclusive manufacturer's parts and labor warranty for a period of five (5) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner, including any required replacement of fluids, glycol or refrigerant. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer's authorized service agent.

Also include one year service warranty on the entire refrigeration system and its associated interlocks. This warranty shall obligate the supplier and installer to service the equipment and attend to all legitimate service calls and make necessary repairs, alterations, additions, adding refrigerant charge, etc., for a period of one year without additional cost to the Owner.

1.7 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements. Note that 23 05 30 requires that Compliance be proven at time of submittals with a wind certification performed by a licensed professional engineer.

PART 2 - PRODUCTS

2.1 Each chiller shall contain:

A. One, two or more scroll refrigeration compressors with direct drive motor, thermal winding protectors, oil pump, crankcase heater, suction and discharge service valves and steel spring or rubber in shear vibration mounts.

B. The evaporator shall be a shell and tube direct expansion type with seamless finned copper tubes expanded into tube sheets, or brazed stainless steel/copper plate-and-frame type. The evaporator shall be designed for minimum 430 psig refrigerant side and 150 psig water side. The evaporator shall be constructed and tested in accordance with ASME and so labeled. Electric heater tape shall be provided on the heat exchanger and piping to protect the

evaporator down to 20 degrees F. The evaporator shall be insulated with 0.75 inch closed cell foamed plastic insulation. Provide a line size stainless steel strainer on the inlet to each evaporator, per the manufacturer's requirements. If a plate-and-frame is provided, the strainer shall be 20 mesh or finer, one pipe size larger than line size.

C. Condenser section shall consist of condenser coils with seamless copper tubes and aluminum fins, propeller fans with direct drive motors and integral sub cooling circuit. Motors shall have internal thermal overload protection or such protection integral with the motor starter contactor. Condenser coils shall be pressure and leak tested and fans statically and dynamically balanced. Painted steel louvered panels or hail guards shall be provided for external protection of condenser coils and fans. Grilles or wire guards that do not afford protection from hail are not acceptable.

D. Unit enclosure shall be galvanized steel or aluminum panels with galvanized steel frame and access doors. Enclosure and other exposed parts shall be finished with enamel paint.

E. Refrigerant piping shall be factory installed. Suction piping shall be insulated with closed cell foamed plastic insulation. Each refrigerant circuit shall include liquid line service valve, solenoid valve, filter drier, hot gas muffler, liquid line sight glass, thermal expansion valve (or stepper motor actuated electronic expansion valve) and suction and discharge pressure gauges with shutoff cocks.

F. The unit shall have a full operating charge of R 410A refrigerant and lubricating oil.

G. Capacity control shall be regulated from supply water temperature, with return water temperature compensation, by staging compressor operation and/or cylinder unloading. Minimum number of steps shall be four.

H. The unit shall have a single point of connection with integral unit mounted disconnect for the power feeder. The chiller power wiring is specified at a particular total KW input, and wiring sized to minimize voltage drop. During bidding and again during show drawing review, the chiller supplier shall review the Division 26 drawings for conformance with the electrical service being provided including number and size of conductors and associated required lug sizes, fuse sizes, etc. and shall inform the Contractor of all changes which must be included. Needed modifications in feeder size, number of conductors, disconnect switch and fuse sizes, etc. shall be borne by the chiller supplier. In addition, if the chiller disconnect is unable to accept the feeder sizes or required lug sizes, the chiller manufacturer shall provide a transition box at the chiller (Nema 3R weather-proof enclosure) to accept the specified electrical feeders and then transition to appropriate feeder sizes to the chiller disconnect. Chiller supplier shall include in their price any modifications required to accommodate the incoming electrical feeder, including cost of wiring from the transition box to the disconnect. No modifications are to be made that would void the UL Listing of the disconnect or chiller, unless a field UL Listing is obtained. Coordinate with Division 26 a separate 115 volt power connection for controls and heat tracing. Provide a factory wired unit mounted fused disconnect for this purpose.

I. Provide sound package that meets or exceeds Sound Power level of 92 dBA and Sound Pressure level of 65 dBA at 30 feet in a free field or equivalent.

J. Chiller shall have BACnet interface capability to interface with the BAS.

K. Control panel shall contain power, operating and safety controls and devices, factory wired and tested, mounted in a weathertight enclosure with hinged and latched door. Included in the panel shall be:

1. Power terminal blocks and control wiring terminal strip.
2. Disconnecting means (switch or circuit breaker) for each motor.

3. Magnetic starter with 3 leg overload protection for each compressor with starting controls for across the line starting.
4. Power contactor for each condenser fan or starter with overload protection if such protection is not integral with the motor.
5. Start stop control switch.
6. Controllers for leaving chilled water temperature, head pressure control and pumpout. The chilled water temperature controller shall be microprocessor based and in direct control of steps of loading/unloading. The controller shall have soft loading/cool down feature.
7. Safeties for low water temperature, low water flow, loss of refrigerant charge, low oil pressure and high and low refrigerant pressure.
8. Low ambient cutoff set at 50 degrees.

L. A flow switch shall be furnished for mounting in the chilled water piping and wiring into the operating control circuit to allow normal pumpout and shutdown.

M. Terminal connections for interfacing each chiller with the automatic temperature controls system. Coordinate interface requirements. Features to be included in the chiller control panel shall be:

1. Remote start stop (enable).
2. Abnormal shutdown (safety trip, etc.) alarm (trouble).
3. Remote leaving chilled water temperature setpoint adjustment.

2.2 Vibration isolators, rubber in shear type, with 0.50 inch static deflection and weather protective coating shall be furnished with each unit.

2.3 Connectivity

A. Each Chiller Controller or Sequencing Panel shall have integral hard-wired network connectivity to a remote cloud service such that each chiller controller can be accessed via the web for informational and troubleshooting activities.

B. Owner’s access thru the cloud shall be free of charge for the chiller warranty period plus one year. Cost for extending the access period beyond that stated above shall be made available to the Owner via a formal contract proposal.

C. Access shall be password protected, via IOS or Android or Windows operating systems, with secure outbound only data transmission of the following live information as a minimum via a Graphical Dashboard Display:

1. Hourly, Daily and cumulative unit energy usage
2. Outdoor Air Temperature
3. Evaporator Leaving Water Temperature
4. Evaporator Leaving Water Setpoint
5. Evaporator Entering Water Temperature
6. Compressor Start/Stop times
7. Compressor Starts and Run Hours
8. Condenser Pressure
9. Evaporator Pressure
10. Chiller Capacity
11. Chiller Capacity Setpoint
12. Chiller Status
13. Customizable email notifications.
14. System and Data History
15. Service Log History

2.4 Water chiller(s) shall be manufactured by Trane, Daikin, Quantech, JCI, or Carrier.

PART 3 - EXECUTION

3.1 Install a strainer on the inlet side of each evaporator, per the chiller manufacturer's requirements.

3.2 Provide all required field installed control wiring. Wiring shall be in conduit and shall conform to the applicable provisions of Division 26 Specifications except that 0.50 inch conduit and wiring smaller than No. 12 AWG may be used when in conformance with the chiller manufacturer's instructions.

3.3 Coordinate connectivity requirements, including any required network connections, with the project IT contractor and the Owner.

3.4 Each unit and associated controls, safeties and wiring shall be checked out, tested, started and adjusted by a factory trained service technician.

3.5 Chiller to be mounted on existing rails on the roof. Clean existing steel and repaint prior to setting chiller.

END OF SECTION

SECTION 23 73 23 - CUSTOM AIR HANDLING UNITS

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 custom air-handling units with coils, VFDs, wiring, and accessories as further described herein.

1.3 SUBMITTALS

A. Product Data: Air-handling unit provide the following:

1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings and linkages.
8. Product data for all specified accessories.

B. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

C. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

D. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

E. Field Quality-Control Test Reports: From manufacturer.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-handling units and are based on the specific system indicated. Refer to Division 23 Section “Basic Mechanical Requirements” for guidelines concerning the use of other systems or models.

C. NFPA Compliance: Air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, “Installation of Air Conditioning and Ventilating Systems.”

D. Fan Performance Ratings: Rate according to AMCA 210, “Laboratory Methods of Testing Fans for Rating.” In addition, all airfoil fans shall comply with AMCA standard 99-2408-69 and 99-2401-82 and shall bear the AMCA Seal.

E. Sound Power Level Ratings: Rate according to AHRI 260-2001, “Sound Rating of Ducted Air Moving and Conditioning Equipment.”

F. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.

G. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.

H. Comply with NFPA 70 for components and installation.

I. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled. The terms “Listed” and “Labeled” are defined in the National Electrical Code, Article 100.

1.5 WARRANTY

A. Two (2) years on all parts and labor. Warranty starts at substantial completion of project.

B. Special Warranty: The manufacturer shall submit a written warranty agreeing to repair or replace components that fail in materials or workmanship within the specified warranty period. The warranty does not include parts associated with routine maintenance, such as belts, air filters, etc.

1. Flat Plate: A ten (10) year non-prorated parts warranty shall be provided for all flat plate air-to-air heat exchangers. The warranty period shall begin at start up or six (6) months after shipment, whichever occurs first.

1.6 COORDINATION

A. Coordination: Coordinate layout and installation of air-handling unit with piping and ductwork and with other installations.

1.7 DELIVERY, STORAGE, AND HANDLING:

A. Deliver air-handling unit as a factory-assembled module with shipping splits only as necessary and with protective crating and covering.

1. Air handling units shall be shipped as sections.

B. Lift and support units with manufacturer’s designated lifting or supporting points.

1.8 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. Filters: One set for each air handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Innovent
2. Ingenia
3. Air Enterprises
4. Ventrol
5. Haakon
6. Trane
7. ANNEXAIR

2.2 CABINET

A. Walls and roofs:
1. Fiber glass construction shall be constructed of minimum of 16 gauge galvanized steel minimum acoustic thermal panels. Panel thickness shall be minimum 4". The inner liner shall be minimum of 20 gauge wash-down aluminum liner in all sections except the chilled water coil sections. The interior wall mechanically secured to vertical support columns to make the air tunnel watertight. The chilled water section shall be wash-down stainless steel liner. Insulation shall be a minimum of 4", 3 lbs density fiberglass. Minimum casing R-value=14. Insulation shall meet flame spread rating of less than 25 and a smoke developed rating of less than 50 when measured in accordance with ASTM E84. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 1/8" x 3/8" tape sealer. Tape sealer shall be LEED qualified. Wall (and roof) seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.
2. Foam panel construction shall be constructed of minimum of 22 gauge galvanized steel minimum on the exterior. The inner liner shall be minimum of 22 gauge wash-down aluminum liner in all sections. Panel thickness shall be minimum 2". The individual panels shall be insulated with injected hydrophobic polyurethane foam. Insulation shall be a minimum of 2", injected hydrophobic polyurethane foam. Minimum casing R-value=14. All panel seams shall be sealed during assembly to produce an airtight unit

B. Under scheduled supply air temperature and design conditions on the exterior of the unit, condensation shall not form on the casing exterior (doors included).

C. All insulation edges shall be protected with metal lagging. Insulation systems using stickpins or adhesives are not acceptable. No insulation shall be exposed to the airstream.

D. Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/250 at 8" of static pressure. If panels cannot meet this deflection, add additional internal reinforcing.

2.3 BASE CONSTRUCTION

A. Base shall be constructed from welded structural steel channel or I-beam around the perimeter of the unit, with intermediate channel and angle supports. Units shall have a minimum 8" base. Base steel shall be primed and painted on both sides. Base shall be welded at all seams.

B. A minimum of 1/8" thick aluminum checker plate floor shall be installed on the base. Floor shall be flat reinforced from below. Drive screw or bolt attachment and caulking are not acceptable. Base shall be provided with lifting lugs. The base shall be insulated with a minimum of 2" injected foam insulation sheeted with a 22 gauge galvanized steel liner. Floors that "oil can" are not acceptable.

C. The chilled water coil section and fixed plate heat exchanger sections will have a drain pan and stainless steel condensate connection.

D. All drain connections on floor mounted air handling units shall terminate at the side of the unit and capped.

E. Maximum floor deflection shall be L/500 when subjected to an 800 lb/sq ft point load.

F. The casing shall be designed for outdoor installation. Seams and joints shall be watertight. Roof shall extend beyond the casing and shall be pitched to ensure adequate drainage. Screws and attachments shall be cadmium plated or equal corrosion protected.

G. Piping shall be routed from second floor plenum into the unit. All piping connects to be internal to the unit casing.

2.4 ACCESS DOORS

A. Access doors shall be manufactured to match the construction of the cabinet walls and roof. Corners of the doors shall be continuously welded for rigidity. Doors must be the same thickness and construction as the unit casing to maximize thermal and acoustical resistance. Hinges shall be continuous piano type stainless steel.

B. Two chrome plated "Ventlok" Model #310 high pressure latches operable from either side of the door shall be provided. (PLASTIC DOOR HANDLES ARE NOT ACCEPTABLE) Door opening shall be fully gasketed. Fan compartments must have a door of minimum width to remove the motor or the largest component.

C. All access doors must swing against the air pressure (i.e. positive pressure plenum doors must swing in) and must be fully gasketed.

D. All access doors shall be provided with Metal Test Ports for unit air stream for testing in each plenum section between each component with the AHU.

E. Provide windows which are at a minimum 10" X 10" or 12" diameter double pane safety vision in all access doors.

2.5 DRAIN PANS

A. Drain Pans: Readily cleanable, formed sections of stainless steel sheet complying with ASHRAE Standard 62. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) when units are

operating at maximum catalogued face velocity across cooling coil. Pans shall be sloped in two planes for complete drainage to a single outlet without standing water. The drain pans at floors shall be depressed below the air handler floor level to prevent overflow.

1. Double-Wall Construction: Fill space between walls with insulation and seal moisture tight.
2. Drain Connection: Same side of unit as coil connection side, unless noted otherwise; pre-piped to exterior of unit.
3. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil. Provide stainless steel intermediate drain pans that extend a minimum 3" downstream of coil face. Provide multiple 1" stainless steel condensate piping from intermediate pan to main drain pan.All portions of the drain pan, including intermediate pans and any hardware subject to contact with condensate, shall be constructed of Type 304 stainless steel.
4. Fasteners: All fasteners exposed to weather shall be corrosion-resistant.

2.6 DIRECT DRIVE FAN SECTION

A. Fan-Section Construction: Fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan scroll, wheel, shaft, bearings, and motor on concrete inertia fan bases with structural-steel frame, with frame mounted on base with spring vibration isolation.

1. Mount fan and motor on an internal, fully welded, rigid structural steel base. Base shall be free floating at four corners on housed spring vibration isolators, minimum 2-inch static deflection, with seismic snubbers.

B. Fans, General: All fans shall be direct drive plenum style including aluminum wheels, with smooth-curved inlet flange, heavy back-plate, and hollow die-formed airfoil-shaped blades welded at tip flange and back-plate; cast-iron or cast-steel hub riveted to back-plate and fastened to shaft with set screws.

C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

D. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Fans shall have inlet OSHA approved inlet screens.

F. Unit shall be provided with VFD's, refer to specification section 23 05 14 for requirements.

2.7 MOTORS

A. General: Refer to Division 23 Section "Electrical Requirements For HVAC Equipment" for general requirements, which are fully applicable to the work of this Section as if repeated herein.

B. Motor Sizes: Minimum size as indicated, but larger if necessary so driven load will not require motor to operate in service factor range at design point. Motor HP must be at least 1.15 times BHP.

C. Inverter-Duty or Inverter-Ready Motors are required for all fans indicated to be controlled by a variable frequency drive.

D. Provide an Aegis shaft grounding kit for all motors.

E. Motors shall have extended lube lines.

F. Motor bearing life shall be L10-100,000 hours.

2.8 HYDRONIC COILS (HOT WATER AND CHILLED WATER COILS)

A. Coil Sections: Individual, insulated casings for cooling coil. Design and construct to facilitate removal and replacement of coil for maintenance and to assure full airflow through coils.

B. Chilled Water Cooling Coils: Comply with all requirements specified herein for cooling coils.

C. Coil Casing: Cooling coils shall be all stainless steel materials. The hot water coil shall have galvanized steel casing.

D. Circuit Arrangement: Self-draining and self-venting coil fabricated according to AHRI 410. Number of rows shall be determined by manufacturer to meet scheduled performance requirements.

E. Piping Connections: Threaded or flanged, on same side. Coil connections shall be integral to the unit.

F. Tubes: Copper, 5/8-inch O.D. with 0.025-inch minimum wall. Select coils for not less than 2 fps water velocity and not more than 6 fps water velocity.

G. Fins: Aluminum of minimum thickness 0.075-inch. Spacing shall not exceed 10 per inch for cooling coils.

H. Fin and Tube Joint: Mechanical bond created via thermal expansion.

I. Headers: Non-ferrous, such as seamless copper tube with brazed joints, with drain and air vent tappings. Headers and return bends shall be enclosed within the air handling unit casing.

J. Ratings: Design tested and rated according to ASHRAE 33 and AHRI 410.

K. Working-Pressure Ratings: 200 psig, 325ºF.

L. Source Quality Control: Test to 300 psig and to 200 psig underwater.

2.9 FAN INLET, EXHAUST AIR, AND RETURN AIR DAMPERS

A. Furnish and factory-install integral air dampers within air handling units.

B. Dampers shall be TAMCO 9000 or equivalent insulated dampers for outdoor air and relief air.

C. Dampers shall be TAMCO 1500 or equivalent low leakage Dampers for return air and other internal dampers.

2.10 ENERGY RECOVERY SECTION (WHEEL)

A. Air Handling Unit shall be provided with an energy recovery wheel as shown on the drawings. The wheel shall be provided with an inverter duty motor, variable speed drive and speed controller. Speed controller shall incorporate four temperature sensors on both entering and leaving air sides of the supply and exhaust air streams and incorporate the following control modes: Heat recovery winter mode controlling the wheel speed to maintain a setpoint; economizer mode to slow wheel to minimum speed to allow outside air to be used in economizer operation; summer mode in which the wheel runs at full speed to recover as much cooling energy as possible. Sections shall be U.L. 1812 or 1815 listed, as appropriate for the application. The variable speed drive shall meet Section 23 05 14 or the applicable section of Division 26.

B. Substrate material. Construct wheel of 50 micron hardened aluminum alloy or synthetic substrate. Wheel shall be a minimum of 8" deep as scheduled.

C. Desiccant. Provide permanently bonded 3 angstrom molecular sieve, non-migrating, water selective desiccant. Silica Gel desiccant shall not be acceptable.

D. Dedicated Purge Sector. Provide purge sector to minimize cross-over of return air to supply air during rotation. Purge sector shall limit the Exhaust Air Transfer Ratio (EATR) to the AHRI Certified value at 3” w.c. pressure differential between the airstreams.

E. Drive System. Provide a VFD factory wired to the wheel motor for defrost and economizer provisions. Provide gear motor with V-belt drive. Sheaves shall be cast iron. Belts shall be fabric reinforced urethane coated perforated V-belts.

F. The unit shall be provided with outside air and exhaust air bypass dampers.

G. Hot water preheat coil shall be provided upstream of the wheel in the outside air stream.

2.11 HEAT RECOVERY SECTION (FIX PLATE)

A. Air Handling Units shall be provided with an heat recovery fixed plate as shown on the drawings. Capacity control shall be provided by sequencing the exhaust and outside air bypass dampers.

B. The heat recovery fixed plate heat exchanger shall be cross-flow orientation and have no moving parts. The flat plate media shall provide laminar flow and to prevent air leakage of the exhaust air to the supply air through the media and shall have complete separation between exhaust air and supply air. Heat exchanger shall be made of aluminum plates. Provide access doors on the inlet and outlet sides of the flat plate for service.

C. The heat recovery flat plate shall include bypass dampers arranged in parallel blade configuration on both the outside air and exhaust air stream. Provide access doors for damper access.

2.12 FILTER SECTION

A. Pre-filters: Filter Section: Pre Filters shall be 2" MERV 9 pleated, disposable types. Each filter shall consist of a non-woven cotton and synthetic fabric media, media support grid and enclosing frame. The filter shall be listed by Underwriters' Laboratories as Class 2.

1. Pre-filters shall be installed in prefabricated channel rack.
2. Pre-filters shall be lift-out. Provide vertical blockoffs at filter seams to prevent air bypass when filters are loaded.

B. Final filters shall be 12" MERV 13 high performance, deep pleated, totally rigid and disposable type. Each filter shall consist of high density microfine glass fiber media, media support grid, contour stabilizer and enclosing frame.

1. Final filter media shall be of high density microfine glass fibers that are laminated to a non-woven synthetic backing to form a lofted filter blanket. The filter media shall have an average efficiency of 90-95% on the ASHRAE Test Standard (52-76) and a MERV 13 rating. It shall have an average arrestance of not less than 99% on that standard. Filters shall be listed by Underwriters' Laboratories as Class 2
2. Holding Frames: Holding frames shall be factory fabricated of 16 gauge galvanized steel and shall be equipped with gaskets on all 4 sides of the filter and 2 heavy duty positive sealing fasteners. Each fastener shall be capable of withstanding 25 lbs. pressure without deflection and be attached or removed without the use of tools.
3. Final Filters shall be lifted out. Side slideout filters are not acceptable.

C. Provide Dwyer 2000 (photohelic) magnehelic gauge. The gauge shall be accurate to +-2% of full range. One gauge shall be provided for each filter bank. Gauges shall be recessed into cabinet casing.

D. Provide two additional sets of filters for attic stock.

2.13 FAN INLET AIRFLOW MEASURING

A. Provide an airflow piezometer measuring probes for each fan capable of continuously monitoring the air handling capacity of the respective fans.

B. Each piezometer airflow probes shall contain multiple, averaged velocity pressure taps located symmetrically around the throat of the fan inlet(s) and a single static pressure tap located on the fan housing. The entire airflow monitoring probe must be located outside the inlet throat as to not obstruct the airflow. Provide interconnecting tubing and single connection point for transducer. Interconnecting tubing shall be mounted outside the inlet throat.

C. The piezometer probes shall be capable of producing steady, non-pulsating signal of the velocity pressure, independent of the upstream static pressure without adversely affecting the performance of the fan. The sensing probes shall be accurate to 5 percent of actual fan airflow.

D. Provide differential pressure versus airflow calibration curves and equations. The air handling unit manufacturer shall provide the transducer with LCD screen to display CFM. Supply voltage shall be 24 VAC and output signal shall be 4-20 mA. Provide Bacnet connection to building automation system.

E. Fan airflow measure shall be manufactured by air handling unit manufacturer, Ebtron, or CRC.

2.14 FINISH

A. The exterior shall be factory painted to withstand a salt spray test in accordance with ASTM B117 for a minimum of 2,500 consecutive hours.

B. Paint color shall be selected by the Architect and can be a custom color.

2.15 ELECTRICAL

A. Factory wire and test all air handling units. by CSA, ETL or UL.

B. Unit manufacturer shall provide non-fused disconnect for single point power connection for the air handling unit. Factory wire from the main disconnect to each VFD. Wiring and devices shall comply with the NEC. All wiring shall be concealed in conduit, provide junction boxes as required.

C. Unit manufacturer shall provide, install, and wire the complete electrical system and all branch circuit wiring and conduit.

D. Label and number code all wiring and electrical devices in accordance with the unit electrical diagram. Mount the devices in a control panel inside the unit's service enclosure or on the outside. Ensure the control panel meets the CSA, ETL or UL.

E. Marine Lights in Airstream: Each section which includes an access door shall also include a factory-mounted, enclosed and gasketed, vapor-tight, LED light fixture. Include junction box, globe, aluminum globe guard, receptacle, and bulb ready for field wiring. 60 minute timer switch shall be provided for the lights. Provide lights where shown on the drawings, minimum of two lights in each section.

2.16 CONTROLS

A. Manufacturer shall provide a programmable digital control system for each custom unit. A user terminal with LCD display shall provide capability of monitoring operation and changing setpoints through an integral keypad. The user terminal shall be capable of being either unit mounted (UUT) or remote mounted (RUT) using straight through six wire flat cable. The manufacturer shall program the sequence of operation as specified in this section. The program shall include the following:
   1. Unit start-up and shut-down requirements including fan/airflow proving indication and damper actuator end switch indication.
   2. Temperature control for all heating and cooling devices.
   3. Humidity control for all dehumidification devices and processes.
   4. Economizers (dry-bulb, enthalpy, dewpoint, energy recovery) where applicable.
   5. Fan controls for each mode of operation.
   6. Defrost control for all energy recovery devices (where applicable).
   7. Requirements for modes of operation other than Normal Occupied mode.
   8. Integration of all optional devices (firestats, smoke detectors, pressure transducers, airflow stations, etc) specified in this section.
   9. Alarms:
      a. Informational auto-reset alarms shall be provided and stored for all sensors, end devices, and components, and shall be accessible through the controller user interface.
      b. Manual reset alarms shall be provided as specified for some optional devices (e.g. firestats, freezestats, smoke detectors, fan duct static pressure limits) and where required to protect the space served or the

equipment.

c. A list of standard alarms available to the BAS shall be included in the points list as specified in this section.

B. The controller shall communicate with the Building Automation System (BAS) through a factory provided BACnet MS/TP interface card. A points list necessary to control the equipment, perform the sequence of operation, and informational points required by the BAS shall be provided as specified in this section.

C. The controller shall have the capability through a web-based User Interface to remotely monitor all inputs/outputs, control the user terminal, view status of all alarms including both alarm and cleared time stamps, remotely upload a new program, and view historical and live log data for the past 24 hours. The controller shall save the log data for a rolling 7 days in a csv file that can be downloaded, with the additional capability of storing 31 days of logged data to an external thumb drive.

D. Alarm Indication. DDC controller shall have one digital output for remote indication of an alarm condition. (i.e. Blower current switch, differential pressure switch, damper end switch, supply discharge low limit, freeze stat, fire stat, smoke, dirty filters…). Alarm Indication shall be configurable to indicate only shut down alarms if desired. The type of alarm shall be distinguishable through the BMS.

E. All HW and CW valves and actuators shall be provided and installed by others.

F. Sequence of Operation. Manufacturer shall provide the sensors required for the Sequence of Operation, including additional points listed in the BMS Points listed when included in this section. The sequence of operation shall incorporate devices such as smoke detectors, filter switches or transducers, and kill switches specified in the Electrical section of this equipment specification.

G. BMS Points List.

H. Hot water and chilled water controls valves provided by TCC and wired to DDC controller.

PART 3 – EXECUTION

3.1 Manufacturer shall field verify existing curb and connection locations prior to submitting shop drawings, as existing unit will be installed on existing curb.

3.2 All power wiring shall be run in conduit and comply with the N.E.C., including flexible type at motor connections.

A. Connect all wiring, piping, and other services at shipping splits. Contractor is responsible for making all connections required for full and complete operation of units.

3.3 Condensate drain piping with a deep trap from the drain pan to the designated discharge point shall be provided.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Leak Test: After installation, fill coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.

2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
B. Final Checks before Startup: Perform the following:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices ant that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Perform cleaning and adjusting specified in this section.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
   5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
   6. Set zone dampers to fully open position for each zone.
   7. Comb coil fins for parallel orientation.
   8. Install clean filters.
   9. Verify that manual and automatic control and fire dampers in connected duct systems are in fully open position.
C. Starting procedures for air handling units include the following:
   1. Energize motor; verify proper operation of motor, drive system, and fan wheel.
   2. Measure and record motor electrical values for voltage and amperage.
   3. Manually operate dampers from fully closed to fully open position and record fan performance.
D. Testing, Adjusting, and Balancing is the work of Division 23 Section “Testing, Adjusting, and Balancing” which shall include adjustment of fan to indicated rpm.

3.6 CLEANING

A. Unit to be flushed, cleaned and new filters prior to turning over to Owner.

3.7 DEMONSTRATION

A. Engage the service of a factory-authorized service representative to train Owner’s maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
   1. Schedule training with Owner, through Engineer, with at least 7 days advance notice.

END OF SECTION

23 81 28 DX MINI SPLIT SYSTEMS – AIR-COOLED

PART 1 - GENERAL

1.1 The heating-cooling systems shall be variable capacity, DX split heat pump systems. The systems shall consist of indoor fan coil unit(s) matched to outdoor air-cooled heat pump condensing unit(s), singularly outdoor unit, and associated controls. Refer to drawings for capacities and arrangements.

1.2 The design is based on Mitsubishi equipment. The other manufacturers listed in Part 2 are acceptable manufacturers but shall include in their bid price all necessary revisions from the basis of design required to install their system, including but not limited to variations in electrical services, branch controllers, pipe sizing, quantities and arrangements.

1.3 Equipment shall be rated in accordance with ARI 210/240 and so labeled, and shall be Listed by UL or ETL and so labeled.

1.4 The condensing units shall be factory charged with R-410A refrigerant.

1.5 Provide a set of spare filters for each indoor unit.

1.6 The systems shall carry a five (5) year warranty from date of installation. In addition, the compressors shall be covered by the manufacturer's limited warranty for a period of seven (7) years from date of installation. If, during these periods, any part shall fail to function properly due to defects in workmanship or material, it shall be replaced or, at the discretion of the manufacturer, repaired. The 2nd thru 5th year and 2nd thru 7th year warranties do not include labor.

1.7 Refer to the HVAC and Electrical drawings for electrical power feeds. Compare unit requirements to feeder sizes shown. Refer to 23 05 13 Electrical Requirements for HVAC Equipment.

1.8 Installing contractor shall be factory trained and certified to install the systems. Training shall be documented by the manufacturer and certification shall be submitted for review with shop drawings, prior to the installation of the systems.

1.9 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Each Air-Cooled Heat Pump Condensing Unit shall consist of:

A. General:

1. Each outdoor unit shall be specifically matched to the corresponding indoor unit size(s), factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll or rotary compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines, individually insulated between the outdoor and indoor units.
2. Accumulator with refrigerant level sensors and controls; high-pressure safety switch, over-current protection and DC bus protection.
3. High efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

4. Auto-charging feature and a refrigerant charge check function. The unit shall be capable of metering the refrigerant charge as additional refrigerant is added to the system and will calculate how much additional refrigerant is to be added to the system.
5. Oil recovery cycle shall be automatic occurring after start of operation and then at re-occurring intervals during unit operation.
6. Cooling operation down to 0 degF dry bulb ambient temperature. Provide accessories as necessary to achieve the low ambient operation.
7. The system shall automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.
8. Unit shall have a sound rating no higher than 64 dB(A) measured at 3 feet from any side of the unit.

B. Cabinet shall be fabricated of galvanized or rust-proofed steel, bonderized and finished with a powder coated baked enamel. The outdoor unit shall come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to an equipment pad.

C. Condenser fans shall be statically and dynamically balanced direct drive, variable speed propeller type. Fan motor shall have inherent protection, permanently lubricated bearings, and be completely variable speed. Fan motor shall be mounted for quiet operation. Fan shall be provided with a raised guard to prevent contact with moving parts.

D. Condenser coils shall be copper or other nonferrous construction with corrugated fin tube. The fins shall be aluminum or covered with an anti-corrosion acrylic resin and hydrophilic, rated for up to 500 hours salt spray. Automatic defrost shall remove any frost from the outdoor unit allowing the system to maintain heating capacity.

E. Compressor

1. Compressors shall be inverter scroll or rotary type, inverter-driven variable speed, capable of changing the speed to follow the variations in total cooling and heating load.
2. Each compressor shall be equipped with a crankcase heater (if required for specified design and operating conditions), high pressure safety switch, and internal thermal overload protector.
3. The capacity control range shall be minimum 10% to 100%.
4. Compressor assembly shall be installed on vibration isolators.
5. The following safety devices shall be included on the condensing unit: high pressure switch, control circuit fuses, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

F. Units shall be rated under AHRI 210/240 and 340/360. Single-Phase heat pump units shall meet or exceed the DOE requirement of 14 SEER and 8.2 HSPF.

Note: Shop drawing submittals shall include AHRI ratings to show compliance with the requirements.

2.2 Fan Coil Units

A. Wall Mounted Units

1. General
   a. Wall mounted units shall be completely factory assembled and tested. Included in the unit shall be factory wiring with on/off switch, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, time delay fusing, and test run switch. The unit shall have an auto-swing louver which ensures efficient air

distribution, which closes automatically when the unit stops. The local controller shall be able to adjust the discharge angle.
   b. A mildew-proof, polystyrene air filter and condensate drain pan shall be included. The indoor units sound pressure shall be no more than 54 dB(A) at high speed measured at 3.3 feet from the unit.
   c. Refer to drawings for required capacities.
2. Cabinet shall be zinc-coated bonderized steel finished with a baked enamel paint. Inlet grilles shall be attractively styled, high-impact polystyrene. Matching mounting brackets shall be provided.
3. Fans
   a. Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
   b. Horizontal and vertical air sweep operations shall be user selectable.
   c. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
4. Coil shall be a 2-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header. The drain pipe shall be able to be fitted from either left or right sides.
5. Electrical Requirements
   a. Unit shall operate on 115 volt, 208 volt, or 230 volt, 60 Hz single-phase power supply as specified on the equipment schedule. Power and control connections shall have terminal block connections.
6. Controls
   a. Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The space temperature control range shall be from 64F to 84F.
   b. Provide hard wired wall-mounted local programmable controller with integral space sensor for each unit, with features as specified in the “Controllers” paragraph below.
   c. Controls shall be 24 volt, and shall be easily operated by the user from the wall-mounted local controller.
7. Accessories
   a. Condensate Overflow Switch -- A level sensor on the condensate pan shall stop cooling operation and alarm the BAS if the level in the condensate pan is near overflow condition.
   b. Condensate Pump – Provide a factory-furnished UL 2043 plenum-rated condensate pump and sensing unit compatible with the fan coil voltage to remove condensate from the drain pan. Pump shall be thermally-protected (auto reset) and designed for quiet operation (less than 27 dBA) and consist of two parts: a reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be minimum 36”. Pump shall be powered and wired from the fan coil unit power connection, downstream of safeties.

B. In-Ceiling Cassette Units

1. General
   a. Ceiling cassette fan coil units shall be designed to fit into a 2x2 ceiling grid system, as a lay-in device. Each unit shall be equipped with an electronic expansion valve, air panel return grille, four-way air distribution louvers, ivory white, impact resistant, and washable decoration panel. The supply air louvers shall be adjustable from 4-way throw to 3-way and 2-way throws. Refer to drawings for throw types. The indoor units sound pressure shall be no greater than 35 dB(A) at high speed measured at 5 feet below the unit.
   b. Refer to drawings for required capacities.

2. Unit Cabinet
   a. Cabinet shall be constructed of zinc-coated steel. Fully insulated discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall have a mildew-proof, polystyrene air filter accessible from below with a 1/4 turn fastener.
   b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention. The airflow of the unit shall have the ability to shut down one or two sides allowing for custom pattern control.
3. Fans shall be direct-drive fan with statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high, medium, and low settings. The fan motor shall be thermally protected. Air louvers shall be adjustable for 2, 3, or 4-way discharge.
4. Coils shall be a 2-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Fin spacing shall no greater than 17 fins per inch. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate.
5. Motors shall be totally enclosed and permanently lubricated with inherent protection. Fan motor shall be 3-speed.
6. Electrical Requirements
   a. Unit shall operate on 115 volt, 208 volt, or 230 volt, 60 Hz single-phase power supply as specified on the equipment schedule. Power and control connections shall have terminal block connections.
7. Controls
   a. Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The space temperature control range shall be from 64F to 84F.
   b. Provide wireless wall-mounted local programmable controller with integral space sensor and a return air sensor for each unit, with features as specified in the “Controllers” paragraph below.
   c. Controls shall be 24 volt, and shall be easily operated by the user from the wall-mounted local controller.
8. Accessories
   a. Condensate Overflow Switch -- A level sensor on the condensate pan shall stop cooling operation and alarm the BAS if the level in the condensate pan is near overflow condition.
   b. Condensate Pump – Provide a factory-furnished UL 2043 plenum-rated condensate pump and sensing unit compatible with the fan coil voltage to remove condensate from the drain pan. Pump shall be thermally-protected (auto reset) and designed for quiet operation (less than 27 dBA) and consist of two parts: a reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be minimum 21”. Pump shall be powered and wired from the fan coil unit power connection, downstream of safeties.

2.3 Controllers:

C. Local Controllers (Room Thermostats)

1. Wall mounted local remote controllers (thermostats) shall be provided to allow the user to change on/off, temperature setting, and fan speed setting for each fan coil unit. The room temperature shall be sensed at this wall mounted remote controller (thermostat) unless noted otherwise. The controller shall display a four-digit error code in the event of system abnormality/error.
2. The fan coil thermostats shall have their buttons locked out thru software so that the setpoints are only adjustable thru the BACnet interface. Review with Owner prior to implementation.
3. The Local Controller shall be mounted into a standard 2” x 4” junction box.
4. Unit Display

a. The Local Remote Controller shall be a backlit LCD display with contrast adjustment.
b. The controller shall display On/Off Status, Operation Mode, Setpoint, and Fan Speed. The controller shall display temperature setpoint in one degree increments with a range of 60-90 degF. On/Off status shall be displayed with an LED.
c. Error codes shall be displayed in the event of system abnormality/error.
d. The following system temperatures shall be capable of being displayed to assist service personnel in troubleshooting:
    1) Return air temperature
    2) Liquid line temperature
    3) Gas line temperature
    4) Discharge air temperature (if available on the unit)
    5) Remote temperature sensor temperature (if applicable)
    6) Indoor space temperature setpoint

5. Operation
    a. The controller shall be capable of controlling an indoor unit coupled to a outdoor unit. Refer to drawings for groupings. The following operation group shall be controlled:
        1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery System))
        2) Independent cooling and heating setpoints in the occupied mode
        3) Independent cooling setup and heating setback
        4) Fan speed
        5) Airflow direction
        6) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
        7) Lock out key settings
        8) Indoor unit group assignments.
6. Program Functions
    a. Controller shall support schedule settings with selectable weekly pattern options.
        1) Seven day week
        2) Weekday + weekend
        3) Weekday + Saturday + Sunday
        4) Independently settable Cooling and/or Heating setpoints when unit is on (occupied).
        5) Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied)
        6) A maximum of 5 operations schedulable per day
        7) Time setting in 1-minute increments.
    b. The Controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint.
        1) Changeover to cooling mode shall occur at cooling setpoint + 1oF .
        2) Changeover to heating mode shall occur at heating setpoint - 1oF .
    c. The Controller shall support an Auto-Off-Timer for temporarily enabling indoor unit operation during the unoccupied period.
        1) When the Off Timer is enabled and when the unit is manually turned on at the remote controller, the controller shall shut off the unit after a set time period.
        2) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments.
    d. The space temperature shall be sensed at the local controller.

2.4 Refrigerant Piping:

D. Refrigerant piping shall be copper tubing conforming to ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition.

E. Copper tubing shall be Type ACR, hard-drawn straight lengths. Fittings shall be copper, UL or ETL tested to UL 207, and certified to a working pressure of 600 psig. All joints shall be brazed using silver brazing alloy while flowing an inert gas such as dry nitrogen through the piping. Copper tubing that is downstream of branch controllers and .625" size and smaller may be Type ACR soft annealed coils for lengths under 25 ft if approved by the equipment manufacturer. Refer to 23 23 00 for additional information.

F. Pipe arrangement, devices and sizing information shown on the drawings is limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Drawings shall be submitted to the Engineer for review with the equipment shop drawings.

G. The equipment supplier shall provide piping installation instructions to the Contractor and supervision as needed to ensure that the piping system is installed in accordance with the equipment manufacturer's recommendations.

2.5 Connectivity

H. Each system shall have integral hard-wired network connectivity to a remote cloud service such that fan coil and each condensing unit can be accessed via the web for informational and troubleshooting activities.

I. Owner's access thru the cloud shall be free of charge for the condensing unit warranty period plus one year. Cost for extending the access period beyond that stated above shall be made available to the Owner via a formal contract proposal.

J. Access shall be password protected, via IOS or Android or Windows operating systems, with secure outbound only data transmission of the following live information as a minimum via a Graphical Dashboard Display:
1. Space Temperature
2. Fan Coil Status
3. Condensing Unit Status
4. Alarms.
5. Customizable email notifications.
6. System and Data History
7. Service Log History

2.6 The split systems shall be manufactured by Mitsubishi, LG, Trane, JCI.

PART 3 - EXECUTION

3.1 Installers shall have received training by the manufacturer of the systems being supplied for the project. If they have not received training the system manufacturer shall schedule and perform required installation training.

3.2 Piping Installation

A. Pipe arrangement, devices and sizing information shown on the drawings is schematic in nature, limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Exact routing, and pipe quantities and sizing shall be per manufacturer's requirements. Refrigerant piping shall conform to ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be

engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition. Drawings shall be submitted to the Engineer for review with the equipment shop drawings. Exact routing, and pipe quantities and sizing shall be per manufacturer's requirements.

B. At time of equipment submittal approval a piping diagram shall be provided by the equipment manufacturer to the Installing Contractor for each split system. The equipment manufacturer shall review the piping diagram with the Installing Contractor.

C. A copy of the Approved piping diagrams shall be kept at the jobsite.

D. The Installing Contractor shall update the piping diagrams with any field changes such as re-routing, shortening, lengthening or changing diameter of a pipe segment, adding or eliminating elbows and or fittings, resizing adding or eliminating indoor units, changing the mounting height, or moving the location of a device or fitting during installation. Those changes shall be communicated to the equipment manufacturer PRIOR TO INSTALLATION. The equipment manufacturer shall review and provide written approval or required modifications prior to installation.

E. The equipment manufacturer shall update their Piping Program to an "As-Built" program. Proper refrigerant charge shall be calculated and communicated to the Commissioning/Startup Technician along with the As-Built piping program.

F. The equipment manufacturer's representative shall inspect the piping system prior to charging and start-up, and document their approval or required changes.

G. System shall be leak checked, evacuated and charged by the Installing Contractor. Refer to 23 23 00.

3.3 Control wiring shall be installed between indoor units and condensing units in strict accordance with the manufacturer's instructions. All control wiring shall be low-voltage plenum rated type.

3.4 Coordinate connectivity requirements, including any required network connections, with the project IT contractor and the Owner.

3.5 Furnish and install all controls, wiring and accessories for a complete and operational system. Coordinate control integration into the BAS with the BAS installer.

3.6 Locate equipment so as to afford adequate service space.

3.7 Outdoor condensing units shall be installed in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Set with Type A1 isolators and secure to a 4" reinforced concrete pad. Piping shall be connected utilizing flexible connectors.

3.8 Roof mounted condensing units shall be installed a minimum of 10'-0" from any roof edge not protected with a code compliant guard rail regardless of location indicated on plans. Units shall be installed in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Set with Type A1 isolators, all bases and curbs for roof mounted equipment shall be constructed and attached to the roof deck such that installed equipment can withstand 90 mph wind loads. Piping shall be connected utilizing flexible connectors.

3.9 Install fan coil units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. For gravity drained units, provide a drain pipe with trap from fan coil drain pans and

extend piping to a floor drain or other point of discharge as shown and terminated per the Code. For fan coils fitted with condensate pumps, install pump and sensing devices in evaporator condensate drain piping, and provide and/or extend power and control and safety wiring, all in strict accordance with the manufacturer's instructions. Condensate piping shall be extended to a floor drain or other point of discharge as shown and terminated per the Code.

3.10 Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

3.11 The system shall be checked, started, tested, adjusted and commissioned by a factory trained service agent of the manufacturer prior to operation. The unit manufacturer will be responsible for the start-up, programming, and commissioning of the entire variable refrigerant volume system. This shall include coordinating the interface requirements and system points with the temperature controls contractor. Manufacturer shall test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.12 Provide services of manufacturer's technical representative for 2 days to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner.

3.13 In addition to the adjustments and fine tuning, the Contractor shall include as a part of this contract the equivalent of three (3) man days of service technician time for work as may be specified by the Engineer.

3.14 The control equipment supplier shall provide 4 hours of instruction and training of the Owner's personnel regarding the hardware and software of the system. Software training shall include programs, methods of programming, control loops, scheduling and reports. Site training classes shall not be scheduled for longer than 4 hours duration except at the discretion of the Owner. Contractor shall videotape the demonstrations and make copies available to the Owner.

END OF SECTION

DIVISION 26

ELECTRICAL

26 05 01 BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions and Supplementary Conditions, including Division 00 and Division 01, apply to work specified in this Division.

B. The scope of the Division 26 work includes furnishing, installing, testing and warranty of all Division 26, 27 and 28 work and complete systems as shown on the Division 26, 27 and 28 drawings and as specified in Division 26, 27 and 28 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors to the Prime Contractor assignments of work by division are not intended to restrict the Prime Contractor in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

D. Refer to the description of Alternates in Division 01, which affect the Division 26 work.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in this Division. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the local jurisdictional authority.

1.3 Inspection of Site

A. Inspect the project site / and the / premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a

later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having bus duct, wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install bus duct, wireways, fittings and equipment.

D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where they consider such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork and piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces about Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance to Enclosures and Access to Work Space – 110.34 Work Space and Guarding. Caution other trades to comply with this stipulation.

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of bus duct, conduit, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect.

1.5 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 26 Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Architect who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.6 Coordination Drawings

A. The Division 23 Contractor shall initially prepare and be responsible for 0.25 inch scale coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format and distributed to the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 23

Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings and that specified ceiling heights are maintained.

1.7 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.8 Record Drawings

A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work and within 90 days of system acceptance, these hand marked drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.9 Operating and Maintenance Manuals

A. Assemble two copies each of operating and maintenance manuals for the Electrical work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate. Major items of equipment shall consist of not less than the following:

1. Transformers.
2. Panelboards.
3. Motor controllers and motor control centers.
4. Specialty equipment.
5. Fire alarm, communications and sound systems.
6. Lighting equipment and lighting controls.
7. SPD

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. Original purchase order number; date of purchase; name, address, and phone number of the vendor; warranty information.

E. Copy of required test reports.

F. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer for review. Upon approval and within 90 days of system acceptance, manuals shall be turned over to the Owner.

1.10 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 26 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect or Engineer for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.11 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Use of equipment for temporary electric is not the start of the warranty period.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to, motor controller malfunction, heater element changes required for motor controller, fuse replacement where fuses blow due to abnormal shorts, adjustments and/or replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having See Spec Writer Note 2.

2.3 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will only be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Within ten (10) days after award of contract, the names of Subcontractors and manufacturers of the major items of equipment which are proposed shall be submitted to the Architect for approval.

D. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.

E. If extensive changes in conduit, bus duct, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.4 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing

requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Shop drawings of the following equipment and materials shall be submitted:

1. Wireway.
2. Firestopping.
3. Pull boxes and handholes.
4. Miscellaneous cabinets.
5. Wiring devices and coverplates.
6. Surge suppression (SPD).
7. Dry type transformers.
8. Panelboards.
9. Cabinets and enclosures.
10. Fuses.
11. Motor controllers and disconnects.
12. Lighting fixtures and lamps.
13. Lighting standards.
14. Lighting controls/contactor and photocell.
15. Fire alarm system.
16. Sound reinforcement system - auditorium.

PART 3 - EXECUTION

3.1 Testing

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. On all electric services including change-outs, backfeeds, etc. the Contractor shall verify phase rotation and voltage readings to ensure the final installation is proper. Submit to the Engineer in writing a record of voltage readings and current readings taken at no-load and fully loaded conditions.

D. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

E. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Submit four (4) copies of reports indicating results.

F. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.

G. Instruments required for tests shall be furnished by the Contractor.

3.2 Equipment Cleaning

A. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be performed in accordance with equipment manufacturer's recommendations.

B. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents; verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

B. Caution: Verify that all bearings of equipment furnished are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the other trades judgment in these matters. Follow specific instructions in regard to lubrication of equipment furnished under this Contract.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect / Engineer that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O & M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

D. A minimum of 8 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:

1. Show location of items of equipment and their purpose.
2. Review binder containing instructions and equipment and systems data.
3. Coordinate written and verbal instructions so that each is understood by personnel.
4. Separate instructions shall be given by manufacturer's representatives for the various special and communications systems.

E. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

END OF SECTION

26 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. **Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form.** Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project's name and address, the Architect's / and / Engineer's / and / any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any

software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

ELECTRONIC FILES
HEAPY RELEASE FORM TO CONTRACTORS

Project: New Castle Henry County Public Library Addition and Renovation
376 S 15th Street
New Castle, Indiana

Owner: New Castle Henry County Public Library

Heapy Engineering Project Number: 2022-07145

Heapy Engineering Project Manager: Mathew Root

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

    b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

    d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by

the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Recipient Address: _____

    Name of authorized Recipient Representative: _____

    Title of authorized Recipient Representative: _____

    E-mail address of authorized Recipient Representative: _____

    Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____

_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ CD-ROM ☐ DVD-ROM ☐ Heapy FTP ☐ User's FTP site ☐ Flash Drive

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 2018 DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG
Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 26 Electronic .DWG Files:

First Drawing: $50.00 $50.00

Additional Drawings $15.00 each _____ x $15.00 = $ _____

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _____ x $ 5.00 = $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____
All files will be bound together.
Available electronic Revit file format:
☐ 2022 .RVT

Cost of Preparation of Division 26 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

26 05 04 BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Continuity of Service

A. Work shall be so planned and executed as to provide reasonable continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch over, the Owner shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done during normal working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without mark up.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed junction boxes, valves, traps, devices and equipment requiring service or adjustment.

B. Access panels shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with tamperproof screws. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.

2. Standard flush type for drywall ceilings and walls, Milcor Style “M” or equal.

C. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

D. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Electrical work shall be performed by a licensed Contractor in accordance with requirements of the jurisdiction.

3.2 Protection

A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where conduits, cable trays, bus ducts and wireways are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect. Any damage caused to the building shall be repaired or rectified.

C. Where conduits, cable trays, bus ducts and wireways are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching, refinishing and painting of same shall be included in this contract. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls etc. are to be cut for presence of existing utilities.

D. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system brace floor or alter location of new work to maintain existing system.

E. All sleeves and openings not used or partially used shall be closed to prevent passage of fire or smoke.

F. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

G. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

H. Engage a Roofing Contractor on a subcontract basis for roofing and roof insulation work necessitated by the Electrical work. The Roofing Sub-Contractor shall be certified for installation and repair of the roofing system so as to maintain the existing roofing warranty.

3.4 Removals, Alterations and Reuse

A. Refer to the drawings for the scope of remodeling in the existing building.

B. Cooperate with the General Contractor regarding all removal and remodeling work. The Contractor shall remove existing work which is associated with their trade, and which will be superfluous when the new system is installed and made operational. Void unused conduit behind walls or below floors as necessary or as directed. No wire or conduit shall be removed which will impair the functioning of the remaining work unless first replaced with a rerouted section of wire or conduit to ensure continuity. Remove inactive wiring back to the last active junction box, panelboard or piece of equipment.

C. Upon completion, no unused conduit or stub shall extend thru floors, walls or ceilings in finished areas. Abandoned conduit where remaining in place shall have any unused wiring removed. All accessible unused conduit shall be removed.

D. When it is necessary to reroute a section of an active circuit, the rerouted section shall be installed before removing the existing in order to minimize system down time. Rerouted sections shall be installed as required for new work.

E. Materials and equipment which are removed shall not be reused within the scope of this project unless specifically noted to be relocated or reused. Turn over to the Owner and place where directed on the premises all removed material and equipment so designated by the Owner. All material and equipment not claimed by the Owner after a reasonable time frame shall become the property of the Contractor responsible for removal and shall be removed from the premises.

F. Remove, store and reinstall lay-in ceiling tile and grid as needed to perform work in areas where such removal and re-installation is not to be done by the General Contractor. Damaged tile and/or grid shall be replaced with new matching tile and/or grid.

G. In areas of minor work where the space is not completely vacated, temporarily move portable equipment and furnishings within the space as required to complete the work. Coordinate this activity with Owner. Protect the Owner's property by providing dust covers and temporary plastic film barriers to contain dust. Remove barriers and return equipment and furniture upon completion of the work.

H. Refinish any surface disturbed under this work to match existing, except where refinishing of that surface is included under the General Contract.

3.5 Painting

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 26:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

5. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.

B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.

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

3.6 Access Panels

A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Access locations thru HVAC ductwork must be coordinated with the ductwork installer. Location of the hinged access door with latch must be coordinated in advance with the HVAC Contractor.

C. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

3.7 Backboards

A. Where shown on the drawings, backboards shall be provided for wall mounting of disconnect switches, devices and communications equipment. The Contractor may opt to mount additional groups of disconnect switches on backboards.

B. General

1. Backboard shall be 0.75” thick waterproof flame retardant plywood secured to structure.

2. Each board shall be painted.

3. Telephone backboards shall be normally 4 ft. x 8 ft. mounted 6” above floor where located on drawings. Where other sizes are required, they will be noted on the drawings.

C. Each terminal cabinet for communication systems, relays, etc., shall be fitted with a full size 0.50” thick backboard for mounting terminal strips, equipment, etc.

END OF SECTION

26 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of conduits, bus ducts, cables, cable trays and other electrical items thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions and smoke barriers. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with ANSI / UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests shall be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

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

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 26 05 33 Raceway and Boxes for Electrical Systems for sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION

26 05 09 EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 Excavate for all in-grade underfloor conduit, exterior ducts, conductors, conduit, lighting standard bases, and incidental work which are included in the Electrical contract. Backfill to finish grade or to levels consistent with the General Contractor's and the Site Contractor's activities. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition where such are not affected by Division 31 – Earthwork or Division 32 Exterior Improvements. Cut existing floor slabs and replace slabs in conformance with 26 05 04 Basic Electrical Materials and Methods. All work shall comply with requirements set forth in Division 31 and 32.

1.2 Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in the contract.

1.3 Contact the Indiana 811NOW.com?'State' 811 Service sufficiently in advance of the start of any excavation so that notification can be made to member utility departments and utility companies (water, sewer, gas, petroleum, electric, telephone, cable, etc.) having underground utilities in or near the project area. Also contact those companies to verify that utility lines have been located and duly marked and identified.

1.4 A utility locator service shall be engaged to locate, mark and identify private lines and other utilities that are not located by the means mentioned above.

1.5 Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by this Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 Refer to Division 31, Earthwork for bedding and backfill materials specifications.

PART 3 - EXECUTION

3.1 Interior and exterior trenches shall be over excavated and the duct, conductor or conduit shall be laid on 4 inches minimum depth sand bed. Where ductbank is concrete encased, excavate to required depth, if fill or backfill needed under ductbank use washed pea gravel or crushed limestone and compact.

3.2 Backfilling of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with graded pea gravel, graded coarse sand or crushed limestone 0.75 inch maximum size, to prevent undue settlement. Backfill material for non-metallic conduit shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials or with excavated material up to 18 inches above the top of the conduit. The remainder shall be with similar materials or with excavated material having no large clots, stones or rocks.

3.3 Backfill shall be mechanically compacted in layers not over 6 inches deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of as directed by the General Contractor. Refer to Division 31 Earthwork for compaction requirements.

3.4 Concrete floor slabs, paving, sidewalks, curbs, sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced by this Contractor equal to original conditions. Refer to Division 31 and 32 for Surface Restoration Requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.

3.5 Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadway shall be included in this contract so that no additional cost will accrue to the Owner.

3.6 Maintain in place adequate barricades, guards, planking, plating, signage, warning lights, etc., at and around excavations.

3.7 All exterior underground conduit, concrete encased ducts, and direct buried conductors shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6 inches wide with black letters identifying the type of service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18 inches above and on the centerline of the conduit, duct or conductor.

END OF SECTION

26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS

PART 1 - GENERAL

1.1 This section pertains to the use of copper conductors, 600V insulation class.

PART 2 - PRODUCTS

2.1 All conductors shall be copper: conductors shall be insulated for 600V.

2.2 Insulation types referenced are those of NEC. All conductors shall be UL labeled and shall be marked for size and type at regular intervals on its' length. Conductors #8 and larger shall be stranded; #10 and smaller may be stranded provided approved terminations are used.

2.3 Types of conductor insulation for general use may be any of the following, subject to limitations listed, in addition to those in the NEC:

A. Type THHN - restrictions - do not use for conductors in slab. Do not use in wet locations.

B. Type THWN - no restrictions.

C. Type XHHW - no restrictions.

2.4 Use shielded VFD cables for feeds from VFD to motor where conductor length is longer than 25 feet. VFD cable shall be 3 conductor XHHW low capacitance copper, full size insulated copper ground, 1.5 mil AL foil and 85 percent tinned copper woven braid shield with PVC oil and sunlight resistant jacket. UL TC-ER, 90 degrees C., 600V wet/dry. Manufactured by Belden, AWC, Lutze or equal.

2.5 Use Type THHN or XHHW, (90 degrees C. rated) types for connecting luminaires and for running thru fixture housings.

2.6 Use conductors such as type FEP with high temperature insulation as identified in the NEC for connections to resistance heating elements or in other areas subject to temperature exceeding the rating of THWN, XHHW or THHN.

2.7 Color Coding – The use of colored commercial building wire is encouraged.

A. On 208/120 volt, three phase, grounded systems, wires colored black, red and blue shall be used for phase conductors. Neutral wires on these systems shall be white. If conductors No. 4 AWG or larger are not available in white or white stripes, the neutral may be a black wire identified with white tape, minimum size 0.50 inch wrapped twice around at the following points:

1. At each terminal.
2. At each conduit entrance.
3. At intervals not more than 12 inches apart in all accessible enclosures.

B. On 480/277 volt, three phase system, wires colored brown, orange and yellow shall be used for phase conductors. Neutral wires on these systems shall be gray or other NEC acceptable means for distinguishing each system grounded conductor from another. If conductors No. 4 AWG or larger are not available in the proper colors, black wire may be used with 0.50 inch tape bands of the proper color at the following points:

1. At each terminal.

2. At each conduit entrance.
3. At intervals not more than 12 inches apart in all accessible enclosures.

C. Equipment grounding conductors shall be green, or for 4 AWG and larger may be completely taped green, at all accessible points.

D. All control circuits shall be red with individual wire identification on each conductor.

E. Where existing wiring systems (remodel work or building additions) have different color coding, consult the Engineer concerning matching existing wire color coding and phasing.

2.8 Wire size ampacity shall equal or exceed its overload protective device. Where wire sizes shown on the drawings are greater than the apparent ampacity requirements, the size shown shall prevail to compensate for voltage drop. In no instance shall conductors be installed that are less than required by N.E.C. Minimum conductor size shall be No. 12 AWG except No. 14 AWG may be used only for control wiring or where otherwise specifically shown.

2.9 When necessary to use a lubricant for pulling wires, lubricant must be listed by Underwriters' Laboratories, Inc. Only cable lubricants approved for the type of jacket material or insulation shall be used, and must be of such consistency that it will dry completely when exposed to air. Lubricant must leave no obstruction or tackiness that will prevent pulling out old wires or pulling in new wires or additional wires, and, after drying, must leave a film of lubrication which will promote easy movement of the wires. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes. Lubricant shall be Ideal "Yellow 190", 3M “WL”” Wire Pulling Lubricant, or approved equal.

2.10 Splices No. 10 AWG and smaller shall be made using the following:

A. Preinsulated spring pressure connectors as follows: ITT Holub "Freespring", with metal grip threads 3M "Scotch-Lok", Ideal "Wingnut", Thomas and Betts Type "PT", or Buchanan "B Cap". Other hard insulated wire connectors which have bakelite or ceramic insulation are prohibited. (Non-metallic thread connectors shall not be used.)

2.11 Splices No. 8 AWG and larger shall be made using the following:

A. Approved crimp type connectors with special crimping tool; T&B, Burndy, Buchanan or approved equal. Joints and free ends shall be covered with tape or approved moistureproof insulating kits. Applied insulation shall exceed 150 percent of conductor insulation voltage rating.

B. For two or more taps use Power Distribution Blocks by Square D, Gould, Taylor, Ilsco or Connectron.

2.12 Wiring in vertical raceways shall be supported with strain relief devices; Kellem's grips or approved equal.

2.13 Connections to equipment shall be made with pressure type terminals. On stranded wire, use spade type terminals or terminals approved for use with stranded wire. Connections shall contain only single conductors unless approved for multiples.

A. For conductors No. 10 AWG and smaller, applied crimp type terminals shall be T&B "Sta Kon" or approved equal.

B. For No. 8 AWG and larger conductors, applied crimp type terminals shall be Burndy, T&B or approved equal.

2.14 Where tape is applied over wires and connectors on 600 volt or lower voltage applications, it shall consist of a minimum of two (2) half lapped layers of Scotch "88" or Plymouth No. 4240 for both indoor and outdoor applications, except Scotch 33 Plus or Plymouth No. 4453 is acceptable for use indoors.

2.15 Where fireproofing of cables is noted on the drawings or required by Code, each cable shall be arc and fireproofed with one (1) half lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape. Tape shall be secured with a 2 layer band of Scotch Brand 69 Glass Electrical Tape over the last wrap. Installation shall comply with manufacturer's recommendation.

2.16 Where installed underground, splices and terminations shall be listed and approved for waterproof application. Utilize kits approved for the application.

PART 3 - EXECUTION

3.1 Branch circuit conductor identification means shall be permanently posted at each panelboard and switchboard. This identification shall be installed on the inside of the door and shall identify conductor colors for each voltage system in the building. Provide identification at all new panelboards and existing panelboards utilized within this project.

3.2 Conduit systems shall be clear and clean before pulling wire. Branch circuit conductors shall be pulled without resorting to levers or heavy pulling devices.

3.3 Cable pulling tensions shall not exceed recommended values.

3.4 Group ungrounded and grounded circuit conductors for each multiwire branch circuit by cable ties in panelboards and tap boxes.

3.5 Each branch circuit or multiwire branch circuit shall have its own dedicated neutral. Group neutral conductors with phase conductors by wire ties in each enclosure where multiple neutrals provided.

3.6 Shielded VFD cables shall be provided for VFD to motor conductors length longer than 25 feet. VFD motor feed cables shall be terminated per VFD manufacturer’s direction.

3.7 Control conductors shall not be run in same raceway with branch circuit or motor circuit conductors.

3.8 Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only, ground conductors are not counted when determining maximum fill for this purpose.

3.9 Wire tags shall be provided on all main and feeder conductors in all pull boxes, wireways and panelboard and switchboard wiring gutters. Tags shall identify wire or cable number and/or equipment served. Tags shall be of flame resisting adhesive material, T&B Type WSL or approved equal.

3.10 Perform meggar tests on all feeders and motor branch circuit conductors prior to energization of circuits. Provide documentation in standard NETA format to the Engineer for review. Do not run meggar check on solid state equipment.

END OF SECTION

26 05 20 LOW-VOLTAGE ELECTRICAL POWER CABLES METAL CLAD "MC" CABLE

PART 1 - GENERAL

1.1 This section covers copper multi-conductor metal clad cable, Type MC. Metal clad cable constructions shall conform to UL #1569, UL 83 and N.E.C. Article 330.

PART 2 - PRODUCTS

2.1 Multi-Conductor Metal Clad Cable, Type MC, with copper conductors in sizes #12 thru #6 for continuous operation at a maximum conductor temperature of 90 degrees C dry. Cables shall have Underwriters' Laboratories labels for Metal Clad Cable and are suitable for use as branch circuits in both exposed or concealed work in accordance with the applicable sections of the National Electrical Code, Article 330.

2.2 Multi-conductor, Super Neutral, Metal Clad Cable, Type MC, with copper conductors in sizes #12 through #1/O AWG for continuous operation at a maximum conductor temperature of 90 degrees C dry. Super Neutral Cable, Type MC Cables are comprised of four or more conductors with one neutral per phase for three phase, a ground for four-wire power supply systems to receptacle circuits. Cables shall have Underwriters' Laboratories labels for Metal Clad Cable and are suitable for use in both exposed or concealed work or in accordance with the applicable sections of the National Electrical Code, Article 330. Receptacle circuits requiring separate neutrals, the neutrals shall be considered a current carrying conductor and derated per NEC 310.15.

2.3 Multi-Conductor Metal Clad Cable Conductors shall be copper type THHN with a full sized copper ground conductor and mylar assembly tape. MC cable type utilizing an integrated aluminum grounding/bonding conductor system as the equipment grounding conductor is not acceptable.

PART 3 - EXECUTION

3.1 Multi-Conductor Metal Clad Cable shall be supported and installed per NEC. Article 330. Except not permitted to be run exposed in finished spaces and the use of non-metallic ties for support is prohibited.

3.2 Plastic anti-short bushing (red head) shall be inserted into the armor cover at terminations.

3.3 Branch circuits from panelboards shall be run in conduit to a central junction box in spaces or group of spaces where all incoming conductors and outgoing MC cable conductors are terminated. At these junction boxes the transition is made to type MC cable with all terminal points identified along with the circuit numbers. The Multi-Conductor Metal Clad Cable runouts continue to lighting fixtures, receptacles, etc.

3.4 MC cable shall not be run horizontally in walls between device boxes. Box-to-box wiring must go up the wall, over to the stud cavity for the next box and down the wall.

3.5 Conductors in central junction boxes shall be labeled indicating panel and branch circuit, refer to Electrical Identification; Section 26 05 53.

END OF SECTION

26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Work includes grounding and bonding of system neutral, equipment and conduit systems to conform to requirements of NEC and as detailed on the plans and in the specifications.

PART 2 - PRODUCTS

2.1 Clamps and continuity devices shall be non-ferrous material, UL approved. Connections to ground rods and all underground connections shall be "Thermoweld" or "Cadweld".

2.2 Ground conductors shall be insulated, identified by green insulation or by painting or taping green at all accessible locations and shall be connected with approved connectors and terminators to boxes, devices, equipment, etc. and to ground bars in panels.

PART 3 - EXECUTION

3.1 Wiring devices shall be connected with grounding jumper from ground pole on device to grounding screw in the outlet box. Branch circuit to be connected to grounding screw in the outlet box.

3.2 The complete metal conduit system shall be used for the equipment grounding system. Conduit systems and associated fittings and terminations shall be made mechanically tight to provide a continuous electrical path to ground and shall be safely grounded at all equipment by bonding all metallic conduit to the equipment enclosures with locknuts cutting thru paint or enclosures. Bond all conduits entering pad-mount transformers, secondary service entrance switchboard with a ground wire connecting the grounding type bushings to the equipment ground bar. Conductors shall be sized per NEC Tables 250.66, 250.102 and 250.122. Bond all communications conduit systems to ground.

3.3 In addition to using the conduit system for grounding, a complete auxiliary green wire equipment grounding system shall be installed, continuous from main ground, thru distribution and branch circuit panelboards and paralleling all feeders and branch circuit wiring. Grounding conductor sizes shall comply with NEC Table 250.122, minimum size shall be #12 copper except #14 on control circuits. This shall apply to all circuits rated 100 volts or more above ground potential.

A. Connect ground terminal on wiring devices to auxiliary green wire equipment grounding system.

3.4 Ground neutral of all transformers for separately derived systems. Grounding electrode conductor shall be to the street side of the main water service plus a bond ground ran to nearest structural steel in area or to other NEC approved electrodes. A common grounding electrode size #3/0 may be used for multiple separately derived systems. Conductors shall be sized per NEC Table 250.66.

3.5 Motor frames shall be bonded to the equipment grounding system by an independent green insulated copper wire, sized to match equipment grounding conductor. Motors with VFD shall be bonded with flat braided tinned copper straps in lieu of wire.

3.6 Cord connected appliance frames shall be grounded to the equipment grounding system thru a green wire in the cord.

3.7 Equipment mounted on vibration isolation hanger and supports shall be bonded so bond does not transmit vibration. Size bond to match equipment ground conductor.

3.8 A green grounding conductor shall be installed in each non-metallic conduit and all flexible conduits, including exterior underground conduits.

3.9 System neutral connections shall be insulated from metal enclosures except at the neutral of the service entrance equipment and on the neutral of a separately derived system. Connections to the main panelboard enclosure shall be by means of bonding jumpers.

3.10 The building neutral shall be identified throughout with white conductors. Where there are neutral conductors from a separately derived system (such as 120/208 volt, 3 phase, 4 wire where the main building service is 277/480 volt, 3 phase, 4 wire) the neutrals of the two systems shall be separately identifiable per NEC Article 200.

3.11 Steel frame buildings and metal exterior coverings on buildings that are not effectively grounded (i.e., all metal connections bolted w/o insulating washers) shall be grounded thru a low resistance grounding system whether or not a lightning protection system is required. Ground metal exterior coverings and metal roofs with minimum #4 copper conductor at a minimum of two points, intervals not exceeding 100 feet. Ground steel frame buildings at each corner with maximum of every 60 ft. around the outside perimeter by cadwelding #2/0 (#4/0 for buildings over 75 ft. tall) copper conductor to steel columns and extending below ground to driven ground rods; top of 0.625 inch x 10 ft. ground rod shall be minimum of 12 inches below finished grade and 3 ft. out from building foundation. Bond the water service, street side of water meter, to the adjacent perimeter steel column with #4/0 insulated copper conductor. Sleeve all concrete foundations and masonry walls with PVC sleeve.

3.12 Where metal covers on pull boxes and junction boxes are used, they shall comply with the grounding and bonding requirements of NEC Article 250.

3.13 Connections to driven ground rods or other such electrodes shall be a minimum of three feet from the foundation wall or beyond the roof drip line, whichever is greater.

3.14 The electrodes (driven ground rods) of the electrical grounding system shall not be used for the electrodes for the lightning protection system, and vice versa. However, these two systems shall be bonded together at one point per NEC.

END OF SECTION

26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 This specification section covers common conduit systems, boxes, firestopping, and sleeves. Where other methods are specified under separate sections for specific applications, the specific application requirements shall govern.

1.2 Refer to Section 26 05 05 Firestopping and Division 07 for firestopping requirements.

PART 2 - PRODUCTS

2.1 Conduit Type - Application (Use only conduit types listed)

A. Conduit - Rigid or Intermediate Grade Galvanized Threaded.
Application - restrictions - (Not to be used in):

1. Direct buried in corrosive soils.
2. Corrosive atmospheres.

B. Conduit – Thin wall EMT.
Application - restrictions - (Not to be used in):

1. Poured concrete.
2. Exposed to weather.
3. Underground.
4. Exposed in mechanical equipment or other equipment/process rooms below 48 inches.
5. Hazardous or corrosive atmospheres.
6. Not to be used for medium voltage (2001 volts or higher) cable.
7. Not to be used in utility tunnels.

C. Conduit - PVC Type 40 (Schedule 40) rigid, conforming to ANSI, NEMA specifications and each length UL labeled.
Application - use limited to:

1. In or under concrete slabs on grade where permitted by electric legend on the drawings.
2. Exterior use when encased in 3 inch concrete.
3. Direct buried, underground when indicated on drawings.

D. Conduit - Flexible Metal (Greenfield type), galvanized steel.
Application - use limited to:

1. Connection to lighting fixtures; not over 6 ft. in length.
2. Narrow movable partitions where other raceways are not practicable, when approved by the Architect or Engineer.
3. Connections to transformers, dynamic equipment and for motors only when in air streams or plenums.
4. In existing walls for remodel projects, vertical drops to outlets and switches; no more than 3 ft. out the top of the wall.

E. Conduit - Liquidtight Flexible Metal.
Application - use and limitations:

1. Connections to all motors, except in air stream or plenum.

2. Connections to controls on dynamic equipment, transformers, etc., outdoors and indoors in wet locations.
3. Use not permitted underground or where subject to physical damage.

2.2 Conduit sizes

A. Conduits shall be 0.75 inch minimum size except 0.50 inch size may be used for switch legs and flexible connections to lighting fixtures.

2.3 Conduit Fittings

A. Fittings and workmanship shall ensure electrical continuity. All conduit systems in poured concrete shall be concrete tight.

B. Application of bushings, locknuts and insulated fittings shall comply with NEC requirements.

C. Use conduit fittings as manufactured by Efcor, Steel City, Raco, Midwest, Appleton, ETP / O-Z / Gedney, American Fitting Corporation or T&B, equal to the following catalog numbers:

1. Rigid and intermediate conduit
   - all fittings, couplings and connectors shall be threaded type.
   - grounding bushings, malleable iron; insulated; Steel City BG-801; Midwest Series GLL.
2. EMT
   - fittings shall be all steel, set screw or compression type, concrete tight.
   - set-screw type couplings; Midwest Series 460; Steel City TK 121; Appleton TW 50S.
   - compression type couplings; Midwest series 660S; Steel City TK111; Appleton TWC50CS.
   - set-screw type connectors; Midwest Series 450; Steel City TC 121; Appleton TWC 50S.
   - compression type connectors; Midwest Series 650; Steel City TC111; Appleton TW50CS.
3. Flexible metal conduit
   - malleable iron, "squeeze" type, non-insulated; Midwest series 1708; Steel City XC 901; Appleton 7481V. (For lighting fixture whips only - all steel or die cast screw in connector; Midwest 771; Steel City XC 241; Appleton SGC 50DC).
4. Liquid tight conduit
   - steel or malleable iron; Midwest Series LT; Steel City LT 100; Appleton ST.
5. PVC Type 40 and Type TC-6
   - couplings and fittings socket type solvent weld, coupling and solvent by same manufacturer as conduit.

2.4 Boxes

A. Junction boxes and pull boxes shall be code gauge galvanized steel with multiple screw fasteners and galvanized steel covers.

B. Outlet boxes all steel construction with galvanized or plated finish or otherwise all metal, by Steel City, Appleton, Crouse Hinds, R&S or Raco.
1. Lighting fixture outlet boxes 4 inches square or octagonal, 2.125 inches deep, with 0.375 inch fixture studs. Equal to Steel City Series 54171; Series 52171 with FE 421 stud. Fixtures weighing more than 50 lbs. shall be supported independently of the outlet box.

2. Flush mounted device outlet boxes shall be minimum 4 inches square. Provide extension rings as required. Use Erico Caddy No. H2-3 mounting support plate where metal studs are used.
3. Device rings in finished masonry or tile walls shall be square corner masonry type with no extended ears, to allow flush mounting of plates.
4. Surface mounted device boxes shall be cast "FS" type or special surface mounted boxes for use with surface raceway systems.

C. Floor boxes shall be UL listed for its application as manufactured by Hubbell, Steel City, Walker, Raco or Wiremold. Drawings identify material type.

D. Provide water tight boxes, slip expansions and bonding jumpers where dictated by construction conditions.

E. Terminations at boxes shall be secured by locknuts or approved bushings.

2.5 Surface Metal Raceways

A. Snap on cover types by Mono-Systems, Panduit or Wiremold / Walkermold with prime gray finish (enamel finish coat to match room finishes in remodel areas). Application - permitted only when specifically shown on the drawings.

1. Fittings, boxes and extension rings: Furnish manufacturer's standard accessories; match finish of raceway.

2.6 Sleeves and Openings

A. Sleeves and formed openings shall be placed in walls, partitions, floor slabs and poured concrete roof decks for the passage of conduit, cable, wireway, cable tray and bus duct. Sleeves and formed openings are not required:

1. In floor slabs on grade.
2. Where conduit is installed before the wall, partition or slab is constructed.
3. Openings are cut for conduit passage and patched with equal or comparable material to close the space around the conduit.
4. In stud and gypsum board or plaster walls and partitions which are not fire rated.
5. For conduit passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions. Sleeves are required however, for which expansion, contraction and other movement can be expected.
6. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.
7. In large floor openings for multiple pipe and duct risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after conduits are set.
8. Sleeves for passage of conduit and cables shall be schedule 40 black steel pipe or galvanized rigid conduit. Rectangular sleeves for cables, wireway, cable tray and bus duct shall be 18 gauge galvanized steel in poured concrete floors, walls and roof decks; 26 gauge galvanized sheet steel in other than poured concrete.
9. Sleeves shall be sized to afford 0.25 inch to 0.75 inch clearance space.

2.7 In areas having special membrane waterproofing in or on the floor slab, a Josam 26420, or equal approved by the Architect, riser sleeve with clamping ring and auxiliary conduit sleeve extending 4 inches above finished floor or 8 inches above finished roof shall be used. Waterproofing membrane for roof and floor construction shall be secured by the clamping ring. These are to be used in areas having special membrane water-proofing in or on the floor slab and at roof decks.

2.8 Multiple conduits extending through the roof may be fitted with a manufactured pipe curb weatherproofing assembly equal to Pate # pca, lpca and mpca as an alternative to that specified in paragraph 2.7 above.

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

2.10 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.

PART 3 - EXECUTION

3.1 Conduit shall be run concealed in all finished areas of new construction and elsewhere unless specifically indicated or upon specific permission by the Architect. All conduit shall parallel building lines.

3.2 Conduit shall be run overhead and shall not be run in or below concrete slabs unless specifically indicated on the drawings and in the legend on the drawings.

3.3 Where feeders are permitted to be run below floor slab on grade, they shall be installed in non-metallic conduit encased in 3 inch concrete using galvanized rigid steel (equal to Champion Fiberglass) elbows with all necessary fittings and couplers.

3.4 All conduits installed below concrete slab on grade shall have a minimum of 6-inches fill over the conduits in order to prevent accidental damage to conduits should the floor be saw-cut in the future.

3.5 Conduits shall not be installed above the vapor barrier in concrete floors poured on grade.

3.6 Conduit crossing building expansion joints shall have expansion provisions with grounding continuity; use special expansion fittings or other NEC approved method. Refer to the Architectural and Structural floor plans and details for locations of expansion joints.

3.7 Do not install wall-mounted boxes back-to-back in opposite sides of wall; in stud walls, boxes shall be on opposite side of studs. In acoustic rated and fire rated walls boxes shall be separated a minimum of 24 inches.

3.8 Boxes not otherwise accessible in ceilings and walls shall be made accessible by installation of hinged door access panels. Refer to Section 26 05 04 - Basic Electrical Materials and Methods.

3.9 Use cast floor boxes for installation in slab on grade; formed steel boxes are acceptable for other installations.

3.10 Work shall be so planned as to:

A. Minimize the number of offsets and junction boxes. For feeder conduits, use all long radius conduit bends or accessibly located large junction boxes with screw covers.

B. Generally run conduit and conductors as high as practicable against underside of floor slab in concrete construction or immediately below the top chord of bar joist construction unless otherwise shown. This high level zone shall be used for running electrical raceways. Running conduits promiscuously at various levels and directions will not be acceptable. Runs at bottom chord level or ceiling grid level will not be acceptable.

C. Where spray on fireproofing is used, coordinate with the General Contractor about installing supports, panel feeders and larger conduits before fireproofing is applied. Branch circuit conduits and smaller size conduits may be run as high as possible on stud walls that go all the way up to the structure; this will minimize damage to spray on fireproofing. Patch and repair damaged spray on fireproofing caused by electrical installation; conduits shall not be fully covered with fireproofing.

D. Coordinate activity in advance to avoid interference with other trades.

E. Provide access to all junction and pull boxes.

F. Maintain 6 inches from conduit to paralleled hot water piping and 4 inches from cross piping and 12 inches from generator exhaust piping.

3.11 Secure feeder conduit to basic structural elements with galvanized strap hangers and clamps; use of trapeze type hangers is encouraged for multiple conduits where space will permit. Galvanized metal clamps and screws may be used for attaching and supporting branch circuit conduit. Non-metallic fasteners shall not be used except plastic inserts may be used in concrete for small conduits. Vertical conduits shall be supported at each floor by clamps.

3.12 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”.

3.13 During construction temporarily cap open ends of conduit. Caution trades to take special care of runs in concrete slabs during pouring.

3.14 Empty conduit installed for communications use or for future systems shall have an insulated pull wire or heavy nylon cord inserted for use in pulling wires.

3.15 Pull mandrel or large swab thru conduit to ensure freedom from debris before pulling wires. Use pulling lubricants sparingly.

3.16 Sleeves for passage of conduit, cables, wireway, cable tray and bus duct shall be placed in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect.

3.17 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor.

3.18 Refer to 26 05 05 Firestopping. Sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.19 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the conduit, cable, cable tray, bus duct and raceway shall be closed with caulking to retard the passage of smoke.

3.20 Openings for multiple conduits extending through floors where water protection is required (mechanical rooms, kitchens, other potentially wet areas) may be protected with a 4 inch high by 4 inch wide concrete curb with chamfered corners in lieu of individual sleeves. These concrete curbs may be used in lieu of the Josam 26420 riser sleeve and clamping ring provided the floor membrane and curbing are arranged to maintain the integrity of the membrane.

3.21 Conduits, wire and cables entering from outside the building shall be sealed water and moisture tight. Seal between conduit and sleeves, conduits and core drilled holes and around conductors inside conduits.

3.22 Conduits extending through the roof shall be made watertight by means compatible with the roofing system and as directed by the Roofing Contractor and approved by the Architect.

3.23 Conduit, wire and cable, where exposed to different temperatures, shall have raceway or sleeve filled with approved material to prevent circulation of warm air to cold.

3.24 Power actuated fasteners of any type are prohibited in occupied buildings. This includes anchors which are driven into place by any device which produces an impact force by use of a powder charge, compressed air, gas or any other propellant.

3.25 Provide four (4) 1 inch diameter spare conduits for each flush mounted branch circuit panelboard; extend from top of panelboard to above an accessible ceiling for future use.

3.26 All conduit terminations to be equipped with locknuts and bushings. Conduits 1-1/2 inches and larger shall have insulating bushings, grounding lug and shall have locknuts inside and outside the enclosure.

3.27 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 contained within Architectural Elevation. 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. 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.

3.28 Contractor shall record carefully on a set of "as built" prints the exact location of all feeder conduits.

3.29 Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only - ground conductors are not counted when determining maximum fill for this purpose.

END OF SECTION

26 05 43 PULLBOXES, HANDHOLES, UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEM

PART 1 - GENERAL

1.1 Work includes pullboxes, handholes and underground duct banks complete as shown, including excavation, backfill and accessories.

PART 2 - PRODUCTS

2.1 Pullboxes

A. Pullboxes shall be constructed of reinforced concrete either 3500 lb. test poured in place or precast type, complete with cover, accessories and accommodations for duct banks as shown. Construction shall be for heavy-duty traffic service to meet Indiana Department of Transportation Specifications H 20.

B. Precast pullboxes including moving and setting installation requirement shall be submitted for approval.

C. Refer to the drawings for number and sizes of pullboxes required.

D. Furnish ground rod for each pullbox and bond all exposed metal parts, including the ring for the manhole cover, to rod with minimum #8 copper conductor.

E. The use of precast concrete manholes is encouraged. Acceptable manufacturers: Oldcastle Infrastructure, Mack Industries, Norwalk Concrete Industries, E. G. Babbert or approved equal.

F. Cover shall have bolt down provisions and have "ELECTRIC" or "TELEPHONE" cast in top. Covers weighing less than 100 pounds shall have bolted fastening provided.

G. Provide pulling rings on each side of pullbox.

2.2 Handholes

A. Constructed of polymer concrete reinforced with fiberglass. Cover to be bolted with stainless steel pentahead bolts. Manufactured by Quazite, Oldcastle, or MacLean Highline.

B. Enclosures, boxes and cover are required to conform to all test provisions of ANSI/SCTE 77 “Specifications For Underground Enclosure Integrity” for Tier 15 (unless marked otherwise on drawing) applications. When multiple Tiers are specified the boxes must physically accommodate and structurally support compatible covers while possessing the highest Tier rating. In no assembly can the cover design load exceed the design load of the box.

C. All components in an assembly (box and cover) are manufactured using matched surface tooling. All covers are required to have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level embossed on the top surface.

D. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.

2.3 Duct Banks

A. Duct material, where concrete encased, shall be concrete encasement type PVC with 3" envelope of 3,000 psi concrete. Fittings shall be fully compatible for the duct material, assembled with recommended sealants to form a watertight joint. All bends shall be long sweep type; use proper adapters between PVC duct and galvanized rigid steel.

B. Ducts shall be carefully placed, aligned and tied to avoid disruption during pouring using plastic spacers.

C. Duct runs shall pitch slightly toward manholes to provide drainage; pitch away from building entrance.

D. Pull a mandrel or swab through each completed duct run; leave a No. 10 THW copper or equivalent, pull wire in all unused duct runs: plug ends of all unused duct runs.

E. Use rigid galvanized steel conduit at all bends and within five (5) ft. of the building wall. RTRC elbows may be used at risers where specifically noted.

F. Provide taper end bells at all pull in points.

G. Mark the top of all underground duct runs with one of the following methods:

1. Concentrated red dye or powder on top.
2. 6 inches wide yellow plastic tape, with black letters; place approximately 18 inches above on the centerline of the duct bank.

EXECUTION

3.1 Installation

A. Refer to Section 26 05 09 for excavation and backfill.

B. Pullboxes, handholes and ducts shall be placed only on firm soil, carefully graded. Tamped sand or gravel shall be used to compensate for over excavation.

C. Use saw cuts where existing paving, walks or curbs are cut. Replace all surfaces to near original condition as practicable.

D. Coordinate duct bank, pullbox and handhole locations with underground utilities and piping.

E. Duct runs shall be covered only after inspection and approval by the Engineer or the Architect.

F. Where concrete encased ductbanks meet building walls and manhole walls, drill and set a minimum of four size 6 reinforcing bars into manhole wall and builder walls and extend bars parallel to conduits 5 feet beyond the area excavated for manhole. Also provide size 3 cross-ties (top and bottom) 12" on center. Where ductbank crosses road also place rebars to extend under roadbed and 5 feet beyond.

G. Handhole installation over excavate hole by 6" to 8", provide minimum 6" bedding of compacted crushed stone with 6" to 12" extension beyond sides of box. Fill and compact with crushed stone around sides of box. Top of box shall be flush with finish grade.

3.2 Grounding Underground Distribution System Components

A. Grounding handholes and pullboxes: Install a driven ground rod through floor, close to wall and set rod depth so 4" will extend above finished floor. If necessary, install ground rod before structure is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into handhole through a waterproof sleeve in handhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2" above to 6" below concrete. Seal floor opening with waterproof, non-shrink grout.

B. Grounding Connections to Handhole and pullbox Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

END OF SECTION

26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Equipment Identification

A. Identify all the following items with laminated plates:

1. Every motor, lighting and equipment controller and disconnect switch.
2. Panelboards.
3. Motor control centers and individual motor starters within panelboards.
4. Transformers.

B. Nameplate on motor controllers, disconnect switches, switchboards, panelboards and transformers shall indicate source, voltage, disconnect location, and load served.

C. Branch circuit panelboards:

1. Identify panel designation on directory card within the panel.
2. Fill out branch circuit directory indicating circuit number and area served, rooms, group of rooms, lighting, convenience outlets, motors, etc. Card index shall be neatly typed. Provide electronic file for card using Excel.
3. Update or replace branch circuit directory in existing panelboards in areas of alteration.
4. Branch circuit phase conductor color format shall be permanently identified inside each panelboard.

D. Conduit and junction boxes:

1. Color code or label all junction boxes and exposed conduit at 20 ft. intervals. Coding shall be painted or labels of the pre manufactured type permanently mounted with metal or plastic band.
2. Provide a color identification scheme under heavy plastic cover hanging in the electrical rooms; identification shall be:
   a. Normal - Black
   b. Fire Alarm - Red
   c. Sound - Blue
3. Identify communications and signaling system wiring and branch circuit wiring by circuit number in panels and motor control center wiring gutters by means of permanent durable wire markers wrapped around or fastened to conductors. This shall be done concurrently with pulling of conductors.
4. Wiring or fiber cabling installed by Contractor for termination by Owner's vendor such as for telephone or data systems shall be identified at both ends utilizing the alpha/numerical identification schedule established by the system vendor.

PART 2 - PRODUCTS

2.1 Nameplates

A. Nameplates shall be laminated phenolic with black surface (red surface for emergency) and white core. Use 0.0625 inch thick material for plates up to 2 inches x 4 inches and 0.125 inch thick for larger sizes. The lettering shall be Condensed Gothic with space between the lines equal to the width of the letters. Use 0.25 inch minimum height letters on the small plates increasing the size proportionately to plate size.

B. The lettering on the plate shall indicate the name of equipment, the specific unit number, voltage, phases, which panel, switchboard or motor control center the equipment is served

from, and any other reference data pertinent to the operation. Names and numbers shall coincide with those listed on the drawings. Sample: Panel 3A; 277/480 V, 3 phase, 4 wire, served from unit substation USI.

PART 3 - EXECUTION

3.1 Nameplates shall be secured with screws, one on each end.

END OF SECTION

26 09 23 LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 Lighting control devices are identified on the drawings per legend symbols or as specifically noted. Catalog numbers from acceptable manufacturers for the common wiring devices shall be as listed herein. Catalog numbers are not listed for all devices. Other devices, such as key switches, clock hanger outlets, etc. shall be furnished by one of the manufacturers listed and shall be equal in quality to the device series listed.

1.2 When shop drawings are required for wiring devices the submittal shall be comprehensive for all wiring device configurations listed in the legend and for devices specifically noted on the drawings, including wall box dimmers, occupancy sensors and load control relays.

PART 2 - PRODUCTS

2.1 Toggle type AC switches shall be listed by Underwriters Laboratories, Inc. Switches shall be 20A, 120/277VAC and WHITE in color unless noted otherwise.

Acceptable Manufacturer	General Purpose	Red Pilot Lighted	Illuminated Handle	Momentary
Eaton	AH1221 series	AH1221 PL series	AH1221 LT series	1995 series
Bryant	4901 series	4901 PL series	4901 GL series	4921 series
Hubbell	HBL1221 series	HBL1221 PL series	HBL1221 IL series	HBL1557 series
Leviton	1221-S series	1221 PL series	1221 LH series	1257 series
P&S	PS20AC2 series	PS20AC2 RPL series	20AC1 SL series	1251 series

2.2 Ceiling/Wall Mount Occupancy Sensor

A. Sensor shall be dual-technology to detect human presence in controlled area by ultrasound and passive infrared. Dual sensing with both technologies must occur to activate lighting system. Sensor to be fully adaptive with self-adjusting and self-calibration.

B. Sensor shall have signal processing to respond to only those signals caused by human motion. Sensor to operate instantly for room motion and time off delay adjustable for 5 – 30 minutes. Sensor to be equipped with a walk-thru mode.

C. Sensor area coverage to be minimum of 1,000 SF for one sensor. Provide multiple sensors where needed for space coverage.

D. Sensor shall have provisions for manual-off function for lighting circuit from remote momentary switch (reset when not occupied) or maintained (off override).

E. Provide an additional single-pole, double throw isolated contact with each power pack for remote interface.

F. Integral photosensor for delaying turn-on of fixtures when sufficient light available in the space. Provide in ceiling mounted sensor where noted on drawings.

G. Power pack for remote mounting to match occupancy sensor.

H. Verify color with Architect.

I. All components to have 5-year warranty.

J. Manufactured by Watt-Stopper, Greengate (Cooper Controls), Hubbell Control Solutions, Leviton, Sensor Switch or Lutron.

2.3 Wall Switch Occupancy Sensor (Small Offices and similar room w/single entry door)

A. Switching w/manual and automatic control. Sensor shall use PIR sensing and shall have photocell/daylight override, vandal resistant lens. Sensor to be fully adaptive with self-adjusting and self-calibration.

B. Switches to provide two-level and incorporate two (2) dedicated relays in addition to the manual switches.

C. Verify color with Architect.

D. All components to have 5-year warranty.

E. Manufactured by Watt Stopper, Greengate (Cooper Controls), Hubbell Control Solutions, Leviton, Sensor Switch or Lutron.

2.4 Electronic Low Voltage (0 – 10V) Dimmer

A. General Requirements

1. Utilize air gap off, activated when user selects "off" to disconnect the load from line supply.
2. Operates at the rated capacity across the full ambient temperature range including modified capacities for ganged configurations which require removal of fins.
3. Provide radio frequency interference suppression.
4. Surge Tolerance: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
5. Dimmers: Provide full range, continuously variable control of light intensity.
6. Dimmers for Electronic Low Voltage (ELV) Transformers:
   a. Provide circuitry designed to control the input of electronic (solid-state) low voltage (ELV) transformers. Do not use dimmers that utilize standard phase control.
   b. Provide resettable overload protection that provides automatic shut-off when dimmer capacity is exceeded. Do not use protection methods that are non-resettable or require device to be removed from outlet box.
   c. Designed to withstand a short, per UL 1472, between load hot and either neutral or ground without damage to dimmer.

B. Preset Smart Wall Dimmers and Switches:

1. Dimmer Control: Multi-function tap switch with raised rocker for dimmer adjustment.
   a. Rocker raises/lowers light level, with new level becoming the current preset level.
   b. Switch single tap raises lights to preset level or fades lights to off.
   c. Switch double tap raises light to full on level.
   d. Switch tap and hold slowly fades lights to off over an extended period.
   e. LEDs adjacent to tap switch indicate light level when dimmer is on, and function as locator light when dimmer is off.
   f. Preset Smart Dimmer: 3-wire fluorescent ballast/LED driver (6 A, 120 V); multi-location capability using companion dimmers (up to nine companion dimmers may be connected); minimum load requirement.
   g. Companion Dimmer: Provides multi-location capability for compatible dimmers.

C. Preset Smart Wall Dimmers and Switches with Wireless Communication Inputs:

1. Communicates via radio frequency with up to nine compatible occupancy/vacancy sensors and/or wireless control stations, and one daylight sensor.
2. Dimmer Control: Multi-function tap switch with small, raised rocker for dimmer adjustment.
    a. Rocker raises/lowers light level, with new level becoming the current preset level.
    b. Switch single tap raises lights to preset level or fades lights to off.
    c. Switch double tap raises light to full on level.
    d. Switch tap and hold slowly fades lights to off over period of 10 seconds.
    e. LEDs adjacent to tap switch indicate light level when dimmer is on, and function as locator light when dimmer is off.

D. Dimmers shall be rated for the wattage it is supplying. Contractor shall coordinate lighting load on each respective dimmer and provide properly rated dimmer accordingly (600w to 1000w).

E. Contractor is responsible to coordinate the dimmer with each lighting manufacturer and verify that dimmer is compatible and capable of controlling lighting loads/fixtures from fixture manufacturer being supplied on the job.

F. Verify color of dimmer with architect prior to ordering.

G. Dimmer shall control loads down to 1%.

H. 0-10V electronic digital dimmer shall be Lutron Skylark Contour, Leviton IllumaTech, Hunt Simplicity, Cooper Slide, Watt Stopper Architectural or approved equal.

2.5 Provide a device plate to suit each particular application. Cover all empty outlet boxes with a blank plate. Coverplates shall be manufactured by Pass and Seymour, Hubbell, Cooper, Bryant, Leviton or Mulberry; Taymac is an acceptable manufacturer for weatherproof non-metallic coverplates Multi-Mac Series, “While-In-Use” type, 3.5” depth, opaque grey, locking tab, marked “EXTRA Duty”. Provide jumbo sized plates for outlets installed in masonry walls.

2.6 In finished spaces, wall plates shall be unbreakable Lexan or nylon, non-combustible, minimum 0.100” thick, with color matching metal screws; "smooth" styling. Plates shall match color of devices.

2.7 Installations consisting of three or more wall switches or wall box dimmers mounted together with either separate coverplates or a common coverplate shall have each coverplate engraved so as to identify the circuits or fixtures being controlled by each switch or dimmer. Refer to the drawings for special instructions.

PART 3 - EXECUTION

3.1 Locate devices as shown on the drawings, coordinate exact location with other trades, to avoid interference. Check for potential interference from door swings, cabinets, HVAC equipment and other wall mounted devices.

3.2 Clean debris from device boxes prior to installation of devices. Adjust devices and coverplates to be flush and level.

3.3 Control Cabling Installation

A. Lighting control low voltage wiring shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all Local, State and National codes. This Contractor shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

B. Provide firestop material and seal all cable penetrations as required.

C. All wiring shall be organized and run parallel or perpendicular to building lines above ceilings. Provide all required cable management systems such as J-hooks to support wiring to meet building codes and manufacturer's recommendations.

D. Cables shall not be laid upon ceilings, structure or equipment or supported in a manner that would violate any codes or standards.

E. All cabling installed in accessible ceiling spaces shall be UL plenum rated.

F. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

3.4 Identification/Labeling

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

3.5 Occupancy Sensor Installation

A. Verify location of occupancy sensor(s) with selected manufacturer prior to rough-in to minimize false activation of the device. Locate sensor and adjust activation field to avoid nuisance activation by movement outside of the controlled space. Sensors shall sense any human motion in the space and allow turn on with entrance into the space.

B. Provide all material and labor for a complete and operational system including power and slave packs, auxiliary relay modules and backboxes. Verify application voltage rating and provide proper rated devices.

C. Low-voltage wiring can be open wired above accessible ceilings, utilize plenum rated cabling. Installation in exposed or inaccessible locations shall be installed in conduit.

D. Coordinate time delay off setting of each occupancy sensor with the Owner. Maximum time delay off shall be 30 minutes. Minimum off delay is 10 minutes for intermittent use spaces.

E. Maintain 6 feet (minimum) to 8 feet distance from an HVAC air outlet.

3.6 Functional Testing – Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

A. Occupant Sensors

1. Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
2. For projects with up to seven (7) occupancy sensors, all occupancy sensors shall be tested.
3. For projects with more than seven (7) occupancy sensors, testing shall be done for each unique combination of sensor type and space geometry.
    a. For each sensor to be tested, verify the following:
        1) Status indicator (as applicable) operates correctly

2) Controlled lights tum off or down to the permitted level within the required time
3) For auto-on occupant sensors, the lights tum on to the permitted level when someone enters the space
4) For manual-on sensors, the lights turn on only when manually activated
5) The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation

B. Automatic Time Switches

1. Confirm that the automatic time-switch control is programmed with appropriate weekday, weekend, and holiday (as applicable) schedules.
2. Document for the owner automatic time-switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
3. Verify that correct time and date are properly set in the time switch.
4. Verify that any battery backup (as applicable) is installed and energized.
5. Verify that the override time limit is set to no more than two (2) hours.
6. Simulate occupied condition. Verify and document the following:
   a. All lights can be turned on and off by their respective area control switch.
   b. The switch only operates lighting in the enclosed space in which the switch is located.
7. Simulate unoccupied condition. Verify and document the following:
   a. All nonexempt lighting turns off
   b. Manual override switch allows only the lights in the enclosed space where the override switch is located to tum on or remain on until the next scheduled shut off occurs

C. Testing shall be performed by equipment supplier. Provide report certifying operation and performance level to Engineer.

3.7 Training Requirements

A. Provide all training and utilize specified manuals and record documentation. Training shall be provided to all Owner designated staff at the project site.

B. Demonstrate adjustment, operation and maintenance of the system including each component and control.

END OF SECTION

26 09 26 LIGHTING CONTROL PANELBOARDS

PART 1 - GENERAL

1.1 Each panelboard shall comply with all applicable codes, recommended practices and standards of IEEE, NEMA and UL. Panelboard shall be UL labeled.

1.2 The panelboard manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and the fuse / circuit breaker combinations indicated on the drawings.

PART 2 - PRODUCTS

2.1 Lighting Control Panelboards –

A. 120/208V AC Panelboards

1. Breakers shall be “bolt-on” type and in sizes thru 100A shall be minimum 22k AIC rated with adequate rating to interrupt the available fault current for fully rated system.

B. 277/480V AC Panelboards

1. Breakers shall be “bolt-on” type and in sizes thru 100A shall be minimum 17k AIC rated with adequate rating to interrupt the available fault current for fully rated system.

B. Breakers shall be remotely operated type as well as providing overload and short circuit protection. Breakers shall have UL listed SWD ratings, HID ratings and HACR ratings.

C. Breaker handle shall mechanically open the power switching device contacts when moved to the OFF position and disable the contacts from being remotely closed.

D. Manual override switch shall enable or disable the remote operation status.

E. A status indicator shall be visible to show if circuit is closed or open.

F. Switching endurance for remote control shall be rated 200,000 operations.

G. A controller shall be provided for operating and monitoring remotely operated breakers. The controller shall have real-time clock, astronomical clock, 16 override digital inputs, and 3 override analog inputs and 16 lighting group outputs. Programming to provide scheduling for 16 time of day ON/OFF, day of week repeating schedule, holiday control override and leap year/daylight saving adjustment operation. Programming to be thru hand-held controller and have Ethernet inputs. Software to be provided for remote PC system for programming and monitoring.

H. Power supply to be furnished for operation of remote operated breakers, controller, control bus system and low voltage override inputs. Power module shall have integral primary and secondary protection.

I. An equivalent master controller and slave control bus system may be provided for 16 digital overrides and 16 schedules are provided per panel.

J. Panelboards by Square D, type NF with Powerlink or Eaton Type “Power-R-Command”.

2.2 Refer to "Electrical Identification" Section 26 05 53, for nameplate requirements.

2.3 General Construction

A. Code gauge, galvanized steel tubs with minimum 4” clear gutters all sides. Minimum tub width 20”, depth 5”. On panels with more than 42 poles, include extra width (4” each side) for conductor pulling space.

B. Locking type reinforced doors with concealed hinges; equipped with directory card holder on inside of door; enameled finish. Doors over 48” high shall have 3 point latch and vault locks. All locks shall be master keyed cylinder, keyed alike including power panelboard.

C. Provide door-in-door construction. Outer door to be mounted with piano hinge and secured with lock.

D. Permanent individual breaker pole numbers affixed adjacent to each breaker in a uniform position consisting of a stamped metallic or painted numeral.

E. Bussing shall be copper.

F. Branch circuit panelboard tubs and fronts shall be sized to have 225 amp bussing and accommodate 42 poles unless indicated otherwise on the drawings. Furnish number of breakers shown.

G. A neutral bar assembly (when required) and separate ground bar assembly shall be provided. Each assembly shall be copper and have the adequate number of terminals, of sufficient size and type of anti-turn solderless lugs. Each assembly shall have conductor terminal screwdriver slots facing the front of the panel. Bond ground bar assembly to panel cabinet.

H. Terminals for feeder conductors to the panelboard mains, neutral, ground and branch circuit breaker wiring shall be suitable for the type of conductor specified.

I. Main or sub-feed breakers shall be provided where indicated. Shunt trip breakers where specified, shall have 120 volt coil and coil clearing contacts.

J. Circuit breakers shall be thermo magnetic, bolted type and where more than one pole is used, they shall employ a common trip.

K. Breakers in panelboards used for switching of 120 and 277 V fluorescent lighting circuits shall be rated for switching duty UL "SWD" or “HID” type; for switching high-intensity discharge lighting shall be “HID” type.

L. Breakers used for protection of heating, air conditioning and refrigeration equipment shall be UL "HACR" type.

2.4 The panelboards and breakers shall be adequately rated for the available fault current as indicated on the drawings and in the specifications. The total breaker and fuse short circuit and overcurrent protective system shall be UL Fully Rated System.

PART 3 - EXECUTION

3.1 Mount top of wall mounted cabinets 6’-0” above floor. Coordinate location of recessed panels so they are accessible and to avoid interference with other equipment and trades. Mount and anchor floor set panelboards on a 4” high concrete pad furnished by Contractor.

3.2 The position of breakers in each panel shall be arranged in the field for sequence phasing by this Contractor to best suit wiring conditions and balancing of phases. Fill in, typewritten, the directory of each branch circuit panelboard.

3.3 For multi-wire branch circuits, group circuit breakers together and provide breaker handle tie. Group conductors together with tie-wrap.

3.4 Provide initial programming of breaker operation. Verify with Owner the desired operation before programming and then demonstrate operation.

3.5 Provide on-site training for operation and programming of lighting panelboard controllers.

3.6 Functional testing – Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation instruction. The equipment supplier shall functionally test the system and provide report to engineer.

END OF SECTION

26 22 13 DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 Transformers shall be dry type, air cooled, two winding, insulated, high efficiency units, size and voltage as listed on drawings.

1.2 Construction and testing in accordance with NEMA, IEEE and ANSI Standards. Transformers shall bear the UL label for the specified temperature rise.

PART 2 - PRODUCTS

2.1 Manufacturer Square D, Siemens, GE/ABB, Hammond Power Solutions or Eaton.

2.2 Transformer Construction

A. Core: The magnetic circuit shall be 3 phase core type. Laminations are to be manufactured from non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses; the core shall be grounded by means of a flexible grounding conductor.

B. Coils: Coils shall be wound of continuous copper magnet wire of the barrel wound design.

C. Impregnation: Core and coil with core brackets shall be thoroughly dried followed by impregnation with a silicone varnish or non-hygroscopic thermosetting varnish.

D. Construction: Individual core and coil assemblies shall be mounted adjacent to one another but isolated from transformer case and base by means of vibration isolators. Vertical assemblies one above the other will not be acceptable. The conduit entrance and terminal board shall be located at the bottom of the enclosure. The taps must be accessible when the cover is removed.

E. Taps: Transformers 25 kVA and above shall be equipped with NEMA Standard full capacity 2.5% taps:

1. Up to 500 kVA (2) FCAN and (4) FCBN taps

2. Above 500 kVA (2) FCAN and (2) FCBN taps

F. Three phase transformers shall be 480V delta primary and 208Y/120V secondary.

G. Ground system termination bar for terminating coil, housing and system bonding jumpers and feeder equipment grounds bar shall not be installed on or over ventilation openings.

2.3 Performance:

A. Temperature Rise: Transformers 25 kVA and above shall have Class H (220 degrees C.) insulation system. When the transformer is delivering the full kVA load continuously, the temperature rise shall not exceed a 115-degree C. rise above 40 degrees C. ambient.

B. Short Circuit Strength: Transformers shall be capable of withstanding without injury, stresses caused by short circuits on the secondary with rated voltage applied to the transformer provided the short circuit duration does not exceed time limits as specified by NEMA.

C. Audible Sound Level: Sound levels shall be guaranteed by the manufacturer not to exceed the following when tested per NEMA and ANSI Standards:

kVA	Max. DB
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 – 500	60

D. Efficiency: Minimum efficiency shall be per DOE 10 CFR 431.196 amended standard (min. January 1, 2016 level). Efficiency shall be marked on label.

2.4 Housing: All live parts of the transformer shall be enclosed with a heavy gauge steel enclosure. Ventilation openings shall be protected against falling dirt and drip, shielded against actual touching of live parts. Top of case temperature shall not exceed 35 degrees C. above ambient. The terminal compartment shall be so designed to permit the use of 75 degrees C. wire. Lifting eyes or other provisions for lifting shall be provided.

2.5 Obtain from the transformer manufacturer and submit to the Architect and Engineer, copies of guaranteed performance data on NEMA forms. The minimum efficiency to meet 10 CFR Part 431 Test Procedures. Data shall be based on transformers of identical design to those specified. Test shall be in accordance with 10 CFR Part 431 Test Procedures for Distribution Transformers. Copies of tests shall be included with shop drawings. The data shall include the following:

A. Efficiency at 25%, 35%, 50%, 75% and 100%.

B. Percent regulation shall be given at 100% and 80% power factor.

C. Core loss in watts.

D. Conductor loss in watts based on reference temperature 20 degrees C. above the temperature rise of the transformer.

E. Impedance at reference temperature.

F. Sound level.

G. Average temperature rise with 40 degrees C. ambient.

H. Hot spot temperature rise with 40 degrees C. ambient.

2.6 A vibration isolation pad shall be field installed between the transformer enclosure and the concrete base or wall mounting supports, one at each of the four corners. The isolator pad shall be a one-bolt assembly with 0.75” minimum thickness neoprene isolation pad, galvanized 16 gauge minimum metal plate bonded to the neoprene pad, rubber isolator washer, flat plated steel washer, plated steel bolt; Eaton B-Line type CNNK, Amber Booth (VMC Group) Shearflex Multilayer or equal. Size isolation pad for transformer weight and mounting configuration.

PART 3 - EXECUTION

3.1 Where indicated as floor set, mount transformer on and bolt to a 4” high concrete base furnished by this Contractor. For wall mounted units, provide new factory mounting brackets and all necessary mounting hardware. For ceiling trapeze suspended transformer provide manufacturer supplied kit and suspension hardware.

3.2 Mount each transformer and enclosure on the vibration isolator pad.

3.3 All raceway connections to the transformer shall be made with liquid-tight flexible metallic conduit.

3.4 Clean the inside of the transformer of any debris or dirt before energizing the unit.

3.5 Measure primary and secondary voltages at no load and full building load and make appropriate tap adjustments to within 2% of rated voltage.

3.6 Electrical Tests

A. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a megohmmeter with test voltage output as recommended by manufacturer and International Electric Testing Association. Test duration shall be for 10 minutes with resistance tabulated at 30 seconds, 1 minute and 10 minutes. Values less than manufacturers recommendation shall be investigated. Calculate polarization index. The Polarization Index shall not to be less than 1.0.

B. Perform a turns ratio test between windings at all tap portions. Results shall not deviate by more than one-half percent for either adjacent coils or the calculated ratio.

C. Perform winding resistance tests for each winding at nominal tap position.

D. Perform power factor or dissipation-factor tests on all windings in accordance with the test equipment manufacturer's published data. Expected results vary by equipment design, confirm acceptable valves with transformer manufacturer or test equipment manufacturer.

E. Perform individual excitation current tests on each phase in accordance with established manufacturer's procedures. Typical test data pattern for a three-legged core is two similar readings and one lower current reading.

F. Measure secondary voltage phase-to-phase and phase-to-ground after final energization and prior to loading. Voltage shall be in agreement with nameplate data.

G. Provide copy of test report to Engineer.

3.7 Temporary heating: Apply temporary heating inside the enclosure according to manufacturer's written instructions throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION

26 24 16 PANELBOARDS

PART 1 - GENERAL

1.1 Each panelboard shall comply with all applicable codes, recommended practices and standards of IEEE, NEMA and UL. Panelboard shall be UL labeled.

1.2 The panelboard manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and the fuse/circuit breaker combinations indicated in the fault current analysis.

PART 2 - PRODUCTS

2.1 Panelboard Types

A. 240 Volt (Maximum) AC Panelboards

1. Breakers shall be “bolt-on” type and in sizes thru 100A shall be minimum 22k AIC, rated with adequate rating to interrupt the available fault current for a fully rated system.
2. GFCI breaker – UL Class A (5 milliampere sensitivity, combination type). Ground fault circuit protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection. Space required in panelboard shall be same as standard single pole circuit breaker.
3. Panelboard by Square D Type “NQ”, G.E. Type “AQ”, Eaton “Pow-R-Line PRL2” or Siemens P2 series.

B. 277/480 Volt AC Panelboards

1. Breakers shall be “bolt-on” type and in sizes thru 100A shall be minimum 14k AIC rated with adequate rating to interrupt the available fault current; for a fully rated system.

2. Panelboards by Square D type "NF" G.E. type “AE”, Eaton “Pow-R-Line PRL2”, or Siemens P2 Series.

2.2 Refer to "Identification for Electrical System" Section 26 05 53, for nameplate requirements.

2.3 Refer to Section 26 24 17 “Panelboard with Surge Protective Device” for panelboards with surge suppression and filter system built into panelboard enclosure.

2.4 General Construction

A. Code gauge, galvanized steel tubs with minimum 4” clear gutters all sides. Minimum tub width 20”, depth 5”.

B. Locking type reinforced doors with concealed hinges; equipped with directory card holder on inside of door; enameled finish. Doors over 48” high shall have 3 point latch and vault locks. All locks shall be master keyed cylinder, keyed alike.

C. Provide door-in-door construction. Outer door to be mounted with piano hinge and include lock.

D. For service entrance panelboards, provide a barrier so no service terminals or bus bar is exposed when servicing load terminal.

E. Permanent individual breaker pole numbers affixed adjacent to each breaker in a uniform position consisting of a stamped metallic or painted numeral.

F. Bussing shall be copper.

G. Branch circuit panelboard tubs and fronts shall be sized to have 225A bussing and accommodate 42 poles unless indicated otherwise on the drawings. Furnish number of breakers shown.

H. A neutral bar assembly (when required) and separate ground bar assembly shall be provided. Each assembly shall be copper and have the adequate number of terminals, of sufficient size and type of anti-turn solderless lugs. Each assembly shall have conductor terminal screwdriver slots facing the front of the panel. Bond ground bar assembly to panel cabinet.

I. Terminals for feeder conductors to the panelboard mains, neutral, ground and branch circuit breaker wiring shall be suitable for the type of conductor specified.

J. Main or sub-feed breakers shall be provided where indicated. Shunt trip breakers where specified, shall have 120V coil and coil clearing contacts.

K. Circuit breakers shall be bolted on type and where more than one pole is used, they shall employ a common trip.

L. Breakers in panelboards used for switching of 120V and 277V fluorescent lighting circuits shall be rated for switching duty UL "SWD" or “HID” type; for switching high-intensity discharge lighting shall be “HID” type.

M. Breakers used for protection of heating, air conditioning and refrigeration equipment shall be UL "HACR" type.

2.5 All panelboards serving life safety loads are to have a SPD connected to each panel. Provide branch circuit breaker and SPD refer to specification section 26 43 13 Surge Protective Devices.

2.6 The panelboards and breakers shall be adequately rated for the available fault current as indicated on the drawings and in the specifications. The total breaker and fuse short circuit and overcurrent protective system shall be U.L. Fully Rated System.

PART 3 - EXECUTION

3.1 Mount top of wall mounted cabinets 6’-0” above floor. Coordinate location of recessed panels so they are accessible and to avoid interference with other equipment and trades. Mount and anchor floor set panelboards on a 4” high concrete pad furnished by this Contractor.

3.2 The position of breakers in each panel shall be arranged in the field for sequence phasing by this Contractor to best suit wiring conditions and balancing of phases. Fill in, typewritten, the directory of each branch circuit panelboard.

3.3 For multi-wire branch circuit group circuit breaker together and provide breaker handle tie. Group conductors together with tie-wrap.

3.4 Adjust circuit breaker trip and time delay settings to values as indicated in the coordination study.

END OF SECTION

26 24 17 PANELBOARD WITH SURGE PROTECTIVE DEVICE

PART 1 - GENERAL

1.1 Each panelboard shall comply with all applicable codes, recommended practices and standards of IEEE, NEMA and UL. Panelboard and panelboard extension containing the Surge Protective Device (SPD) shall be UL labeled.

1.2 The panelboard manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and the fuse/circuit breaker combinations indicated on the drawings.

1.3 The basic panelboard with integral surge protective device (SPD), shall comply entirely with Section 26 24 16, Panelboard, have breakers fully interchangeable and by the same manufacturer as those breakers furnished for this project under Section 26 24 16.

PART 2 - PRODUCTS

2.1 For panelboard and breaker types refer to Specification Section 26 24 16 Panelboard approved manufacturers are Square D, Siemens, Eaton and G.E.

2.2 Refer to "Identification for Electrical Systems", section for nameplate requirements.

2.3 Refer to Section 26 43 13 “Surge Protective Devices (SPD’s) for Low-Voltage Electrical Power Circuits” for additional requirements for surge suppression and filter system and acceptable manufacturers for SPD and panelboard extension for SPD.

2.4 General Construction

A. Code gauge, galvanized steel tubs with minimum 4” clear gutters all sides. Minimum tub width 20”, depth 5”.

B. Locking type reinforced doors with concealed hinges; equipped with directory card holder on inside of door; enameled finish. Doors over 48” high shall have 3 point latch and vault locks. All locks shall be master keyed cylinder, keyed alike.

C. Integral SPD is defined as a device that is placed directly inside a completely barriered off section of the panelboard by the panelboard manufacturer (panelboard or SPD manufacturer or UL recognized OEM) or by the use of a panelboard extension that is provided directly from the SPD manufacturer. In any case, the SPD shall be in a separate barriered off section so that conductive smoke and ionized gases from a failed SPD will not cause flashover within the panelboard.

D. The SPD shall be connected to the panelboard through a 30A/3P breaker provided by the panelboard manufacturer. The SPD shall be easily accessible without the need to remove the panelboard dead-front shield, exposing live bus bar.

E. If panelboard extension is used it shall include an enclosure backbox with knock-outs for feeder and branch circuit conduit and shall have similar dimensions as the panelboard tub.

F. The front cover of the panelboard extension shall be of the same width as the panelboard cover. Note: An option is to build an oversized panelboard cover that will extend over the SPD enclosure or have a separate hinged door over the SPD section with matching key and lock.

G. The panelboard extension shall provide sufficient space to allow for feeders and/or branch circuits to pass through the extension without affecting the operation of the SPD.

H. The SPD lamps, indicators and audible device available on the panelboard extension shall be protected from tampering.

I. The panelboard cover shall be secured to the SPD enclosure with a tamper-proof means. For example, special tools may be required to remove this cover.

J. Permanent individual breaker pole numbers affixed adjacent to each breaker in a uniform position consisting of a stamped metallic or painted numeral.

K. Bussing shall be copper.

L. Branch circuit panelboard tubs and fronts shall be sized to have 225A bussing and accommodate 42 poles unless indicated otherwise on the drawings. Furnish number of breakers shown.

M. A neutral bar assembly (when required) and separate ground bar assembly shall be provided. Each assembly shall be copper and have the adequate number of terminals, of sufficient size and type of anti-turn solderless lugs. Each assembly shall have conductor terminal screwdriver slots facing the front of the panel. Bond ground bar assembly to panel cabinet.

N. Terminals for feeder conductors to the panelboard mains, neutral, ground and branch circuit breaker wiring shall be suitable for the type of conductor specified.

O. Main or sub-feed breakers shall be provided where indicated. Shunt trip breakers where specified, shall have 120V coil and coil clearing contacts.

P. Circuit breakers shall be bolt-on type and where more than one pole is used, they shall employ a common trip.

2.5 The panelboards and breakers shall be adequately rated for the available fault current as indicated on the drawings and in the specifications. The total breaker and fuse short circuit and overcurrent protective system shall be U.L. Fully Rated.

PART 3 - EXECUTION

3.1 Mount top of wall mounted cabinets 6’-0” above floor. Coordinate location of recessed panels so they are accessible and to avoid interference with other equipment and trades. Mount and anchor floor set panelboards on a 4“ high concrete pad furnished by this Contractor.

3.2 The position of breakers in each panel shall be arranged in the field for sequence phasing by this Contractor to best suit wiring conditions and balancing of phases. Fill in, typewritten, the directory of each branch circuit panelboard.

3.3 The circuits from AFCI breakers shall be connected with independent neutral conductors i.e., no shared neutral conductors.

3.4 For multiwire branch circuits, group circuit breakers and provide a handle tie. Group conductors together with tie-wraps.

END OF SECTION

26 27 16 ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 Work includes all special cabinets and enclosures; equipment shall conform to requirements of N.E.C. and shall be UL labeled.

PART 2 - PRODUCTS

2.1 Indoor Cabinets - NEMA 1

A. Cabinets shall be galvanized code gauge steel, finished gray enamel or manufacturer's standard equivalent finish, of sizes shown with flush painted hinged door and master keyed cylinder locks keyed to match panelboard locks. Cabinets in finished areas shall be designed for flush mounting with separable front overlapping flange. Cabinets in concealed areas shall be surface mounted types.

B. Each cabinet shall be equipped with a 0.75” thick waterproof fir plywood backboard painted gray.

PART 3 - EXECUTION

3.1 Mount the cabinets and enclosures as indicated on the drawings and in accordance with manufacturer's instructions.

3.2 Mount top of wall mounted cabinets 6’-0” inches above floor. Coordinate location of recessed cabinets so they are accessible and to avoid interference with other equipment and trades.

3.3 Refer to "Identification for Electrical System" Section for nameplate requirements.

END OF SECTION

26 27 19 SINGLE AND MULTIPLE CHANNEL ALUMINUM MULTI-OUTLET ASSEMBLIES

PART 1 - GENERAL

1.1 Scope

This specification covers a power wiring system with a factory wired multioutlet assembly used for branch circuit wiring and/or voice, data, video and other low voltage wiring. Multiple outlet raceway system shall consist of raceway, appropriate fittings, receptacle harness and receptacle identification to complete the installation as shown on the building plans.

1.2 Classification and Use

The multioutlet assembly is to be utilized in dry interior locations, and UL Listed as a Multioutlet Assembly and Surface Metal Raceway as covered in Articles 386 and 380 of the National Electrical Code.

1.3 Submittals

A. Shop Drawings

Submit drawings for approval, show the complete layout of all products that make up the complete system for each floor prior to installation with raceway lengths, device type (power and communications), locations and circuit identification.

PART 2 - PRODUCT

2.1 Manufacturer

The multioutlet pre-wired assembly specified herein shall be Legrand AL7320 Three channel-two cover / AL4750 and Two channel-one cover / AL3000 Single channel or equal by Hubbell.

2.2 Materials

A. Raceway

Raceway shall have (insert # of compartments) wiring compartments with field removable cover(s). Raceway shall have a nominal wall thickness of (insert wall thickness from series specification). Multiple compartment raceway shall have (an) integral dividing barrier(s) isolating wiring compartments and provided with fittings that maintain the separation of compartments.

Raceway covers shall be 12" in length to facilitate future modification or shall be provided in other specified lengths. Covers must be removable with a standard straight blade screwdriver without marring. Raceways having two covers must allow each cover to be removed separately without allowing access into the compartment(s) enclosed by the other cover.

Raceway shall be manufactured of extruded #6063-T5 aluminum with a heavy etched Architectural Class II clear anodized finish (AA-C22A31). Dimensions of the raceway shall be (insert series dimension H&W) and each length of raceway shall be cut to specified job requirements. Field cutting of raceway will not be permitted.

B. Wiring Devices

Wiring devices and other connectors shall be factory installed, electrically wired, and covers labeled with (insert labeling choice) as identified in the building plans. Each receptacle shall be identified noting the panel number and circuit number from which it is fed. Receptacles rated higher than a NEMA 5-20R configuration shall also be provided with voltage, phase and amperage identified in the same manner. Raceway sections shall be provided with 12" pigtails at feed locations for ease of installation. Grounding shall be maintained by means of factory installed NEC sized grounding conductor(s) and utilize insulation displacement connectors as required.

C. Communication Outlets

Raceway covers shall have either holecut provision for communications outlets, if Wiremold Interlink Cabling System data connectors are used, or the voice and data/LAN outlets shall be factory mounted to the cover plates. The raceway must be capable of containing, but not limited to, snap-in modular jacks (3-pair, 4-pair, 4-pair keyed and MMJ), coaxial and F-connectors and communication grommets. Wiring connections of these devices shall be completed at the jobsite by the appointed contractor.

D. Fittings

The multioutlet assembly is to consist of factory assembled product with a full complement of fittings including, but not limited to, elbows (90º, internal and external), slide couplings for joining raceway sections, blank end caps for closing open ends of the raceway, and flat tees.

E. Communication Devices and Accessories

The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP (including Category 5), STP (150 ohm) Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available.

PART 3 - EXECUTION

3.1 Installation

Prior to and during installation, refer to system layout drawings containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets that accompany system components, as well as instruction sheets.

A. Mechanical Security

All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets in accordance with manufacturer's installation instruction sheets.

B. Electrical Safety

All metal raceway shall be electrically continuous and bonded in accordance with the National Electrical Code for proper grounding.

C. Raceway Support

Raceway shall be securely supported at intervals not exceeding 10' or in accordance with manufacturer's installation sheets.

D. Completeness

Raceway shall be installed with all appropriate fittings in accordance with the manufacturer's installation instructions and in compliance with all appropriate codes. Raceway is to be plumb, square, level and in alignment with casework or furniture as required.

END OF SECTION

26 27 26 WIRING DEVICES AND COVERPLATES

PART 1 - GENERAL

1.1 Wiring devices are identified on the drawings per legend symbols or as specifically noted. Receptacles are identified in the legend by NEMA configuration numbers only. Catalog numbers from acceptable manufacturers for the common wiring devices shall be as listed herein. Catalog numbers are not listed for all devices. Other devices, such as clock hanger outlets, etc. shall be furnished by one of the manufacturers listed and shall be equal in quality to the device series listed.

1.2 When shop drawings are required for wiring devices and coverplates, the submittal shall be comprehensive for all wiring device configurations listed in the legend and for devices specifically noted on the drawings.

PART 2 - PRODUCTS

2.1 Standard specification grade receptacles shall be listed by Underwriters Laboratories, Inc. and shall be minimum 20A, 125V, NEMA 5-20R and WHITE in color unless noted otherwise. Where identified on drawing that receptacle is controlled a device of same design to be furnished but with controlled symbol marking.

Acceptable Manufacturer	Single	Duplex	Ground Fault	Isolated Ground	WR GFI	Tamper Resistant
Eaton	5351	5352	SGF20	IG5362	WRSGF20	TR5362
Bryant	5351	5352	GFRST20	BRY5362IG	GFWRST20	CBRS20TR
Hubbell	HBL5361	5352A	GFRST20	IG5352	GFFIWRST20	HBL5362TR
Leviton	T5020	5842	G5362WT	5362IG	G5362WT	TD63
Legrand	5351	CRB5362	2095	IG6300	2095TRWR	TR63

2.2 Receptacles installed in a damp or wet location shall be a listed weather-resistant (WR) type.

A. Receptacle shall be installed in a listed weatherproof enclosure, whether or not the attachable plug cap is inserted.

2.3 Provide GFCI devices as shown on drawings and in compliance with NEC 210.8 for type and location. Where GFCI receptacle devices not available at rating required a GFCI protection device to be provided. Bender Lifeguard series.

2.4 Tamper-Resistant Receptacles. All 15A and 20A, 125V and 250V nonlocking-type receptacles shall be listed tamper-resistant receptacles.

2.5 Provide a device plate to suit each particular application. Cover all empty outlet boxes with a blank plate. Coverplates shall be manufactured by Pass and Seymour, Hubbell, Cooper, Bryant, Leviton or Mulberry; Taymac is an acceptable manufacturer for weatherproof non-metallic coverplates Multi-Mac Series, “While-In-Use” type, 3.5 inches depth, ‘Extra Duty’, opaque grey, locking tab. Provide jumbo size plates for outlets installed in masonry walls.

2.6 In finished spaces, wall plates shall be unbreakable lexan or nylon, non-combustible, minimum 0.100” thick, with color matching metal screws; "smooth" styling. Plates shall match color of devices.

2.7 Coverplates for telephone and other communication system outlets shall be a blank coverplate unless indicated otherwise on the drawings or in the respective communication system specifications. Color and material of plates shall match plates provided for other wiring.

PART 3 - EXECUTION

3.1 Locate devices as shown on the drawings, coordinate exact location with other trades, to avoid interference. Check for potential interference from door swings, cabinets, heating equipment and other wall mounted devices.

3.2 Clean debris from outlet boxes.

3.3 Install receptacles with grounding pole on top.

3.4 Verify each receptacle device is energized and test each device for proper polarity.

3.5 Adjust devices and wall plates to be flush and level.

END OF SECTION

26 28 13 FUSES

PART 1 - GENERAL

1.1 Safety switches and other fusible protective devices provided under this contract shall be complete with fuses properly sized to protect the feeders and equipment served.

1.2 Fuses shall not be shipped installed in switches in electrical equipment nor shall they be shipped to the job site until the equipment is ready to be energized. Fuses shall be of the same manufacturer to retain selectivity as designed.

PART 2 - PRODUCTS

2.1 Manufacturers shall be Bussmann, Mersen, Littelfuse or Edison.

2.2 Fuses shall be current limiting with 200,000 AIC, all shall be UL labeled.

2.3 Fuses, 601A to 6,000A (bolt type dimensions) shall be UL Class "L" fuses. The size and type is indicated on drawings; Bussmann HI CAP time delay fuse KRP C shall be used.

2.4 Fuses with ampere ratings 1A to 600A (standard dimensions) shall be UL Class RK 1. The size and type is indicated on drawings. Bussmann LOW PEAK Time Delay fuse LPN RK (250V) or LPS RK (600V).

2.5 Where Bussmann specific fuse types are indicated above or on the drawings, acceptable fuses by cross reference of manufacturers are:

Voltage UL Class	Ratings	Bussmann	Mersen	Littel Fuse	Edison
L	600 V	HI CAP KRP C	AMP TRAP A4BQ( )	POWR-PRO KLPC	LCL
RK 1		Low Peak	AMP TRAP II	POWR-PRO	
	250V	LPN RK	A2D ( ) R	LLN-RK	LEN-RK
	600V	LPS RK	A6D ( ) R	LLS-RK	LES-RK
J (Time Delay)	600V	LPJ ( )	AJT ( )	JTD ( )	JDL ( )

PART 3 - EXECUTION

3.1 Place a fuse identification label showing type and size inside door of each switch. Use fuse reducers where fuse gaps are larger than fuse dimension.

3.2 Verify fuse types before installation for proper application by voltage and ampere ratings; fuses protecting motors shall not exceed 150 percent of motor nameplate amps. (Applies to fuses in sizes 600 amps and below.)

3.3 Furnish the Owner with a minimum of 25 percent of quantity of each size installed, but not less than one complete set of three spare fuses for each size of fuse furnished.

END OF SECTION

26 28 16 DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 Provide disconnect switches, fused and non-fused, where indicated on the drawings and in the specifications, and where required by the NEC.

PART 2 - PRODUCTS

2.1 Disconnect switches shall be listed by Underwriter's Laboratories and shall be manufactured by Square D, Siemens, G.E. or Eaton. All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

2.2 Switches shall be Heavy-Duty Type, NEMA 1 enclosures, non-fused except where fuses are specified or required to protect wiring from overload; provide raintight NEMA 3R type enclosures for outdoor applications unless otherwise noted.

2.3 Disconnect switches shall be quick-make, quick-break, externally operated with door interlocked with operating handle. Provide solid neutral and ground bars where indicated or where required by the application.

2.4 Disconnect switches shall have multiple padlock provisions in the off position.

2.5 The fuse holders shall be designed for Class "R" rejection type fuses.

2.6 Refer to "Identification for Electrical Systems" Section for nameplate requirements.

PART 3 - EXECUTION

3.1 Mount top of wall mounted disconnect switch 6 ft.-0 inches above floor where space permits.

3.2 Coordinate location of disconnect switches to avoid interference with other equipment and trades and allow access for safe operation.

END OF SECTION

26 29 13 MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 Schedules on the drawings list motors with disconnect and starter requirements and associated controls. Motor starters and disconnects shall be furnished under this Contract except where specifically shown or specified to be furnished by other trades. Motor starters and disconnects shall be manufactured and rated in accordance with NEMA, UL and IEEE standards. IEC RATED CONTACTORS AND OVERLOADS ARE NOT ACCEPTABLE.

1.2 Refer to "Disconnect Switches" Section for switch requirements.

1.3 All motor starters shall be rated for the available fault current at the point of application.

PART 2 - PRODUCTS

2.1 Manufacturer Allen Bradley, whose catalog numbers are used herein as a standard, or equivalent by Square D Type S (Class 8536), G.E. Series CR306, Eaton Class AN16 or Siemens "U.S. Series". All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

2.2 Where new motor starters and disconnect switches are to be installed in existing motor control centers they shall match existing units.

2.3 Magnetic starters shall be line voltage suitable for the service listed on the drawings. Each starter shall have one extra auxiliary contact for future control purposes, a 3-leg melting alloy thermal overload relay on a single block, a manual reset mechanism, a 120-volt control coil, Bulletin 509. Contractor shall have the option of installing Bulletin 512 combination starters in place of separately mounted switches and starters. Disconnects shall be fused type unless otherwise specifically indicated or required by NEC.

2.4 A HAND-OFF-AUTO selector switch shall be mounted in the face of each starter enclosure. The selector switch shall be so wired that when it is in the HAND or AUTO position, all SAFETY controls are wired in series with the selector switch; all CONTROL DEVICES shall be wired in the AUTO position only.

2.5 Each starter enclosure shall have a suitable 120-volt secondary control transformer fused separately on each phase of the primary and secondary, and grounded on the secondary.

2.6 Each starter shall have a red LED pilot light mounted in the face of the starter enclosure. The LED shall be wired so it will be on when the motor is energized.

2.7 Magnetic starters shall be furnished for motors, one horsepower and greater or any 3-phase motor, unless indicated otherwise on plan.

2.8 Manual starters with thermal overload protection shall be furnished for fractional horsepower, single phase motors unless otherwise noted and shall be Bulletin 600 with a pilot light, flush mounted in finished areas.

2.9 Two speed starters shall be separate winding (two winding); Bulletin 715 with adjustable time delay on high to low speed. Contractor shall verify that starter being provided is proper for motor being furnished.

2.10 Unless otherwise noted or required by Code, safety switches shall be Heavy Duty Type, NEMA 1 enclosures, fused except where fuses are specified or required to protect wiring from overload.

Switches shall be quick make, quick break, externally operated with door interlocked with operating handle and padlock provisions in OFF position. Provide solid neutral and ground bars where required. Switches located outside shall be raintight NEMA 3R, unless otherwise noted.

2.11 Motor Control Center

A. Manufacturers: Square D to match existing.

B. NEMA Class 1 with Type B wiring, ANSI industrial construction. Each starter cubicle shall have a companion circuit overload protection and disconnect device.

C. Minimum starter size shall be NEMA 1; starters thru NEMA size 2 shall be plug in, larger sizes bolt in.

D. Provide adjustable phase failure-reversal-undervoltage relay protection on all motor starters NEMA size 3 and larger; wire ahead of the H-O-A switch.

E. Each cubicle shall include a quick make, quick break fusible switch with an interlocking external handle for use as a disconnect means. The handle position shall indicate the "on" or "off" position. Provisions for three padlocks shall be provided for locking each unit in the "off" position. The fuse holders shall be designed for "Low Peak", Class "R" rejection type fuses.

PART 3 - EXECUTION

3.1 Check full load ampere and service factor rating of each motor after installed and furnish the proper size overload heater elements to protect the motor.

3.2 Provide a permanent directory card with frame and transparent protector with typewritten information identifying each motor by number, location, service, HP, electrical characteristics, full load amps and overload heater size. Directory shall be displayed on the front of the motor control center or motor starter panelboard.

3.3 Those portions of interlock and control wiring which are required but not prewired, shall be done in the field.

3.4 Motor starters and disconnect switches shall be conveniently accessible; all NEC minimum clearances from walls, pipes, ducts, equipment, etc., shall be maintained. Locate as inconspicuously as possible in finished spaces.

3.5 Refer to "Identification for Electrical Systems" section for nameplate requirements.

3.6 Place label in each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage / phase, OL type and OL size.

END OF SECTION

26 43 13 SURGE PROTECTIVE DEVICES (SPD'S) FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 This specification describes the mechanical and electrical requirements for a low voltage Surge Protective Device (SPD); refer to Article 285 of the NEC. The SPD shall be suitable for application in category environments as described.

1.2 Refer to the following specification sections for factory installation of the SPD in equipment:

26 24 13	Distribution Switchboard (Below 600V)
26 24 17	Panelboard with Surge Protective Device

1.3 Submit the following for approval:

A. All related shop drawings, product data, manufacturer's installation instructions and maintenance manuals.

B. Dimensional drawing of each SPD type indicating mounting arrangements.

C. Single line diagram indicating all field connection requirements, conductor and overcurrent sizes, recommended conduit type, alarm contacts, etc.

D. Maximum Surge Current Rating: Provide test reports demonstrating that the SPD is capable of surviving the specified maximum surge current rating. The rating shall be provided on a per mode basis. Reports shall clearly show that the tests have been performed on a COMPLETE SPD including all necessary fusing, thermal disconnects, integral disconnects, monitoring systems, etc.

E. Minimum repetitive surge current ratings: Test reports from a third-party testing organization will demonstrate that a COMPLETE SPD has been tested to specified ratings. A complete device will include all necessary fusing, thermal disconnects, integral disconnects, monitoring systems, etc.

F. Provide name of the nationally recognized independent testing laboratory that performed tests verifying that the COMPLETE SPD can survive the published surge current rating on a per mode and per phase basis and at maximum surge current level the fuses survive without blowing when the manufacturer recommended disconnect and overcurrent protection are installed in same test and circuit.

G. UL documented Voltage Protection Ratings (VPR) for all modes. (L-L, L-N, L-G, N-G)

H. Short Circuit Current Rating (SCCR).

I. Maximum Continuous Operating Voltage Rating (MCOV).

J. I-nominal (I-n).

K. Type listing.

1.4 Manufacturers Qualifications: Firms regularly engaged in the manufacture of SPD products for specified category and whose products have been in satisfactory service for not less than 5 years.

1.5 UL compliance and labeling: Listed per latest edition of UL 1449 Fourth Edition and latest editions of UL 1283 and UL 1414 for Electromagnetic Interference Filters, where applicable.

1.6 SPD shall be independently laboratory tested.

1.7 NEC compliance: Comply with NEC as applicable to construction and Article 285 for installation. The mounting position of the SPD shall permit a short lead length.

1.8 In accordance with NEC Article 285, the SPD shall be clearly marked with the short circuit current rating. The SCCR rating shall meet or exceed the rating of the equipment to which it will be applied. Providing additional fusing to meet this requirement shall not impact the maximum surge current rating or the minimum repetitive surge current rating. Test reports furnished from third party testing organizations shall verify this.

1.9 The SPD shall be warranted for unconditional failure replacement for a minimum of 10 years inclusive of all labor to restore the device to functionality. The first 5 years of this warranty will include the field labor required to remove/replace/or repair the failed SPD. Submit Warranty with shop drawings.

1.10 The SPD MOVs will be individually fused to provide full system redundancy and provide a short circuit current rating of 200kAIC. The fusing system will also allow the full maximum surge current rating to pass through without fuse operation.

1.11 By ANSI/IEEE C62.45 definition, “Category C3 Combination Wave” is 20 KV 1.2 microsecond open circuit voltage, 10 kA 8/20 microsecond short circuit current. Where category C3 is referenced in this specification, it shall mean the same.

1.12 The overcurrent protection/disconnect device shall have a short circuit current rating SCCR greater than that available on the electrical distribution system.

PART 2 - PRODUCTS

2.1 The SPD for main service entrance rated 800 A and above and unit substations shall be located inside the main section of the switchboard and have:

A. SPD shall be UL labeled as Type 1 – verified through certification at UL.com.

B. A surge current capacity of 240,000A minimum total per phase (8/20 microsecond surge current pulse) and rated for category C3; minimum 120 kA L-G, 120 kA L-N, 120 kA N-G.

C. SPD shall be UL labeled with 20 kA I-nominal I-n for compliance to UL96A Lightning Protection Master Label and NFPA 780.

D. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	**L-N**	**L-G**	**L-L**	**N-G**
208Y/120	800V	800V	1200V	700V
480Y/277	1200V	1200V	2000V	1200V

(Mode VPRs verifiable at UL.com. Numerically lower is allowed/preferred/ old-style suppressed voltage ratings (SVRs) shall not be submitted, nor evaluated due to outdated less-strenuous testing).

E. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

F. The SPD shall have a minimum repetitive surge current rating of 5,000 ANSI/IEEE C62.41 Category C3 impulses. Manufacturers may propose alternative maximum surge current ratings provided that this requirement is met.

G. All modes of protection L-L, L-N, L-G and N-G.

H. When a suppression filter system is supplied, it shall comply with UL 1283. Typical noise attenuation shall be:

-34 dB at 100 kHz; -51 dB at 1 MHz; -54 dB at 10 MHz; -48 dB at 100 MHz.

I. Approved manufacturers and models, subject to compliance with requirements, are:

MAIN SERVICE		
	120/208V	**277/480V**
Eaton	SPD250-208Y3M	SPD260-480Y3M
Joslyn (T&B)	JSP240-3Y208B	JSP240-3Y480B
Current Tech (T&B)	CGP120-120/208-3GY	CGP120-277/480-3GY
ASCO	520120YP25ACCLIX	520277YP25ACCLIX
Square D	SSP02EMA24D	SSP04EMA24D

2.2 The SPD for panelboards rated 400A to 600A where indicated on the drawings shall have:

A. SPD shall be labeled as type 2 – verified through certification on UL.com.

B. A surge current capacity of 120,000A minimum total per phase (8 x 20 microsecond waveform) and rated for category C3; 60 kA L-G; 60 kA L-N; 60 kA N-G.

C. SPD shall be UL labeled with 20 kA I-nominal I-n.

D. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	800V	800V	1000V	800V
480Y/277	1200V	1200V	1800V	1200V

E. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

F. The SPD shall have a minimum repetitive surge current rating of 5,000 ANSI/IEEE C62.41 Category C3 impulses. Manufacturers may propose alternative maximum surge current ratings provided that this requirement is met.

G. All modes of protection L-L, L-N, L-G and N-G.

H. UL 1283 high frequency extended range tracking filter. Typical noise attenuation shall be:

-34 dB at 100 kHz; -51 dB at 1 MHz; -54 dB at 10 MHz; -48 dB at 100 MHz.

I. Approved manufacturers and models, subject to compliance with requirements are:

PANELBOARDS AND LOAD SIDE OF ATS		
	120/208 V	**277/480 V**
ASCO	520120YP13ACCLIX	520277YP13ACCLIX
Eaton	SPD 120-208Y3M	SPD 120-480Y3M
Joslyn (T&B)	JSP 120-3Y208B	JSP 120-3Y480B
Current Tech (T&B)	CGP60-120/208-3GY	CGP60-277/480-3GY
Square D	SSP02EMA12D	SSP04EMA12P

2.3 For panelboards with integral surge suppression and filter system where indicated on the drawings, refer to Section 26 24 17 Panelboard with Surge Protective Device.

2.4 The SPD shall be compatible with the electrical system, voltage, current and distribution configuration.

2.5 The SPD shall use only solid-state clamping components to limit the surge voltage.

2.6 The SPD shall use LED indicators, which provide indication of proper suppressor operation and of suppression-failure; provide means for assuring lamps are operable. Include optically isolated N/C drop contacts for remote monitoring.

2.7 A means of mechanical safety disconnect shall be provided with a symmetrical fault current commensurate with the installation location. This disconnect shall be used for isolating the SPD from the electrical service for repair/testing without taking the whole panelboard, switchboard, or ATS out of service.

PART 3 - EXECUTION

3.1 For switchgear and switchboard applications, connect the SPD to the main bus. Provide a 3-pole molded case breaker or fusible switch with overcurrent protection integral with the SPD enclosure to serve as a means of mechanical disconnect. Fuse sizes and type shall be provided by the SPD manufacturer. Provide 3 spare fuses for each SPD. Note: The SPD and overcurrent/disconnect device shall have a short circuit current rating SCCR greater than that available on the electrical system.

3.2 Install SPD external to panel where shown on drawings. Provide 30A/3P circuit breaker, or size as recommended by SPD manufacturer, in panel to serve the SPD as a means of mechanical disconnect and overcurrent protection. Note: The SPD and overcurrent/disconnect device shall have a short circuit current rating SCCR greater than that available on the electrical system.

3.3 All conductors shall be copper and sized per the manufacturer's recommendations. The conductors are to be as short and straight as practically possible and shall not exceed 18 inches in length and shall be installed in PVC conduit (as local jurisdiction allows) where raceway is required. The input conductors are to be twisted together to reduce the SPD system inductance.

3.4 The SPD shall be installed following the SPD manufacturer's recommended practices and in compliance with all applicable codes.

3.5 A SPD will not withstand an overvoltage condition. Disconnect each SPD before using testing equipment on the system such as meggars and high voltage test equipment.

3.6 Before energizing the SPD and before installation of the SPD shall be considered complete, the Contractor shall verify the integrity of the ground system to which the SPD is connected including grounding of all service entrance neutrals and neutrals of all separately derived systems as required by the NEC.

END OF SECTION

26 51 13 INTERIOR LUMINAIRES AND DRIVERS

PART 1 - GENERAL

1.1 Refer to schedule on the drawings for information on luminaires, lamps and manufacturers. Luminaires of manufacturers other than those listed, if offered, shall be on a substitute basis and so listed as a substitute with the bid. (Refer to Section 26 05 01, para. 2.3 B.)

1.2 The catalog numbers listed on the schedule do not necessarily have complete prefix and suffix designations for placing the luminaire order. The Contractor shall verify these numbers and include in their bid the necessary plaster frames, accessories, trim, mounting hardware, etc. to achieve a coordinated installation with ceiling types indicated on the architectural drawings and in specifications. The Contractor shall provide any hardware indicated by notes on the fixture schedule.

1.3 Luminaires, drivers and individual components shall bear UL label.

1.4 Where luminaires are installed in fire rated ceilings the following methods may be utilized: fire rated light covers, fire boxes or custom-built boxes. Detail of method shall be submitted.

1.5 Submittals

A. Detailed cut sheets for all LED luminaire complete assembly shall be submitted for approval with shop drawings. Identifying pertinent information such as the manufacturer, lumens, voltage, wattage/VA, housing construction, lens material, etc. Also, submit emergency battery ballast cut sheets for review. Shop drawings will be rejected if required information is not submitted.

B. Submittals shall include dimensions, ratings, performance data and components of each luminaire. Where indicated on schedule, submit two (2) color chips illustrating luminaire finish color.

PART 2 - PRODUCTS

2.1 LED Luminaire Components

A. LED Luminaire

1. LED luminaire shall be rated for an installation/ambient temperature from -40 degrees C to +40 degrees C.
2. LED luminaire shall be modular in design (when applicable per the basis of design) with the ability to replace drivers, light engines, arrays, optics, reflectors, etc., without having to replace the entire luminaire.
3. The heat sink shall be easily accessible for maintenance or cleaning to maintain the overall thermal performance of the luminaire within specifications. The light engine and driver shall be easily accessible for maintenance.
4. LED luminaire (type V distribution) shall have an even distribution of luminous intensity within the 0 degree to 90 degree zone. Luminous intensity at any angle within this zone shall not differ from the mean luminous intensity for the entire 0 degree to 90 degree by more than 10 percent.
5. Exterior LED luminaire shall be full cutoff or fully shielded as defined by IESNA-RP-8.
6. LED luminaire shall come standard with the ability for full dimming. When luminaire is to be powered by generator for emergency operation the luminaire is to be UL 924 listed.
7. LED Luminaire shall have a minimum of 5 year warranty.
8. Solid State Lighting (LED) – UL 1598.

B. LED/LED Module

1. LED/LED Module(s) shall be manufactured by:
   a. Nichia
   b. Cree
   c. Achriche
   d. Phillips
   e. Osram/Sylvania
   f. Approved Equal (By Engineers approval)
2. LEDs shall be of the highest production quality.
3. LED/LED Module shall be rated for 50,000 hours of life at 70 percent output (L70) and shall have been tested in accordance with IESNA LM-79, LM-80, and TM-21.
4. LED/LED Module manufacturers shall adhere to LED package manufacturer guidelines, certification programs, and test procedures for thermal management.
5. LED/LED Module(s) shall be rated for a minimum luminous efficacy of 80 Lumens per Watt (lm/W).
6. Color consistency NEMA SSL-3.
7. LED/LED module shall have a minimum CRI of 70. High CRI where noted shall be minimum 85 (sample R1 – R8) with sample R9 minimum 80.
8. LED/LED Module(s) shall have one of the following designated CCTs (Correlated Color Temperature) per ANSI C78.377-2008 and all within the 7-step chromaticity quadrangles as defined below:
   a. 2700 K
   b. 3000 K
   c. 3500 K
   d. 4100 K
   e. 5000 K
9. LED/LED Modules shall originate from a common manufactured batch source.
10. Contractor shall provide 5% of each module specified as spare in original sealed packaging and transport to the Building (and put in storage) as directed by the Owner.

C. LED Driver

1. The driver shall have 50,000 hrs. of anticipated/rated life. Minimum efficiency of 85 percent at full load conditions.
2. UL 8750 approved.
3. Driver shall meet UL Class 2 for use in dry or damp location.
4. FCC rule title 47CFR Part 15, Class A minimum compliant.
5. Driver shall have inherent short-circuit protection, self-limited, overload protected. (UL 1449)
6. Driver shall have a Class A sound rating.
7. Driver rated for 100 to 277V input. Power factor .90 or higher.
8. All drivers shall provide full LED dimming range. The drivers in every LED fixture shall have the capability to be dimmable, whether indicated to be dimmed or not on the drawings. When luminaire is to be powered by generator for emergency operation the driver is to be UL 924 listed.
9. Driver shall have a minimum of 5 year warranty.
10. Contractor shall provide 5 percent of each driver specified as spare in original sealed packaging and transport to the building (and put in storage) as directed by the Owner.

D. The complete LED luminaire assembly shall be of the latest and highest efficacy design available.

E. LED Retrofit Lamps

1. LED retrofit lamp for screw base application, with no driver.

2. LED retrofit lamp shall meet Energy Star compliance.
3. CRI shall be 80 or better.
4. Retrofit lamp shall comply with FCC 47 CFR Part 15.
5. LED retrofit lamp shall have a minimum of 5-year warranty.
6. LED retrofit lamps shall meet the criteria for light output as listed in the table below.

Minimum Light Output of Replaced Wattage

Lamp Types	LPW	Lifetime L70	10W	15W	25W	35W	40W
Non-Standard	50 LPW<10W 55 lPW≥10W	25,000 hrs	≥200 lm				
Decorative (B, BA, C, CA, DC, F, G)	40 LPW	15,000 hrs	70 lm	90 lm	150 lm		300 lm
Omnidirectional BT, P, PS, S, T)	50 LPW<10W 55 LPW≥10W	25,000 hrs			200 lm	325 lm	450 lm
Directional (BR, ER, K, R)	40 LPW, ≤20/8” 45 LPW, >20/8”	25,000 hrs				350 lm	
Directional (PAR, MR)	40LPW≤20/8” 40 LPW>20/8”	25,000 hrs					

Minimum Light Output of Replaced Wattage

Lamp Types	LPW	50W	60W	65W	75W	100W	125W	150W	150W
Non-Standard	50 LPW<10W 55 lPW≥10W								
Decorative (B, BA, C, CA, DC, F, G)	40 LPW		500 lm						
Omnidirectional BT, P, PS, S, T)	50 LPW<10W 55 LPW≥10W		800 lm		1100 lm	1600 lm	2000 lm	2600 lm	2600 lm
Directional (BR, ER, K, R)	40LPW≤20/8” 40 LPW>20/8”	500 lm		650 lm					
Directional (PAR, MR)	40LPW≤20/8” 40 LPW>20/8”								

2.2 Battery Powered Exit and Emergency Lighting Luminaires

A. Each unit shall consist of a battery, lights, lamps, automatic controls and connection to the lighting circuit ahead of all switches. Operation shall be such that the battery is maintained constantly charged under normal conditions; upon a loss of normal power, the light shall be switched on and the operating current obtained from the battery.

B. Units shall be UL labeled. Refer to drawings for mounting, capacity and manufacturer.

C. Fasten battery operated exit and emergency lighting units to wall or ceiling using factory-furnished bracket and make rear concealed electrical connection.

D. Electric source shall be from unswitched active lighting circuits only, to ensure that battery will be charged from an active circuit.

2.3 LED AC/Emergency Driver Units – Battery Type

A. Emergency lighting shall be UL listed and labeled and shall be provided by using standard LED luminaires equipped with a self-contained mounted battery-inverter power pack. Furnish and install with each designated luminaire a power pack unit to operate one lamp assembly upon loss of normal power. Initial output rating shall be minimum 3.1 watt. Warranty shall be 5 years from date of acceptance.

B. Emergency operation shall be fully automatic with the power pack unit capable of driving the selected lamp at rated output for a minimum of 90 minutes with a lumen depreciation no greater than 35 percent.

C. Power pack units shall include a sealed maintenance-free nickel cadmium battery, a Solid-state charger, an automatic transfer circuit, a low voltage battery disconnected circuit and a high frequency inverter. An accessible test switch and AC “on” pilot light shall be installed in the fixture and require no field wiring.

D. The power pack’s inverter electronics and battery driver shall, without requiring modification, be compatible with standard driver and lamp assembly supplied and shall not affect normal luminaire operation and shall be used with either a switched or unswitched luminaire. Connect to an unswitched hot leg for either base for charging/loss of power.

E. Provide remote test switch for installation where indicated on plan or where routine testing would be difficult due to luminaire location or accessibility. This option shall consist of a pushbutton test switch and AC “on” pilot light mounted on a white nylon single gang switch plate.

F. LED type inverter units shall be Dual Lite or equal by Chloride, Siltron, Power Sentry, Bodine, Side Lite or IOTA Engineering Company.

PART 3 - EXECUTION

3.1 Luminaire Hanging and Supporting

A. Support each surface mounted or suspended luminaire in a minimum of two locations. In addition, where luminaires are in a continuous row, they shall be fastened together on each end in two places. For suspended luminaires provide pendant length required to suspend luminaire at indicated height.

B. Recessed luminaires shall be supported at all four corners via safety chains (refer to paragraph D). Additionally, securely fasten each luminaire to the ceiling framing member by mechanical means such as bolts, screws, rivets or approved clips; install a minimum of one on each of the four sides of luminaire. This Contractor shall coordinate luminaire locations and luminaire weight with the trade installing the ceiling system to ensure adequate hangers are installed to support the weight of the ceiling plus twice the weight of each luminaire.

C. Surface or flush fluorescent luminaires in ceilings of the suspended lay in type shall be installed so that the long dimension of the luminaire is supported on the main support members of the ceiling system.

D. All recessed LED luminaires for lay in ceilings shall be equipped with galvanized steel safety support wires, or chains, attached from the luminaire housing to the structure independent of the ceiling system; hangers supporting ceiling system shall not be used.

E. For basket style volumetric type troffer fixtures installed in a lay-in grid ceiling, the basket or lens shall be oriented in the same direction for each fixture within the space.

F. Do not support light fixtures directly from light weight roof decks. Provide supplemental angle iron support as required. Do not connect to bottom cord of roof joist without supplemental angle iron ties to the upper cord of joist.

G. For wall mounted exterior luminaires include gasketed cast junction box.

H. Wire battery powered emergency fixtures to circuit which is constantly on. For lamps in fixtures which are switched the charging / sensing circuit shall be extended from ahead of room switch.

3.2 Alignment and Cleaning

A. Luminaires shall be mounted straight, level and true to the building lines. Warped or damaged luminaires shall be replaced or repaired to the satisfaction of the Architect and Owner.

B. Immediately preceding the final inspection, this Contractor shall thoroughly clean all luminaires of dust, dirt, grease, fingermarks, etc. All lamps shall be operating at the time of Owner's acceptance.

C. Coordinate location of luminaires carefully with the Architectural reflected ceiling plan. Verify that no surface mounted luminaire interferes with door swings.

1. Coordinate locations of luminaires with mechanical ducts, sprinkler pipes/heads, smoke alarms and fire alarm devices prior to rough-in to prevent conflicts.
2. Where reflected ceiling plans indicate a larger quantity of luminaires than that shown on the electrical drawings for a particular space, the reflected ceiling plan shall be followed for that space.

D. Adjust all adjustable fixtures to the satisfaction of the Engineer and the Owner.

3.3 Turn over spare LED components to Owner.

END OF SECTION

26 52 00 EXIT AND EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 Exit lighting and emergency lighting system wiring shall be run in conduit system which is completely independent of normal wiring systems.

1.2 Equipment to transfer power from a normal source to an emergency source are to be listed and labeled for load transfer.

PART 2 - PRODUCTS

2.1 Exit lights with battery to have sealed, maintenance free nickel-cadmium battery which delivers 90 minutes capacity to emergency lamps. Test switch provides manual activation of 30-second diagnostic testing for visual inspection. Where noted for self-diagnostic testing fixture to operate 30 seconds every 30 days and 90 minutes annually. Performing diagnostic of LED light source, AC to DC transfer, charging and battery condition.

2.2 Battery powered emergency light. Unit to include test switch, status indicator, and rechargeable battery. Maintenance-free nickel cadmium to provide 90 minutes of emergency power. Charger to have two charge rates and automatically recharges after battery discharge. A low voltage disconnect to prevent battery damage from deep discharge. (Self-diagnostics testing, where noted, operates 30 seconds every 30 days and 90 minutes once annually. Lights to indicate diagnostic evaluation of LED light source, AC to DC transfers, charging and battery condition.)

PART 3 - EXECUTION

3.1 All circuits shall have dedicated neutral conductor.

3.2 Test system operation for full 90 minutes witnessed by the AHJ. Provide report of required corrections, of any.

3.3 Batteries shall carry a five year warranty.

END OF SECTION

26 56 00 EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 Work includes a complete system of exterior lighting including luminaires, lamps, poles, bases, conduit, conductors, fusing, control devices, etc. as shown on drawings. Include all excavation, backfill, concrete bases and concrete encasement of underground conduits.

1.2 The catalog numbers listed on the schedule do not necessarily have complete prefix and suffix designations for placing the luminaire order. The Contractor shall verify these numbers and include in their bid the necessary plaster frames, accessories, trim, mounting hardware, etc. to achieve a coordinated installation with the architectural drawings and in specifications. The Contractor shall provide any hardware indicated by notes on the fixture schedule.

1.3 Luminaires, drivers and individual components shall bear UL label.

PART 2 - PRODUCTS

2.1 Refer to data on the drawings for fixture details.

2.2 The pole manufacturer shall provide a factory installed internal impact type vibration damper in each pole where indicated on the drawings or when the pole is 25 ft. or greater in length.

PART 3 - EXECUTION

3.1 Concrete bases for standards shall be round above finish grade, chamfered corners and rubbed finish. Furnish anchor bolts as recommended by the manufacturer. Concrete bases shall be poured-in-place at the job site; steel reinforced concrete, minimum 3500 lb. test.

3.2 Provide a surge arrester behind the handhole in pole base of each lighting standard exceeding 15 ft. in height and connect to each phase conductor and 0.625” diameter by 10 ft. long copper clad driven ground rod providing a good grounding path. Connect the equipment grounding conductor to this grounding terminal. A separate ground rod is required for each lighting standard exceeding 15 ft. in height. Surge arresters shall be Thomas Research Products BSPS series or Hubbell FSP3 series. Install per NEC Article 280.

3.3 Provide Buss "KTK" fuses in HEB waterproof in-line holder ahead of the driver in each "hot" leg; locate behind handhole in pole base.

3.4 Note these special installation procedures – never install a pole without the intended luminaire in place. Poles are designed to carry a load, and a pole cannot be installed before the luminaire is mounted because of the potential for damaging the pole from unwanted vibrations.

3.5 Mount standards truly vertical. Shim and grout under fixture base to level standards; visible shims will not be permitted. Provide anchor bolt covers.

3.6 Splicing shall be made with listed and approved, waterproof splicing kits and shall be located in base of poles behind handhole.

3.7 Install a green wire ground throughout the underground wiring system, and bond to all standards.

3.8 Measure illumination levels to verify conformance to Performance Requirements.

3.9 Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

END OF SECTION

DIVISION 27

COMMUNICATIONS

27 05 01 BASIC COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 Refer to Section 26 05 01 Basic Electrical Requirements which are hereby made part of Division 27 - Communications.

1.2 Special Note

A. All provisions of the Bidding Requirements, General Conditions and Supplementary Conditions, including Division 00 and Division 01, apply to work specified in this Division.

B. The scope of the Division 27 work includes furnishing, installing, testing and warranty of all work for Communication systems as shown on the E Series drawings, and as specified in Division 27 and elsewhere in the project documents.

1.3 Alternates - NA

1.4 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the Division 27 work. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the Indiana Division of Industrial Compliance who will issue the inspection certificate.

D. Upon completion of work, the Contractor shall furnish to the consulting State Architect the certificate of inspection and approval before final payment on contract will be allowed.

1.5 Coordination Drawings

A. The Division 27 Contractor shall prepare and be responsible for 0.25inch scale electronic coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format with the Division 21, 22, 23, 26 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 27 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings and that specified ceiling heights are maintained.

1.6 Coordination Drawings

A. Refer to Divisions 00 and 01 for requirements.

1.7 Operating and Maintenance Manuals

A. Assemble electronic and two hard copies each of operating and maintenance manuals for the Communications work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of replacement material required. Name and address of a qualified service agency.

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. Original purchase order number, date of purchase, name, address, and phone number of the vendor warranty information.

E. Copy of required test reports.

F. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

G. O&M Manuals shall contain the following information at a minimum:

1. Copies of all approved shop drawings with the Engineer’s stamp.
2. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.
3. Communications drawings updated with final as-built information. This shall be in the form of a complete set of Communications drawings with as-built information indicated in colored pen based upon actual field conditions.
4. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.
5. Rack elevations for all systems with rack mounted equipment.

1.8 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 27 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and

schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.9 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of three (3) years **or the period of time as per specific specification section,** from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. The use of equipment for temporary communication systems is not the start of the warranty period.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include but are not limited to replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

1.10 Software Support Agreement

A. Provide a software support agreement (SSA) with the project for each system with user software, that covers the entirety of the systems including all end devices, switches, servers, etc. as part of the completed system for a period of not less than 1 year. Agreement shall cover software upgrades, system patches and firmware releases and all labor/material to implement at no additional cost to the owner.

B. The SSA shall commence at the completion of the project after final inspection, system demonstration and system training.

C. Provide a copy of the SSA including start and end dates, and a descriptive narrative of what is included with the close-out documents.

1.11 Cyber Security Provisions

A. Contractors are required to coordinate with the owner’s Information Technology Department and implement a password policy for all devices installed on the project. No default username/passwords allowed.

B. Encrypt all sensitive data including passwords, firmware.

C. Contractors have to have/use manufacturer’s cyber security checklist for installation of devices.

D. Contractor to adhere to Cyber Security “best practices” as identified by manufacturers of systems provided.

E. Disable any SSH or telnet capabilities.

F. Utilize Certificate based communications

G. System to have the ability to utilize HTTPS for communications.

H. System to have the option to add 802.1x authentication.

I. Ability to change default ports. Contractors required to coordinate with the owner's Information Technology department and implement a port policy.

J. Ability to do IP address (both IPv4 and IPv6) filtering. Contractors required to coordinate with the owner's OIT department and implement a port policy.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electronic equipment provided under this scope of work shall be of a make/model that is currently in production at the time of installation.

C. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 Reference Standards

A. Where standards (NFPA, NEC, EIA/TIA, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

B. Within ten (10) days after award of contract, the names of Subcontractors and manufacturers of the major items of equipment which are proposed shall be submitted to the Architect / Construction Manager for approval. Refer to the list of equipment below.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.

D. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.3 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured Submittal

information shall clearly identify the manufacturer, specific model number, approval labels, performance data, pump curves, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Electronic format – Shop drawings may be submitted in electronic format utilizing PDF files. The submittal shall be organized by specification section and contain all required information within a PDF document for each specification section. The submittal shall be organized as follows:

1. Primary zip file contains a PDF of master transmittal cover page indicating the project name, submitting contractor, contact information and a list of all the sections with titles being submitted. This primary file shall also contain each of the individual PDF files for the individual sections being submitted.
2. Sub PDF file for each specification section organized as follows:
   a. First page - Cover page indicating the project name, submitting contractor, contact information, space for Engineer’s stamp.
   b. Page(s) for contractor qualifications and project certifications.
   c. Page(s) for Bill of Materials (BOM) list including part numbers, quantities and references to specification section paragraphs for each part.
   d. Page(s) for manufacturer’s data sheets.
   e. Page(s)/Drawing(s) for system diagrams, riser diagrams, block diagrams, etc.
   f. Drawing(s) for floor plans showing equipment locations.

D. Refer to individual system specifications for submittal requirements. At a minimum, shop drawings shall contain the following information:

1. A complete list of materials with model and part numbers and reference to the Part 2 specification paragraph number.
2. Shop drawings including manufacturer’s product and cable data sheets specific to the project. Data sheets shall indicate exact model numbers and options specific to the project.
3. Floor plans showing location of all items of equipment. Drawings shall also indicate each location where 120 power is required.
4. Job specific schematic and point to point wiring diagrams showing all devices, number and size of wires, etc.
5. Contractor qualifications and/or Manufacturer’s Certifications where specifically specified.
6. System software information, where applicable showing features, version, hardware requirements, and any other information required to ascertain conformance with specifications.

E. Equipment that does not fully comply with the specifications and which has not had this information presented in the shop drawing phase and approved, will be removed and replaced with specification compliant equipment at the contractor’s expense.

F. Any shop drawings that do not contain the minimum required information outlined herein and as specified elsewhere shall be considered incomplete and will not be reviewed. It is the contractor's responsibility to fully read and understand all requirements for submittals for each section and to carefully and completely adhere to all requirements.

2.4 Network Enabled Devices with username/password

A. All devices which include a username/password shall be set by the contractor during construction as directed by the owner.

B. Devices shall not be left at default unless specifically directed by the owner.

C. Turn over a spreadsheet with all devices including device description, MAC address, IP address (if static) username and password.

PART 3 - EXECUTION

3.1 Testing

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

D. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Refer to specific sections for required testing of the various systems. Submit four (4) copies of reports indicating results.

E. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.

F. Instruments required for tests shall be furnished by the Contractor.

3.2 Equipment Cleaning

A. No fixed item of active AV/Network/Security electronic equipment shall be installed in any areas where active construction is generating significant amounts of dust/debris (drywall finishing, concrete sanding, wall painting, etc.). It shall be the responsibility of this contractor to fully coordinate the activity of the general trades contractors with regards to floor/wall/ceiling finishing work to assure that active AV/Network/Security equipment is not exposed to or damaged by the materials and debris generated by these and similar activities.

B. No fixed item of passive AV/Network/Security equipment (such as cabling, faceplates, jacks, etc.) shall be installed in any areas prior to substantial completion of floor/wall/ceiling installation and finishing where the installation of such equipment will expose it to damage or defacement from those general trades activities. This contractor shall be fully responsible to fully protect/isolate any installed equipment from damage/defacements from the installation of or application of materials and finishes associated with the General Trades Work.

C. This contractor shall be responsible for fully protecting all equipment and providing final cleaning to restore equipment to its original pre-installation condition prior to project completion and turn-over to owner.

D. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents; verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect / Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O & M Manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

D. A minimum of 24 hours shall be allowed for instruction to personnel selected by the Owner. Instructions shall include not less than the following:

1. Show location of items of equipment and their purpose.
2. Review binder containing instructions and equipment and systems data.
3. Coordinate written and verbal instructions so that each is understood by personnel.
4. Manufacturer’s representatives for the various special and communication systems shall give separate instructions.
5. All operating demonstrations and instructions for each system shall be audio/video digitally recorded and turned over to the Owner.

E. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

F. Note that additional time for training, operating time, etc. may be required per other specification sections and shall be included. This section only establishes minimum requirements.

END OF SECTION

27 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at his sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in the AutoCAD .DWG or Revit model format for a cost as indicated in the Agreement and Waiver Form. Providing the documents in the .DXF format will be an additional charge per sheet as indicated in the Agreement and Waiver Form. Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to contractor's systems.

1.7 Projects developed using AutoCAD MEP will have all drawings converted to the AutoCAD format, when requested to be DWG or DXF format.

1.8 Project models will be furnished without views.

1.9 The electronic files shall be stripped of the Project's name and address, the Architect's and Engineer's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software

or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

27 05 02A
ELECTRONIC FILES HEAPY RELEASE FORM TO CONTRACTORS

Project: New Castle – Henry County Public Library – Interior & Exterior Renovations
376 S 15th St
New Castle, IN 47362

Owner: Henry County Public Library

Heapy Engineering Project Number: 2022-07145

Heapy Engineering Project Manager: Mat Root

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter **collectively** referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of this Agreement and Waiver for Use of Electronic Files.

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

    d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Detail (LoD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

17.

Provider (Name of Company): _____

Recipient (Name of Company): _____

Recipient Address: _____

Name of authorized Recipient Representative: _____

Title of authorized Recipient Representative: _____

E-mail address of authorized Recipient Representative: _____

Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File format and complete applicable cost summary.

1. ☐ DWG / DXF Format - List of Drawings Requested: _____
_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

The following costs are applicable to Delivery of Electronic Files (select one):
☐ CD-ROM ☐ Heapy FTP ☐ User's FTP site ☐ Flash Drive

Requested Electronic DWG / DXF file format (select one):

☐ 2010 DWG ☐ 2007 DWG ☐ 2004 DWG ☐ 2000 DWG ☐ R12 DWG
☐ 2010 DXF ☐ 2007 DXF ☐ 2004 DXF ☐ 2000 DXF ☐ R12 DXF

Cost of Preparation of Division 27 Electronic DWG / DXF Files:

First Drawing: $50.00			$50.00
Additional Drawings $15.00 each	_____ x $15.00	=	$ _____
Conversion to DXF Format: $5.00 additional/sheet	_____ x $ 5.00	=	$ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

All files will be bound together.
Requested electronic Revit file format:
☐ 2022 RVT

Cost of Preparation of Division 27 Electronic Revit Model Files:

Revit Project Model without Views. $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

27 05 04 BASIC COMMUNICATIONS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Refer to Section 26 05 04 Basic Electrical Materials and Methods which are hereby made part of Division 27 – Communications.

END OF SECTION

27 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of conduits, bus ducts, cables, cable trays and other electrical items thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements.

1.2 All existing penetrations which have firestopping which are disturbed as part of this project, shall have the existing firestop restored to its UL listed approved condition.

1.3 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.4 Firestopping materials, assemblies and installation shall conform to requirements of the IBC and the Authority Having Jurisdiction.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Rectorseal-Metacaulk, Tremco, Nelson, Specified Technologies or other approved manufacturer.

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

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

END OF SECTION

27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 Scope of Work

A. Work includes the provision of the technical grounding system including connections within the AV system cabinet for the Auditorium.

B. Work includes bonding of technology pathways and equipment to the technical grounding system.

1.2 System Description

A. Provide a Rack Mount Grounding Bus Bar (RBB) in the new Auditorium AV System Cabinet. The RBB shall be provided under the Division 27 Bid Package.

B. Provide a Telecommunications Bonding Conductor (TBC) from the Auditorium AV System Cabinet to a local electrical panelboard ground. This bonding conductor shall consist of a minimum #6, bare copper grounding conductor. Provide a warning label attached to each Telecommunications Bonding Conductor at each end stating “WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department.” Provided under Division 26 Bid Package.

C. Provide bonding between all joints of cable tray and ladder rack. Provide bonding to all conduit sleeves. Provide bonding to all technology equipment racks and cabinets.

D. This contractor shall be responsible for providing all equipment, cable tray, ladder rack, conduit and sleeve grounding to the grounding system installed under Division 26.

E. All work shall be in compliance with NEC, Article 250 and ANSI/TIA-607B.

1.3 Quality Assurance

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, BICSI Standards, applicable National Electric Code Sections, Indiana Building Codes.

B. All equipment shall be UL listed.

1.4 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.5 Relevant Standards

A. The Telecommunications Grounding Installation shall comply with the following at a minimum:

1. All local, state and national codes
2. The National Electric Code (NEC)

3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA) / Telecommunications Industry Association (TIA) 606, ANSI/TIA-607B and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 Telecommunications Rack Mounted Grounding Bus Bar (RBB)

A. Ground bar shall be solid copper, 1 inches high, minimum 19 inches long with pre-drilled holes for standard-sized Lugs and must be UL listed. Provide final length as required to accommodate 19" Racks that meet EIA-310-D.

B. All connections shall be made with double-bolted, compression style grounding lugs.

C. Bus bar shall be Panduit RGRB19U Busbar Kit or equal by CPI, B-Line, Andrew, Tessco Technologies, Hubbell.

2.2 Telecommunications Bonding Conductor (TBC)

A. Insulated Conductors - Soft, annealed bare copper per ASTM B-3. Concentric, compressed stranded (class B or C Alternate ASTmB-787) per ASTM B-8, UL-83 and UL-854. Insulation Jacket: Nylon per UL-83. Insulation: High dielectric polyvinyl chloride per UL-83 and UL-854.

B. Uninsulated Conductor: Soft, annealed bare copper per ASTM B-3. Stranded as specified herein. Overall Finish: Gray polyvinyl chloride (PVC) per UL-824.

C. All connections shall be made with double-bolted, compression style grounding lugs.

D. RATINGS - Cables conform to the following standards:

1. UL-83 for THHN-THWN Cdrs.
2. Federal Specification J-C-30B

2.3 Bonding Conductors

A. Conductor shall be minimum #6AWG and may be either stranded or solid, insulated or bare.

B. Cable as manufactured by Superior/Essex, Rome, AIWC.

C. All connections shall be made with double-bolted, compression style grounding lugs.

PART 3 - EXECUTION

3.1 General

A. The telecommunications grounding system shall provide an electrically continuous, low impedance path for all connected telecommunications equipment and pathways.

B. When using grounding conductors installed in rigid, ferrous metallic conduit, both ends of the bonding conductor must be bonded to the conduit ends.

C. The bonding conductors shall have no splices or connections.

D. The bonding conductor shall be connected to the building main electrical grounding system through the use of exothermic weld, listed lugs, listed pressure connectors, listed clamps, or other listed means.

E. All metallic telecommunications pathways and equipment within telecommunications spaces shall be bonded to the local TGB/TMGB utilizing Bonding Conductors (BC).

3.2 Wiring

A. Refer to drawings for specific location and arrangement of telecommunications Bonding Backbone and Telecommunications Ground bars.

B. The drawings do not indicate specific routes for telecommunications grounding cables. The Telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the grounding system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Telecommunications Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

C. The new Auditorium Sound System Cabinet shall be provided with the Rack Mounted Grounding Bus Bar (RBB). The RBB shall be bonded to the building electrical system ground and shall be bonded to one additional building electrical system ground (such as building steel).

D. Provide a Telecommunications Bonding Conductor (TBC) from the RBB.

3.3 Grounding/Bonding Connections

A. Ground all backbone cable sheaths, shield drain wires from all AV horizontal cable, equipment racks and equipment to the local RBB.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by ANSI/TIA-607B.

C. All joints of all cable tray and ladder rack shall be bonded together. When bonding to painted equipment, methods shall be utilized to ensure continuity of grounding connection.

D. All connection to ground bars (RBB) shall be made using listed lugs appropriate for mounting provisions in the supplied ground bar.

3.4 Testing General

A. The Contractor shall be responsible for testing the complete technology grounding system.

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

C. Test reports shall be provided to indicate.

1. Impedance values across each TBB from the RBB.

2. Impedance values across the TBC from the RBB to the main electrical service ground.
3. Impedance values across each GE between TGB on a common floor.

D. Tests shall be monitored by a recorder.

E. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

F. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

G. Instruments required for tests shall be furnished by the Contractor.

3.5 Labeling

A. The Contractor shall be responsible for labeling all telecommunications grounding equipment, cable, etc. in accordance with the guidelines as described herein.

B. Each telecommunications ground bar shall be provided with a warning label to read:

1. “WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department.”

C. Each Telecommunications Bonding Conductor (TBC, TBB, GE, etc.) to be provided with a label indicating source and destination ground bars.

3.6 As-Built Documentation

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer’s stamp.

C. Copy of all test reports.

D. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

1. System schematic and block diagrams for technology grounding system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

3.7 Warranty

A. The entire grounding and bonding system as specified herein shall be guaranteed against defects in workmanship and materials for a period of one (1) year as described herein. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION

27 05 28 COMMUNICATIONS SYSTEMS PATHWAYS AND SUPPORT EQUIPMENT

PART 1 - GENERAL

1.1 Scope of Work

A. Work consists of pathways to carry communication wiring for the AV system in the Auditorium, including conduit sleeves, cable management systems, etc.

B. Work includes support equipment for telecommunications cabling including backboards and cabinets.

C. Work includes new cable management systems to support all installed communications cabling per standards and manufacturer's recommendations where portions of the cabling are run in areas with insufficient pathways.

1.2 Quality Assurance

A. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.

1.3 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.4 Drawings

A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc., is directed.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.5 Related Work by Others

A. Communications cabling shall be included as stated in the specification section for each individual system.

PART 2 - PRODUCTS

2.1 Conduit Systems

A. Refer to specification section 26 05 33 Raceway and Boxes for Communications Systems.

2.2 Cable Management System

A. Provide pre-manufactured cable supports as manufactured by Panduit, Cooper B-Line, Caddy, Mineralac, Mono-Systems or Rayco. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

B. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bend, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

D. Bridle rings shall not be acceptable.

2.3 Backboards

A. Refer to Section 27 05 04 – Basic Communications Materials and Methods.

2.4 Rough-In Boxes

A. Refer to Section 26 05 33 – Raceway and Boxes for Communications Systems.

B. Refer to drawings for types, quantities and configurations of outlet boxes used to serve communications cabling.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for pathway types, locations and routing.

B. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 ft.
2. Conduit and cable used for electrical power distribution – 1 ft.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 5 kV – 5 inches.
5. Power lines over 5 kV. – 24 inches.

C. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means; refer to 27 05 33 Raceway and Boxes for Communications Systems paragraph.

D. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from area above suspended ceilings to respective backboards.

E. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.

F. Cabling pathways shall be installed with a minimum of 12" clearance above, 12" to each side and 6" clearance below. It shall not be acceptable for any other building systems including piping, ductwork, equipment, etc. to infringe upon this clear space.

3.2 Conduit Systems – Coordinate with Division 26 Contractor to ensure that conduit system installed for telecommunications cabling shall conform to the following:

A. No section of conduit shall be longer than 100 feet between pulling points.

B. No more than two 90 deg. bends in a section of conduit between pulling points.

C. Pulling points/pullboxes shall not be used to change direction of the conduit pathway. Pulling points/pullboxes shall be placed "in-line" with the conduit pathway.

D. Each section of conduit shall be labeled for length, destination closet and origination closet.

E. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

F. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.

G. Provide a No. 12 gauge pull wire or nylon pull cord in each empty conduit run.

3.3 Cable Management System

A. The drawings do not indicate specific routes for telecommunications cables. The Division 27 Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Division 27 Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

B. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contractor shall be responsible for providing a cable management system. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 feet.
2. Conduit and cable use for electrical power distribution – 1 feet.
3. Fluorescent lighting – 5 inch.
4. Power lines up to 2kVA – 5 inch.
5. Power lines over 5kVA – 24 inch cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.4 Identification / Labeling

A. All continuous communications pathways such as conduit, cable tray, etc. shall be labeled to indicate origination and destination. Label shall be applied every 50 feet wherever accessible or subject to administration. Coordinate label information with Owner.

B. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned / prepped area of raceway.

3.5 As-Built Documentation

A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate “as-built” locations to show the actual route for the communications systems pathways.

B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.

C. Component Service Manuals: Include information for testing, repair, troubleshooting, assembly, disassembly, and required / recommended maintenance intervals for all types of pathways.

END OF SECTION

27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 Refer to Section 26 05 53 Identification for Electrical Systems which are hereby made part of Division 27 - Communications.

1.2 No labeling for any system which relies on room names/numbers as part of the equipment/cable labels shall be applied until the final building signage package with approved room names/numbers has been reviewed and incorporated. Labeling done based upon bid document room names/numbers prior to approved building signage package will not be accepted and may require the contractor to revise labeling at their expense.

1.3 Communications Systems Identification

A. Identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. Audio/Visual Equipment

C. Sound System(s)

D. Paging System

PART 2 - PRODUCTS

2.1 Communication Equipment Nameplates

A. Nameplates shall be laminated phenolic with black surface and white core. Use 0.0625 inches thick material for plates up to 2 inches x 4 inches and 0.125 inches thick for larger sizes. The lettering shall be Condensed Gothic with space between the lines equal to the width of the letters. Use 0.25 inches minimum height letters on the small plates increasing the size proportionately to plate size.

B. The lettering on the plate shall indicate the name of equipment, the specific unit number, which MER / TR the equipment is served from, and any other reference data pertinent to the operation. Names and numbers shall coincide with those listed on the drawings.

C. Nameplates shall be secured with screws, one on each end.

PART 3 - EXECUTION

3.1 Audio/Visual equipment

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.2 Sound System

A. Label all cable lengths at each end and record the same on record drawings.

B. Clearly and permanently label all jacks, controls and connections with permanent engraved laminated plastic labels or by engraving and filling mounting plates, unless otherwise noted. Attach laminated plastic labels with contact cement. Embossed or printed label tape, and press-on or lift-off lettering systems will not be accepted. All labeling shall be completed prior to final system inspections. If permanent labels cannot be furnished prior to system testing, temporarily label all controls with write-on tape.

3.3 Paging System

A. Label all cable lengths at each end and record the same on record drawings.

B. Clearly and permanently label all jacks, controls and connections with permanent engraved laminated plastic labels or by engraving and filling mounting plates, unless otherwise noted. Attach laminated plastic labels with contact cement. Embossed or printed label tape, and press-on or lift-off lettering systems will not be accepted. All labeling shall be completed prior to final system inspections. If permanent labels cannot be furnished prior to system testing, temporarily label all controls with write-on tape.

END OF SECTION

27 41 19 VIDEO DISPLAY EQUIPMENT

PART 1 - GENERAL

1.1 Scope of Work

A. The work described by this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of an audio/visual system in operating condition as indicated on the drawings and/or specified herein.

B. Included in the Scope of this Section:

1. Licenses, permits as may be applicable
2. Provision of submittal information
3. Installation in accordance with contract documents, manufacturers' recommendations and applicable codes
4. Programming and configuration of control and signal processing software
5. Testing and adjustments, including documentation thereof
6. Provision of manuals
7. Maintenance and warranty services

C. Applicable References:

1. National Electric Code (NEC)
2. Underwriters Laboratories (UL)
3. Infocomm International AV Installation Handbook –2nd Edition
4. Telecommunications Distribution Methods Manual (TDMM)

D. In general, the conduit and/or cable tray, junction boxes, electrical power circuits and outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed by the Electrical Contractor under a separate contract. The entire responsibility for the system, its installation, operation and function shall be that of the Systems Contractor.

1.2 Description of Work

A. Work consists of new A/V Display Equipment including:

1. Digital Video Projectors complete with ceiling mounting hardware and connection to the local Auditorium AV System as detailed on the drawings and as specified herein.

a. Existing Digital Video Projector Mount: Install projector on existing ceiling mount, complete with ceiling mounting hardware and supplemental structural support as detailed on the drawings and as specified herein.

B. Connection to Digital Video Projection Screen (provided by architect) complete with connection to the local audio/video control system as detailed on the drawings and as specified herein.

C. All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

1.3 Quality Assurance

A. All system components shall be UL listed.

B. Installation shall be in compliance with the National Electric Code and all other applicable codes.

C. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.

D. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.4 Contractor Qualifications

A. The A/V equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the A/V contractor to utilize a Subcontractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. Equipment supplier shall have a service organization within 75 miles of the project site.

D. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

1.5 Shop Drawings

A. A complete and comprehensive list of materials with quantity, manufacturer, model and part number and reference to the Part 2 specification paragraph number for each item.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1. Drawings shall include designations, dimensions, operating controls, electrical requirements, input/output configurations, operating controls, etc.
2. Major components including all sub-assembly components (daughter cards, option cards, etc.) required to perform the specified functions.
3. Any items of equipment which have features and/or functions that deviate from the specifications contained herein, shall have these deviations clearly called out by a separate attachment with the shop drawings specifically listing and detailing the deviation along with a justification. Deviations must be approved specifically in writing.

C. Job specific diagrams.

D. 30x42 floor plans at a scale of not less than 1/8 inches=1 foot-0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

E. Proposed construction details for all custom fabricated items, including wall plates, interface panels, mounting hardware and systems, and rigging hardware. These details shall show labeling, dimensions and indicate finishes and color selection.

F. Submittals that do not contain all the required information will be REJECTED unless prior approval for partial submittals has been approved.

PART 2 - PRODUCTS

2.1 Product Equivalency

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals **if all specified features are provided**. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 Digital Video Projectors - Provide and install the following types of Projector:

A. Large Venue: Auditorium

1. Digital Video Laser Projector with native resolution WUXGA (16:10) 1920x1200/HD (16:9) 1920x1080/WXGA (16:9) 1280x800, capable of supporting up to WXGA (1920 x 1200) resolution with image resizing, capable of 4K upscaling.
2. Minimum 6000 ANSI Lumens with 85 percent uniformity, 20000 hour life.
3. Inputs
   a. Digital - DVI-D, HDMI
   b. Analog (with audio)- RGB; composite video, S-video.
   c. Control – LAN, RS-232
4. Outputs
   a. Analog - RGB
5. Contrast Ratio minimum of 2,500,000:1.
6. Noise level – 38dB.
7. Lens
   a. Full range of field interchangeable zoom lenses. Lens selection to be sized to accommodate projector setback and screen size to provide maximum image size on screen.
   b. Lens Shift (minimum) – +/- 20◦ (V), 70◦(H)
8. Keystone correction (minimum): +/- 20o. (H), +/- 30o (V)
9. Scanning Frequency Range: Pixel Clock – 13.5 up to 165MHz; Horiz. 15KHz to 80KHz; Vert. 24/30/50/60 (digital), 50Hz to 85Hz (analog)
10. Power Consumption: 382W (2W standby)
11. IR remote control, Electronic "standby" mode accessible through the remote control. Cycling of power to the unit while in "standby" mode shall not cause the unit to switch to "on" mode with lamp burning.
12. Projector must be IP capable with network access for remote diagnostics, Lamp life indicator and file up/down load capabilities through remote software.
13. Mount projector to existing projector mount within the space. Coordinate mounting height and location of projector to provide full video image on screen. Provide all required power, control and signal patch and extension cables required to operate the projector.
14. Projector mount to be security type to deter theft.
15. Coordinate mounting height and location of projector to provide full video image on screen. Provide all necessary power and signal cables required to operate the projector.

B. Projectors to be provided with vibration isolators when attached to ceiling/roof structure.

C. Provide color selection for each projector, coordinated with architect.

D. Provide the following projector:

1. Epson PowerLite Series
2. Equal manufacturers: Sony, NEC, Optoma

2.3 Projection Screens

A. Large Venue: Auditorium (by Architect)

1. Refer to architectural drawings and specifications for projection screen type.
2. Provide integrated control with AV System supporting the space.

2.4 Projector Mount

A. Existing Mount – Mount projector to existing projector mount within the space. Provide supplemental support structure as necessary based upon field conditions at required mounting location.

B. All exposed hardware to have color/finish to match attachment surfaces and/or as coordinated with owner. This may require the use of custom colors which are considered to be included in this contract.

2.5 Centralized Projector Control

A. Provide a means for remotely monitoring and providing basic control (on/standby/off) of all installed projectors through the Owner's LAN / WAN.

B. Centralized Control Software shall be Windows based and shall give the end user the capability to monitor the basic maintenance status of each projector and provide direct or scheduled control of the projector from any networked computer with the appropriate software. The monitoring feature shall include, but not be limited to: connection, hours used, hours on current lamp, etc. The control features shall allow the remote user to turn the projector on/off or place in standby either directly or on a scheduled basis.

C. Projectors shall be provided with serial to Ethernet converters to enable monitoring and control features. The converters and associated software shall have the ability to fully integrate basic control and monitoring functionality with all standard RS-232 control systems as manufactured by Crestron, Extron, FSR, Aurora and others.

D. Acceptable hardware and software manufacturers: Crestron, Extron, FSR, Aurora.

2.6 Surge Suppressors (for all display devices): The surge suppressor shall be a compact mountable unit in a magnetic shielding steel enclosure. It shall operate from 120 volts AC and include a separate 3-foot, grounded, 3-wire #18 line cord. There shall be 2 grounded AC receptacles. Overall dimensions shall be 1.75 inches H x 5.31 inches W x 9.06 inches D. Weight shall be 3.4 pounds. It shall have a load rating of 8 amps @ 120 volts. It shall be listed to UL 1449-2 and certified to Federal Grade A, Class 1, Mode 1 Guidelines for powerline surge suppressors. The unit shall provide auto-resetting overvoltage shutdown. There shall be three limiter circuits: a series surge reactor current limiter, a cascaded auto-tracking dual-polarity voltage limiter, and a pulse inverter. The onset clamping voltage shall be 172 volts nominal, and the unit shall have an instant-reacting snubber to protect against fast-rising surges generated within the installation location. The surge suppressor shall have an unlimited Applied Surge Current rating (8 x 20 µs) and shall withstand at least 1000 occurrences of Surge Pulse Voltages up to 6000 volts. Provide a Surgex model SA82 Flatpak for each flat panel monitor and projector. No substitutes.

PART 3 - EXECUTION

3.1 General Installation

A. Equipment shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all local, city, state and national codes.

B. Provide all hardware, framing members, etc. as required for mounting supports.

C. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.

D. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

3.2 Projector Installation

A. Contractor shall field verify the location of projector, structural elements at the proposed mounting location, and the scree/lens combination to ensure proper installation prior to mounting equipment. Where field conditions will not provide the correct application for the proposed projector type/location/mounting method, the contractor shall notify the Engineer/Architect in writing. Notification shall include proposed alternatives for review.

B. Projectors shall be mounted straight, level and true and shall provide the desired image size/orientation on the projection surface.

C. Contractor shall custom configure the projector video/image/setting menus once source equipment and AV system is operational. Projector set-up shall be completed and the optimal settings stored for later recall.

D. Programming of projectors and centralized projector control software including all network assignments, passwords, schedules, etc.

3.3 Tests

A. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; Submit report indicating result to the Engineer.

3.4 Identification/Labeling

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both end and at each point where the cable is administered.

B. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 Training

A. Provide step-by-step user instructions identifying operator controls for normal use operations. This shall be included with the O&M manuals.

B. The contractor shall arrange for a total of four (4) hours for end user training on the various A/V Systems. This training shall be planned and scheduled with the Owner. Training plan shall be pre-approved by the Engineer/Architect and shall include a review of the proposed syllabus.

C. Video record the training sessions and provide an electronic copy to the Owner.

3.6 O & M Manuals

A. Copies of all approved shop drawings with the Engineer's stamp.

B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

G. Provide statement of warranty with O&M Manuals.

3.7 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

C. Where warranties on individual pieces of equipment exceed three (3) years, the guarantee period shall be extended to the warranty period of the particular items.

D. After completion of the work, the Contractor shall submit a Certificate of Warranty, stating commence and expiration dates and conditions of the warranty, for signature of both

participating parties. Incremental warranties for complete portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor.

END OF SECTION

27 51 25 BUILDING PAGING / INTERCOM SYSTEM

PART 1 - GENERAL

1.1 Scope of Work

A. The Owner currently has an operational Atlas Paging System. Remove and relocate the main system cabinet and paging speakers as described herein and shown on the drawings. Any material and/or equipment necessary for the proper installation and operation of the system, which is not specified or described herein, shall be deemed part of this specification.

B. Provide additional amplifer(s) as required.

C. This Section includes but not limited to the following:
1. Amplifiers
2. Ceiling Speakers
3. Miscellaneous items

D. Applicable References:

1. National Electric Code (NEC)
2. Underwriters Laboratories (UL)
3. Sound System Engineering (Davis & Patronis) – 3rd Edition 2006
4. Audio Systems Design and Installation (Giddings) 1990
5. Telecommunications Distribution Methods Manual (TDMM)
6. In general, the conduit, electrical outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed under the Electrical Contract. The entire responsibility for the system, its operation and function shall be that of the Electrical/Systems Contractor.

1.2 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1. Drawings shall include designations, dimensions, operating controls, electrical requirements, input/outlet configurations, operating controls, etc.

2. Major components including all sub-assembly components (daughter cards, option cards, etc.) required to perform the specified functions.

3. Any items of equipment which have features and/or functions that deviate from the specifications contained herein, shall have these deviations clearly called out by a separate attachment with the shop drawings specifically listing and detailing the deviation along with a justification. Deviations must be approved specifically in writing.

C. Qualifications: A statement of contractor's qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

D. Job specific wiring diagrams.

1. This indicates a block diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed, including details of interconnection with other systems.

E. Supplier shall provide rack elevations showing the configuration of all rack mounted equipment including detailed interconnection diagrams between equipment

F. 30x42 floor plans at a scale of not less than 1/8 inch=1 foot-0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

G. Software data – The data package shall consist of manufacturer's data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

H. Proposed construction details for all custom fabricated items, including wall plates, interface panels, mounting hardware and systems, and rigging hardware. These details shall show labeling, dimensions and indicate finishes and color selection.

I. Submittals that do not contain all the required information will be REJECTED unless prior approval for partial submittals has been approved.

1.3 O & M Manuals – Final Documentation: All final documentation shall be submitted and approved before final acceptance by the Owner will be granted.

A. Within 45 days after completion of the work, deliver to the Owner the following:
1. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.
2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and codings.
3. Documentation of system performance measurements as noted elsewhere in this specification. Include diagrams or charts showing final setting of all control knobs in the system (mixers, equalizers, power amplifiers, etc.)
4. Complete equipment rack elevations showing all rack mounted equipment items.
5. Floor plans, prepared at a scale of not less than 1/8 inch = 1 foot 0 inches, showing loud speaker locations and orientation, wall plates, rack locations and other related device locations.
6. Manufacturer's operations manuals for each and every major equipment item furnished.
7. Copies of any application software and setup data files.
8. Manufacturer's warranty for each major item of equipment furnished.
9. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

B. For submittal quantities and additional requirements, refer to the Record Drawing and Operating and Maintenance paragraphs in the Basic Requirements Specification Section 27 05 01.

1.4 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 100 miles 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. 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. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line **and shall be the most current model in production at the time of installation**.

D. Comply with NFPA 70 – National Electrical Code.

E. Comply with UL 50.

F. ANSI/TIA 607-B Telecommunications grounding.

G. Latest edition of BISCI – 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.

1.5 Warranty

A. The intercommunications and paging program system shall be fully warranted for three (3) years from date of substantial completion by the contractor and manufacturer.

1.6 Training

A. Provide a minimum of four (4) hours of training to the District's personnel. Plan for multiple trips to the site. Training sessions shall cover system equipment connectivity, device configurations and operation, maintenance and upgrade procedures.

B. Training to occur a maximum of 2-hour increments per person or groups of personnel.

C. Provide digital video copy of the training session.

1.7 Coordination

A. Coordinate layout and installation of ceiling-mounted speaker, microphones, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, video projectors, and all other trades.

1.8 Programming

A. The contractor shall schedule a programming meeting with the owner thru the Construction Manager /Architect after award of bids, to review the requirement of the Intercommunications programming for zones, bell changes, etc.

B. The contractor shall install the paging wiring to reflect the zone requirements per the Owner's final direction.

PART 2 - PRODUCTS

2.1 Manufacturers

A. In the event existing speaker(s) or equipment are rendered inoperational or otherwise unfit for relocation and reinstallation, all supplemental equipment items shall be new and unused.

B. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

C. Approved system manufacturers:
1. Atlas Sound

D. Paging: By dialing an extension from any building telephone system extension, entering an access code, entering a station or paging zone code, and speaking into the telephone.

2.2 Ceiling Loudspeakers with Matching Transformers and Baffle

A. Approved Manufacturers:
1. Atlas Sound.
2. Lowell Manufacturing Company.
3. Quam-Nichols Company.

B. In the event existing speaker(s) or equipment are rendered inoperational or otherwise unfit for relocation and reinstallation, provide recessed lay in speaker assembly as described here and as shown on the drawings.

C. Size: 8 inch.

D. Power rating: 25 Watt Peak, 15 Watt RMS.

E. Sensitivity: 97 dB average.

F. Impedance: 8 ohms nominal.

G. Frequency Response: 45Hz-19 kHz Nominal, 50Hz- 8kHz + 5dB.

H. Minimum Dispersion Angle: 100-105 degrees, minus 6 dB at 2 kHz octave band.

I. Magnetic weight: 10 oz. Nominal (260g)

J. Comply with TIA/EIA SE-103 and TIA/EIA-160

K. Line Transformer: frequency response 100Hz-10 kHz (+1.5dB): maximum insertion loss of 1.5 dB; secondary impedance 8 Ohms; power rating 4-5 Watts; primary terminals with 6 inch com. Lead color coded cables and dual voltage 25 V/70.7 V.

L. Multi taps at 4/5,2,1,1/2 and 1/8 watts.(45 ohm speakers will NOT be allowed)

M. Enclosures: Metal protective enclosure, acoustically dampened, with front face of at least 0.0478-inch steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; and with relief of back pressure.

N. Tile bridges: Provide each loudspeaker with load-bearing, rust-resistant steel tile bridge to match the supplied speakers.

O. Grills/Baffle: Provide each loudspeaker with flush mounted baffle, minimum thickness of 0.032-inch aluminum, with textured white finish, to match the supplied speakers.

P. Vandal-Proof, High-Strength Baffle: For flush speakers, self-aging cast aluminum with tensile strength of 44,000 psi, 0.025-inch minimum thickness, countersunk heat-treated alloy mounting screws, and textured white epoxy finish.
   1. Provide surface loudspeakers with matching 16 gauge steel enclosure with sloped baffle

2.3 Volume Control: The wall-mounted volume attenuator shall have a power handling capability of 20 watts continuous power and provide a total attenuation of –36dB between ten steps with steps 1 & 2 each having an attenuation of –6dB. Rotary switches shall allow continuous rotation through all attenuation positions and an additional “off” position. Wall mounted units shall be furnished with a one-gang stainless steel trim plate with embossed position indicators. Provide Quam model QC-10 or equal by Atlas Sound or Lowell.

2.4 Conductors and Cables

A. Conductors: Jacketed and twisted multi-pair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than 4 conductor No. 22 AWG.

B. Insulation: Thermoplastic, not less than 1/32 inch thick.

C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.
   1. Minimum Shielding Coverage on Conductors: 60 percent.

D. Plenum Cable: Listed and labeled for plenum use.

PART 3 - EXECUTION

3.1 Installation

A. 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.

B. Provide plenum rated cabling for the intercommunications system.

C. Existing cabling shall be replaced as required to fully function with the relocation of existing system components as specified herein. It may be re-used where is it in adequate condition and of the proper gauge and configuration to function with the new system.

D. Area wiring shall go to the existing paging system cabinet.

E. All cables shall be concealed in raceways in all exposed spaces with no ceilings. (NO cable will be allowed in exposed areas.

F. Secure and support cables by straps, staples, or similar fittings designed and installed to avoid damage to cables. Secure cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

G. Wiring Terminations: Terminate all intercommunications wiring inside the central-control cabinet. Do not terminate above accessible ceilings or exposed in finished spaces.

H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

I. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

J. 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 school intercom and program equipment conductors as recommended by equipment manufacturer.

K. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

L. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

M. 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.

N. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

O. Connect each room speaker and call in switch to a separate station circuit (Provide minimum of 4 conductor cable home run to each speaker).

P. Connect each corridor, hallway, lobby, or commons area speakers to a separate station circuit. (Maximum of 8 speakers per station circuit with a minimum of 4 conductor cable)

Q. Connect each exterior paging horn speaker to a separate station circuit with a minimum of 4 conductor cable.

R. Provide stainless steel screws for all hardware for pool speakers, outdoor speakers etc.

S. Mounting heights are specified in Division 26 Section "Wiring Devices."

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.

C. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.3 System Programming

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

B. Paging Contractor to coordinate with AV System Integrator, muting of paging system during performances.

3.4 Field Quality Control

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing school intercom and program equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercom station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.

5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
   a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging speakers.
   b. Repeat test for three speaker microphones, one master station microphone, and for each separately controlled zone of paging loudspeakers.
   c. Minimum acceptable ratio is 45 dB.
6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom, paging, and all-call amplifier. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. 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 paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
8. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
9. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Retesting: Correct deficiencies and retest. Prepare a written record of tests.

D. 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 and independent room speaker-line matching transformers.

E. Prepare written test reports.
   1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.5 Start-Up Service

A. Engage a factory-authorized service representative to perform startup service and initial system programming.

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.

3.6 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

27 51 28 AUDITORIUM SOUND REINFORCEMENT SYSTEM

PART 1 - GENERAL

1.1 Scope

A. The work described by this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of a sound reinforcement system in operating condition as indicated on the drawings and/or specified herein. The contractor shall also be responsible for testing of all existing cabling to be reused.

B. Included in the Scope of this Section:

1. Licenses, permits as may be applicable
2. Provision of submittal information
3. Installation in accordance with contract documents, manufacturers' recommendations and applicable codes
4. Programming and configuration of control and signal processing software
5. Testing and adjustments, including documentation thereof
6. Provision of manuals
7. Maintenance and warranty services

C. Applicable References:

1. National Electric Code (NEC)
2. Underwriters Laboratories (UL)
3. Sound System Engineering (Davis & Patronis) – 3rd Edition 2006
4. Audio Systems Design and Installation (Giddings) 1990
5. Infocomm International AV Installation Handbook –2nd Edition
6. Telecommunications Distribution Methods Manual (TDMM)

D. In general, the conduit and/or cable tray, junction boxes, electrical power circuits and outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed by the Electrical Contractor under a separate contract. The entire responsibility for the system, its installation, operation and function shall be that of the Systems Contractor.

1.2 Description of the Work

A. The intent of this specification is to provide a Sound Reinforcement/Audio/Video Playback System for live performances, programs, assemblies and other functions conducted in the Auditorium.

B. The complete sound system for the Auditorium includes, but is not limited to the following items:

1. A surround speaker system, located as shown on the drawings, for full-range coverage of the entire seating area.
2. Touch Panel control locations with analog/digital breakout boxes as shown on plans.
3. A main audio equipment rack housing the processors, equalizers, wireless microphones, power sequencing equipment, media player, power sequencing equipment, touch panel controller, video transmission/receiving equipment, AV switcher, AV cabling patch panels, AV network switch, existing relocated Assistive Listening system, Amplifiers, terminating hardware and ancillary devices necessary to the operation of the system as described herein.
4. An existing personal assistive listening system shall be relocated to the new system location and provide wireless reception of all audio program material for hearing-impaired

individuals. The existing T-Coil wiring shall be intercepted and rerouted to the new AV system cabinet location.

5. Secondary power switching shall be implemented through the touch panels as located on the drawings and shall provide remote system power up/down in addition to the primary system power switch located in the main audio equipment cabinet.
6. Microphones, jacks, wire and all miscellaneous parts of the system.

C. The system shall be provided with the hardware, programming, wiring and required interface modules to perform an automatic mute override upon activation from the local fire alarm system.

D. The system shall be provided with the hardware, programming, wiring and required interface modules to perform a selectable mute override for the paging system upon activation from the touch panels as required.

1.3 Quality Assurance

A. The intent of these Specifications is to describe and provide for a complete Sound Reinforcement System of professional quality and reliability. Professional performance standards as provided by a qualified and experienced sound systems contractor (hereafter referred to as Systems Contractor) will be required. References and documentation of the System Contractor's experience and following qualifications shall be provided, if requested.

B. The Systems Contractor shall:

1. Be an authorized dealer/service organization for all major items of electronic equipment furnished.
2. Be located within 100 miles of the project
3. Have completed, within the past two (2) years the satisfactory installation of at least three (3) systems of similar size and type as that herein specified.
4. Maintain a factory trained service department on call 24 hours a day, 365 days a year, to service the specified product.
5. Employ, on a full-time basis, a qualified audio/electronics Engineer under whose direction and supervision the entire installation shall be carried out. Infocomm, NICET or C-EST audio certification required.
6. Employ, on a full-time basis, technician(s) who are experienced in the installation of sound reinforcement equipment, its interconnection and setup. Qualified technicians shall perform the assembly, wiring, interconnection setup and programming of all equipment, jacks and devices. Infocomm, NICET or C-EST audio certification required.

C. The Systems Contractor shall coordinate final utility rough-in locations with actual equipment furnished. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations and all applicable code requirements.

D. The Systems Contractor shall coordinate final equipment and solutions with the manufacturer to ensure a complete and operational system will be provided.

E. In all cases, the Owner and Engineer shall determine the acceptability of the work based upon site visits and observations.

1.4 Cooperation and Coordination - The Electrical and Systems Contractors shall:

A. Cooperate and coordinate as required with the other contractors who are responsible for related work not included in this section.

B. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations and all applicable code requirements.

C. Coordinate final utility rough-in locations with actual equipment furnished.

D. Provide any and all information as required or requested by the Owner or Engineer in order for this work to be completed to the satisfaction of the Owner, and in the best interests of the Project. Such assistance or information shall be transmitted in writing to the requesting party in all cases.

1.5 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Owner. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. Where manufacturers' warranties on certain equipment exceed three (3) years, the guarantee period on that particular equipment shall match the extended warranty period.

1.6 Shop Drawings and Submittals

A. Contractor shall complete and submit a full acoustic predictive model with all system information as outlined below. Contractor shall not begin any work until this acoustic model has been reviewed by the Engineer. Submitted model shall contain at a minimum the following information: SPL readings at a minimum of (1) location per seating group, intelligibility, horizontal and vertical coverage pattern maps. All submitted values shall be for a range of frequencies to effectively simulate the frequency ranges required for musical/choral production and voice lift programs.

B. A complete and comprehensive list of materials with quantity, manufacturer, model and part number and reference to the Part 2 specification paragraph number for each item.

C. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

D. Qualifications: A statement of contractor's qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

E. Job specific diagrams.

1. This indicates a block schematic diagram that shows all major items of equipment required for the contract project and the actual interconnections that will be installed, including details of interconnection with other systems.
2. Electrical power requirements for the head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with electrical work. Electrical diagrams shall also indicate all required plug and power outlet configurations including where direct connection is required/preferred.
3. Rack elevations showing the configuration of all rack mounted equipment.

F. 30x42 floor plans at a scale of not less than 3/32 inch=1 foot-0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

G. Proposed construction details for all custom fabricated items, including wall plates, interface panels, mounting hardware and systems, and rigging hardware. These details shall show labeling, dimensions and indicate finishes and color selection.

H. Software data – The data package shall consist of manufacturer's data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

1.7 O&M Manuals - Final Documentation: All final documentation shall be submitted and approved before final acceptance by the Owner will be granted.

A. Within 45 days after completion of the work, deliver to the Owner, identical copies of the following:

1. A copy of all approved shop drawings complete with Engineer's stamp, including a complete as-installed equipment list, organized by system, with manufacturer's names, model numbers, serial numbers and quantities of each item.
2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts and other designations and codings.
3. System performance measurements as noted elsewhere in this specification shall be documented. Include diagrams or charts showing final setting of all control knobs in the system (mixers, equalizers, power amplifiers, etc.)
4. Complete equipment rack layouts showing all rack mounted equipment items.
5. Floor plans, prepared at a scale of not less than 3/32 inches = 1 foot 0 inches, showing loud speaker locations and orientation, wall plates, rack locations and other related device locations.
6. Manufacturers operations manuals for each and every major equipment item furnished.
7. Copies of any application software and setup data files.
8. Manufacturer's warranties and operating instructions for each and every equipment item furnished. Include a copy of the Certificate of Warranty, signed by both parties.
9. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

B. For submittal quantities and additional requirements, refer to the Record Drawing and Operating and Maintenance paragraphs in the Basic Requirements Specification Section 27 05 01.

PART 2 - PRODUCTS

2.1 General

A. All equipment items shall be new, unused and the latest version or model.

B. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

C. Speaker locations are shown on the drawings for bidding purposes only. The exact speaker locations, aiming points and mounting angles shall be coordinated with the Engineer and determined through the use of an acoustical modeling program and/or good engineering practices and field conditions. Speaker aiming shall be adjusted as required after installation to provide optimal coverage and system performance.

2.2 Substitutions

A. Products specified herein by manufacturer's name and model number are intended to establish a minimal level of quality, performance and function. Proposed substitute equipment by listed equal manufacturers shall be equal in all respects to the specified product.

B. Proposed speaker substitute requests shall additionally be supported by electro-acoustic modeling data showing proposed speaker location(s) and orientation, maximum SPL levels and evenness of coverage at key frequencies, interaction between multiple speakers and intelligibility predictions (Alcons or STI).

2.3 Products

A. Main AV System Equipment Cabinet

1. Provide a 3-part free standing cabinet 74 inch H (min 40 RU) x 24 inch W x 32 inch D useable. Cabinet to be constructed of 16GA steel, ventilated, side panels, top mounted "quiet" type ventilation fan, and ground bar. Bottom cable entry platform supports entire weight of rack on floor. Provide removable top cable entry cover. Cabinet closes with key lock. Provide wire management panels for both horizontal and vertical wire management. Secure cabinet and extend a #6 ground wire from cabinet to building main electric service ground. Refer to drawings for quantities and locations of cabinets. Cabinet color is selected by the Owner. Final rack configuration including rail width, useable depth, etc. to be carefully coordinated with installed equipment prior to ordering.
2. Coordinate all required 120V power distribution, with the Div-26 contractor, through rack as required by installation equipment to dedicated 20amp receptacle in room.
3. Refer to drawings for cabinet location.
4. Racks as manufactured by Hubbell, Middle Atlantic, Great Lakes, B-Line
5. Provide one (1) rack-mounted power distribution unit with eight (8) rear-panel outlets and one (1) front-panel outlet and spike/surge protection with EMI filtering and a 9-foot cord terminated with a NEMA 5-15R plug and an illuminated combination switch/circuit breaker for the fixed rack location. The rack-mounted power distribution unit shall occupy one (1) EIA rack space and be a Middle Atlantic PD-915R or approved equal by Lowell, Atlas Sound or Furman.
6. Provide one (1) slide out rack shelf by Hubbell, Middle Atlantic, Great Lakes, B-Line
7. Provide one (1) lockable 3RU drawer by Hubbell, Middle Atlantic, Great Lakes, B-Line

B. Audio Digital Signal Processors

1. The Main Audio Digital Signal Processor shall be a multi-channel, software-controlled (RS-232/IP interface to external computer) multi-function unit incorporating the following functions:
   a. Parametric Equalizers: 3-, 5-, 7-, and 10-filter modules with 1/70-octave to 4-octave bandwidth and up to 18dB filter depth
   b. Graphic Equalizers: 10- and 30-band modules; combining and non-combining
   c. Cut/Shelf Equalizer: High/low shelf filters with selectable 6 and 12 dB/octave slopes; high/low cut filters with selectable 6, 12, 18 and 24dB/octave slopes, with selectable filter types (Butterworth, Bessel and Linkwitz-Riley)
   d. Crossover with independently adjustable slopes and selectable types (Butterworth, Bessel and Linkwitz-Riley)
   e. Digital Delay – up to 10 seconds of available delay memory with 20 microsecond resolution
   f. Feedback Reduction Filters – 5-, 10- and 16-filter, single-channel and stereo modules; 1/10-octave to 1/70-octave adjustable Q adaptive notch filters; auto clear

mode removes dynamic filters and restores the DFR to your ideally-tuned configuration after a specified amount of time or upon power cycling

g. Compressor/Peak Limiter: Selectable soft knee or fixed hard knee; single-channel or stereo; peak stop limiter
h. Ducking, gating and downward expander
i. Automatic gain control with a maximum boost of 12dB
j. Window-based software interface
k. Control of input and output switching with regard to different mode selections as described herein

2. The Main DSP shall meet or exceed the following performance criteria:
   a. Frequency response of 20Hz to 20kHz; THD< 0.05 percent (+4dBu, 20Hz to 20kHz)
   b. Minimum 48kHz sampling rate for flat response to 20 kHz
   c. Minimum 110dB, A-weighted dynamic range
   d. Minimum 24-bit digital-analog conversion
   e. DFR filter control
   f. Support of Surround Sound Processing through expansion bus or other means at minimum
   g. Standards compliant audio over ethernet protocol such as Dante or AVB
3. The DSP shall be:
   a. Extron DMP 128 Plus
   b. Equal by Crestron, Biamp

C. Surround Sound Processor

1. The Surround Sound Processor shall be software-controlled (RS-232/IP interface) multi-function unit incorporating the following functions:
   a. Capable of using the following source formats:
      1) LPCM up to 7.1/24-bit/192 kHz (HDMI), LPCM up to 2.0/24-bit/96 kHz (S/PDIF), Dolby Digital 2/0, Dolby Digital 2/0 Surround, Dolby Digital 5.1, Dolby Digital Surround EX, Dolby Digital Plus, Dolby True HD, Dolby Atmos; DTS 2-channel, DTS Digital Surround, DTS-ES Matrix 6.1, DTS-ES Discrete 6.1, DTS 96/24, DTS 96/24 ES Matrix 6.1, DTS Master Audio, DTS Express, DTS:X
   b. Connector Inputs shall consist of the following at minimum:
      1) 1 HDMI connector
      2) 1 RCA connector
      3) 2 TOSLINK™ fiber optic connectors
      4) 1 analog stereo/mono balanced/unbalanced.
      5) 1 3.5 mm captive screw connector, 6 pole.
   c. Connector Outputs shall consist of the following at minimum:
      1) Number/signal type: 10 balanced/unbalanced, for left and right front, left and right surround, center, and subwoofer output, plus four assignable outputs for left and right back, front and back height pairs, and downmix.
      2) Connectors: (5) 3.5 mm captive screw connectors, 6 pole
      3) Impedance: 50 ohms unbalanced; 100 ohms balanced
      4) Gain error: ±0.2 dB channel to channel.
      5) Maximum level: (Hi-Z) >+21 dBu balanced or >+15 dBu unbalanced at 0.03% THD+N
      6) Output level range per channel: -24 dB to 0 dB
      7) D/A conversion: 24 bit, 96 kHz
   d. Control/Remote:
      1) Serial host control port: 1 bidirectional RS-232 rear panel 3.5 mm captive screw connector, 3 pole
      2) Baud rate and protocol: 9600, 19200, 38400 (default), 115200 baud (adjustable); 8 data bits, 1 stop bit, no parity
      3) Serial control pin configuration: 1 = Tx, 2 = Rx, 3 = GND

4) Program control: Extron Product Configuration Sofware (PCS) program for Windows® Extron Simple Instruction Set™ (SIS™)
5) USB configuration port: 1 front panel USB mini-B
6) USB standards: USB 2.0, low speed
7) Ethernet host port: 1 RJ-45 female
8) Data rate: 10/100/1000 Base-T, half/full duplex with autodetect
9) Protocol: ARP, DHCP, HTTPS, ICMP, IEEE 802.1X, IP, SSH, TCP, Telnet

2. The Surround Processor shall be:
   a. Extron SSP200
   b. Equal by Marantz, JBL, Crestron, Biamp, Atlona

D. The power amplifiers shall meet or exceed the following performance criteria:

1. Four-channel, high performance networked model with switch mode power supply.
2. Front panel indicators shall include, at a minimum, bridge mode, ready, signal, clip, fault, data and thermal protection LED's.
3. Selectable high pass filters speaker protection.
4. The unit shall be capable of bridged-mono, stereo and parallel operation.
5. An automatic variable speed fan shall provide front-to-rear airflow through a heat sink.
6. Both direct constant voltage high-impedance (70V/100V/140V) or low-impedance (2/4/8/16 ohm) output shall be available on all channels.
7. Frequency response at one-watt shall be 20Hz to 20kHz (+/-0.5dB).
8. Distortion shall be < 0.05 percent THD and the damping factor (10Hz – 200Hz) shall be > 500 @ 8-ohms.
9. The no-fault warranty period shall be three-years.
10. Basis of Design: Crown DCi Series
11. Acceptable Equal Manufacturers: QSC, JBL, dbx
    a. Contractor shall size all amplifiers as required for system operation at a nominal 95 dB sound level across seat locations. Amplifiers shall be sized to allow for 20% overhead.

E. Wireless Microphone System

1. The Wireless Microphone System shall be a wireless type with both a handheld microphone/transmitter and a bodypack transmitter with lavaliere microphone. It shall provide dual diversity reception from two external equipment cabinet-mounted ½ wave dipole antennas. The receiver shall provide automatic frequency selection with group scan function. A minimum of 1400 selectable frequencies shall be available. It shall feature five-segment LED audio and RF meters, an advance function LCD display and a three-segment transmitter battery gauge. Frequency and volume shall be able to be locked out, once selected. The metal chassis shall be ½-rack-mountable.
2. The handheld transmitter/microphone shall have an 8-hour battery life using a single 9V battery. It shall provide adjustable gain control, three-segment LED battery power indicator, mute and power switches and a grip/switch cover. A backlit LCD display shall show group and channel. Frequency and power settings shall be capable of being locked out. The operating range shall be up to 300 ft. The microphone element shall be a cardioid condenser type. Provide with stand-mount swivel adaptor.
3. The bodypack transmitter shall have an 8-hour battery life using a single 9V battery. It shall provide adjustable gain control, three-segment LED battery power indicator, mute and power switches and a selectable –20dB microphone input pad. A backlit LCD display shall show group and channel. Frequency and power settings shall be capable of being locked out. The operating range shall be up to 300 ft. Provide with stand-mount swivel adaptor.
4. Basis of Design: Sennheiser EW-D EM Series Receiver
5. Microphones shall be provided in types as indicated:
   a. Part No.508750 EW-D 835-S SET (Q1-6) Digital wireless handheld set.

b. Part No.508740 EW-D SK BASE SET (Q1-6) Digital wireless bodypack base set.
c. Part No.508935 ME 2 Omnidirectional electret condenser lavaliers with clip and grille.
d. Part No.508879 EW-D ASA (Q-R-S) Active antenna splitter (dual 1;4) with DC power distribution for EW-D receivers
e. Part No.508863 ADP UHF (470 - 1075 MHZ) Passive, directional external paddle antenna,
f. Part No.508862 EW-D CHARGING SET EW-D Charging set.

6. Equals by Audio Technica, or Shure.
7. Contractor shall be responsible for all frequency coordination at the site and shall provide any/all required FCC licenses for operation and shall ensure no interference with other local systems.
8. Contractor shall provide antenna splitter combiners as required to serve all wireless receivers as shown on the drawings and ensure 100% wireless coverage of the auditorium space.

F. Wired Microphone System

1. The Wired Microphones shall be Boundary type and provided for manual deployment by the owner for connection to the existing inputs on the face of the stage and for connection to the digital stage breakout box as specified herein.
2. The Boundary Microphones shall meet the following performance requirements:
   a. Element: Condenser
   b. Polar Pattern: Half-cardioid (cardioid in hemisphere above mounting surface)
   c. Frequency Response: 70 - 16,000 Hz
   d. Open Circuit Sensitivity: -25dB (56.2mV) re 1V at 1 Pa
   e. Maximum Input Sound Level: 114 dB SPL, 1 kHz at 1% T.H.D.
   f. Dynamic Range: 86 dB, 1 kHz at Max SPL
   g. Signal-to-Noise Ratio: 66 dB, 1 kHz at 1 Pa
   h. Phantom Power Requirements: 9-52V, 2 mA typical
   i. Weight: 67 g
   j. Cable: 25' (7.6 m) long, with TA3F and XLRM-type connectors
   k. Dimensions: 2.87" (73.0 mm) maximum width, 3.56" (90.5 mm) maximum length, 0.59" (15.0 mm) height
   l. Output Connector: Integral 3-pin XLRM-type
3. Boundary Microphones shall be provided as indicated:
   a. Audio-Technica PRO44 Series (QTY. 8)
   b. Equals by Sennheiser or Shure.

G. The Assistive Listening System:

1. The owner has an existing Assistive Listening System in use. This system shall be removed from the existing sound system and installed in the new sound system as specified herein. The existing T-Coil wiring shall be intercepted and rerouted to the new sound system cabinet location. Provide any and all additional hardware and components to facilitate a complete and operational system that will support the seating capacity of the Auditorium space.
2. Provide a Dante Audio Interface to interface the system with the AV network.
3. The Dante Audio Interface shall be:
   a. Extron AXI 02 AT
   b. Equal by Crestron, Biamp, AMX, Kramer or Atlona

H. Equipment for Future Owner Furnished / Owner Installed Equipment:

1. The owner will be utilizing future wireless streaming input devices. Provide all additional hardware and components to facilitate a complete and operational system that will

support the equipment as coordinated with the owner. This includes power control to facilitate proper EDID control of inputs and outputs for HDMI streaming devices.

2. Provide a control processor to interface the system with the AV network:
   a. The control processor shall be Extron IPCP PRO PCS1 xi
   b. Equal by Biamp, Crestron
3. Provide equipment to interface owner corporate Wi-Fi with the AV system network for future wireless streaming devices connected to the Video Matrix Switcher
   a. Provide Extron Sharelink Pro 1100
   b. Equal by Biamp, Crestron, Atlona

I. Streaming Media Processor

1. Unit shall be a rack-mountable solid state recorder and streaming box capable of recording to the following formats:
   a. H.264 and AAC in MP4 container, JPEG, JSON, XML
2. Unit shall be utilize the following storage protocols:
   a. FTP, SFTP, CIFS, CIFS/SMB, NFS
3. Unit shall support the following streaming resolutions:
   a. 480p, 720p, 1080p
4. Unit shall accept RS-232 control
5. Unit shall be capable of ethernet connections
6. Basis of Design: Extron SMP 351
7. Acceptable Equals By: Crestron, Atlona

J. Digital 4K Blue-Ray Media Player

1. Unit shall be a rack-mountable multi-format digital media player capable of playing the following media types:
   a. CD
   b. Bluetooth
2. Unit shall be capable of recording in the following formats:
   a. CD-DA
   b. WAV
   c. MP2
   d. MP3
3. Unit shall accept RS-232/IR and/or Ethernet control
4. Unit shall be capable of ethernet connections
5. Unit shall support 7.1 Surround Sound
6. Basis of Design: Tascam BD-MP1
7. Acceptable Equals By: Denon, TEAC or other Engineer Approved Equal

K. AV Network Switch – Contractor shall provide a dedicated AV Network Switch that has been verified with the manufacturers specified herein for a complete and operational solution that is certified for use with a Dante audio network.

L. AC Power Systems

1. Main Equipment Cabinet: Provide a combination of rack-mounted sequential-switching power strips and vertical power strips to adequately power all active audio devices in the equipment cabinet.
   a. The rack-mounted controller shall provide 6-step sequencing to remote switchable outlets via 12VDC and/or switch closure. Adjustable sequence delay intervals of 1-3-6 seconds and 4-step start delays shall be provided. The unit shall have six (6) LED sequencing status indicators and an LED for power indication. Provide one (1) Middle Atlantic model USC-6R Universal Sequencing Controller or equal by Lowell, Atlas Sound, Furman or Surge-X.

b. The switchable power modules shall be capable of being remotely switched via 12VDC. They shall be wired to multiple 20-amp 120VAC circuits as required to provide adequate load distribution. Provide Middle Atlantic R-20 20-amp duplex modules as necessary or equal by Lowell, Atlas Sound, Furman or Surge-X.
c. Provide a minimum if one (1) Middle Atlantic M-15 un-switched module or equal.
d. Provide one (1) Middle Atlantic MPR-6 modular power raceway or equal with power jumpers as needed.
e. Provide one (1) Middle Atlantic USC-KL remote key switch and LED status indicator panel. Locate where shown on drawings.

M. Type "A" – Wall Mounted Column Line Array

1. The main speaker shall be a wall mounted column line array speaker system
2. The speaker shall meet or exceed the following performance criteria
   a. Frequency Response: 45 Hz – 20 kHz
   b. Horizontal Coverage 140°-160°
   c. Vertical Coverage Pattern UP Settings:
      "Point": -6dB @ +7°, -12 dB @ +12°
      "Tight": -6dB @ +9°, -12 dB @ +15°
      "Narrow": -6dB @ +10°, -12 dB @ +20°
      "Medium": -6dB @ +13°, -12 dB @ +24°
      Pattern DOWN Settings:
      "Point": -6dB @ -7°, -12 dB @ -12°
      "Narrow": -6dB @ -10°, -12 dB @ -20°
      "Broad": -6dB @ -17°, -12 dB @ -28°
      "Downfill": -6dB @ -20°, -12 dB @ -35°
   d. Sensitivity (1W/1m): 102 dB (High), 95 dB (Low)
3. The speaker shall be:
   a. JBL Professional CBT 1000
   b. Equal by QSC, Community, Biamp
4. Color shall be "white"
5. Contractor shall provide all required mounting hardware required for speaker mounting and required safety factors.

N. Type "B" – Center Channel Speaker

1. The speaker shall be a two-way speaker system
2. The speaker shall meet or exceed the following performance criteria
   a. Frequency Response: 65 Hz – 20 kHz
   b. Horizontal Coverage 120°
   c. Vertical Coverage 60°
   d. Sensitivity (1W/1m): 94 dB
   e. The speaker shall have a high frequency horn with a 1 in compression driver
   f. The speaker shall have a 8 in woofer
3. The speaker shall be:
   a. JBL Pro AC28/26
   b. Equal by EAW, Electro-Voice, QSC
4. Contractor shall provide all required mounting hardware required for speaker mounting and required safety factors.
5. Color shall be "white".

O. Type "C" – Surround Wall Mounted Speakers

1. The speaker shall be a two-way speaker system
2. The speaker shall meet or exceed the following performance criteria
   a. Frequency Response: 38 Hz – 20 kHz

   b. Horizontal Coverage 180°
   c. Vertical Coverage 160°
   d. Sensitivity (1W/1m): 90 dB
   e. The speaker shall have a high frequency horn with a 1-inch compression driver
   f. The speaker shall have a 8-inch woofer
3. The speaker shall be:
   a. JBL Pro Control 128 W
   b. Equal by Electro-Voice, EAW, Renkus-Heinz, JBL
4. Contractor shall provide all required mounting hardware required for speaker mounting and required safety factors.
5. Color shall be “white”.

P. Type “SUB” – Wall Mounted Enclosure Housed Subwoofer

1. The subwoofer speaker shall be installed in a wall enclosure as detailed on the architectural drawings
2. The speaker shall meet or exceed the following performance criteria
   a. Frequency Response: 35 Hz – 250 Hz
   b. Sensitivity (1W/1m): 95 dB
3. The speaker shall be:
   a. JBL Pro PRX418S
   b. Equal by Electro-Voice, Community, Biamp
4. Provide a vibration isolation pad for use within the subwoofer wall enclosure:
   a. Auralex Acoustics Gramma V2 or equal

Q. Wire and Cable:

1. All wire and cable shall be new and unused.
2. Wire not installed in equipment racks, not portable, or not installed in conduit shall be plenum-rated and meet all applicable codes.
3. HDMI Cables:
   a. HDMI cables serving the LED screen wall on stage and wall mounted displays: Cables by FSR, Belden, or Panduit
4. Speaker Cable:
   a. Main House Speaker Cable: Stranded 12AWG copper twisted pair or as recommended by manufacturer from the equipment rack to the loudspeaker(s). West Penn 227 or equal by Belden, Mohawk, General.
   b. Monitor/Effects Speaker Circuit Cable: Stranded 16AWG copper twisted pair or as recommended by manufacturer from the equipment rack to the jackplates. West Penn 225 or equal by Belden, Mohawk, General.
   c. Constant-voltage Speaker Circuit Cable: Stranded 18AWG copper twisted pair or as recommended by manufacturer from the equipment rack to the loudspeaker(s). West Penn 224 or equal by Belden, Mohawk, General.
5. Installed Microphone-level Cable: Stranded 22AWG copper twisted, shielded pair with drain wire homerun to the equipment rack or as recommended by manufacturer from each jack. West Penn 291 or equal by Belden, Mohawk, General.
6. Installed Line-level Cable: Stranded 20AWG copper twisted, shielded pair with drain wire homerun to the equipment rack or as recommended by manufacturer from each jack. West Penn 292 or equal by Belden, Mohawk, General.
7. Portable microphone cables: Black flexible cable by ProCo, Whirlwind, Conquest or Rapco.
8. Other equipment control cables shall be stranded wire, appropriately shielded, of gauge and number of conductors required by the manufacturer for proper operation of the system or equipment item furnished and supplied in accordance with the recommendations of the National Electrical Code.

9. Direct Boxes: Provide the following devices intended to facilitate the insertion of a wide variety of program source and other types of audio origination/playback equipment into standard microphone jacks:
    a. Stereo Direct Box shall permit the connection of unbalanced line level audio outputs of computer sound cards, CD players, tape decks, etc. to balanced, low-impedance equipment. The balanced output signal shall be attenuated approximately 20dB below the input level. The color-coded stereo input jacks shall include dual RCA jacks and a 3.5mm stereo TRS jack. The unit shall be equipped with a switchable 20dB input pad and a ground lift switch. Provide Whirlwind model pcDI or equal by ProCo or Conquest with two (2) matching 10ft. dual XLR cables.
    b. Mic Combiner shall combine low impedance, balanced, signals into a single low impedance balanced output. Dual female XLR input jacks and a single male XLR output jack shall be provided, in addition to a polarity reverse switch. Provide Whirlwind model IMCOM or equal by ProCo or Conquest with matching 10ft. dual XLR cable.

R. Jacks, Connectors and Wall Plates

1. All plate-mounted connectors shall be ground-insulated from the plates on which they are mounted.
2. All jacks shall be installed on standard stainless steel finish plates. Nomenclature shall be engraved into the plate with 1/8 inch block letters filled with black paint. All mic jack locations shall be numbered consecutively, starting from one (1).
3. Unless otherwise specified, all jacks and connectors for the sound system shall be as follows:
    a. Microphone and line input receptacles shall be 3-pin XLR-F with locking tab equivalent to Neutrik model NC3FP-1 or approved equal by Switchcraft.
    b. Microphone and line output receptacles shall be 3-pin XLR-M equivalent to Neutrik model NC3MP or approved equal by Switchcraft.
    c. Monitor/Effects Speaker Receptacles shall be 4-pole Speakon-type with gold-plated contacts equivalent to Neutrik model NL4MP-B.
    d. Combination Microphone/Auxiliary Input Jackplates shall be impedance matching units suitable for interfacing one (1) unbalanced high- or low-impedance source to a balanced low-impedance microphone preamplifier input. There shall be one (1) ¼ inch 3-conductor phone jack marked “PROJ IN” and two (2) RCA phono jacks marked “LINE IN L/R” with a resistive mixing network to sum stereo line-level sources. A “HUM CANCEL” rocker-type switch shall selectively isolate the shields. A separate female XLR connector shall provide for a separate microphone input. There shall be no electrical connection between the impedance matching circuit and the microphone circuit. Provide ProCo AVP-1 A/V interface jackplate assemblies or approved equal where shown on drawings.
    e. Cable-end Microphone/Auxiliary Connectors shall be 3-pin XLR equivalent to Neutrik model NC3XX or approved equal by Switchcraft.
    f. Furnish and install the required number of jacks and connectors as indicated on the drawings.
    g. Field Wiring Termination: All mic and line level cables from distributed input/output jackplates and mixer inputs/outputs shall be terminated and cross-connected in the main equipment cabinet using professional termination hardware equivalent to Whirlwind model MPB-58. Quantity as required. Equals by Rapco, ProCo or ADC.
    h. Multi-pin connector: Provide, where shown on plans and as described in Section 1 of these specifications, multi-pin, panel-mounted, quick disconnect connectors, sized to handle a minimum of 28 balanced audio channels (3pins x 28 channels = 84 pins). Provide with protective caps. Approved manufacturers: Whirlwind, Veam, Cannon, Amphenol, Ramtech, Edac/Elco.

S. HDBaseT Transmitter (Rack Mount)

1. The Transmitter shall be rack-mountable
2. The Transmitter shall be a minimum of HDCP 2.2 compliant
3. The Transmitter shall be capable of reading EDID information
4. The Transmitter shall be capable of signal transmission for up to 300 feet
5. The Transmitter shall support HDMI 1.4 and HDMI 2.2
6. The Transmitter shall support the following resolutions:
   a. 1920x1080 @ 60 Hz
   b. 2560x1600 @ 60 Hz
   c. 4096x2160 @ 30 Hz (DCI 4K)
   d. 3840x2160 @ 30 Hz (UHD 4K)
   e. 3840x2160 @ 60 Hz (4:2:0 chroma subsampling)
7. The Transmitter shall support up to 12 bit color depth
8. The Transmitter shall be capable of at a minimum embedding and transmitting analog audio, digital video and RS-232 control on a single HDMI cable
9. The Transmitter shall contain and a minimum the following connectors:
   a. HDMI
10. The Transmitter shall be:
    a. Extron DTP3 T 202
    b. Equal by Visionary Solutions, Crestron, AMX, Kramer, Altinex, Liberty AV, Aurora Multimedia or Atlona

T. HDBaseT Transmitter (Wall Plate)

1. The Transmitter shall be a single-gang decora style wallplate
2. The Transmitter shall be a minimum of HDCP 2.2 compliant
3. The Transmitter shall be capable of reading EDID information
4. The Transmitter shall be capable of signal transmission for up to 300 feet
5. The Transmitter shall support HDMI 1.4 and HDMI 2.2
6. The Transmitter shall support the following resolutions:
   a. 1920x1200 @ 60 Hz – 8 Bit Color
   b. 2048x1080 @ 60 Hz (2K)
   c. 4096x2160 @ 30 Hz (DCI 4K) – 8 Bit Color
   d. 3840x2160 @ 30 Hz (UHD 4K) – 8 Bit Color
7. The Transmitter shall be capable of at a minimum embedding and transmitting analog audio and digital video on a single HDMI cable
8. The Transmitter shall be capable of Bluetooth communications.
9. The Transmitter shall contain and a minimum the following connectors:
   a. HDMI
10. The Transmitter shall be:
    a. Extron DTP T HWP 4K 231 D
    b. Equal by Visionary Solutions, Crestron, AMX, Kramer, Altinex, Liberty AV, Aurora Multimedia or Atlona
11. Coordinate faceplate color with Architect

U. HDBaseT Receiver

1. The Receiver shall be a single gang decora style wall plate
2. The Receiver shall be a minimum of HDCP 2.2 compliant
3. The Receiver shall be capable of reading EDID information
4. The Receiver shall support HDMI 1.4
5. The Receiver shall support the following resolutions:
   a. 1920x1080 @ 60 Hz
   b. 2560x1600 @ 60 Hz
   c. 4096x2160 @ 30 Hz (DCI 4K)
   d. 3840x2160 @ 30 Hz (UHD 4K)
   e. 3840x2160 @ 60 Hz (4:2:0 chroma subsampling)

6. The Receiver shall support up to 12 bit color depth
7. The Receiver shall be capable of at a minimum receiving and deembedding analog audio, digital video and RS-232 control
8. The Transmitter shall contain and a minimum the following connectors:
   a. HDMI
9. The transmitter shall be:
   a. Extron DTP HDMI 4K 230 Rx
   b. Equal by Visionary Solutions, Crestron, AMX, Kramer, Altinex, Liberty AV, Aurora Multimedia or Atlona

V. HDMI Matrix Switcher (Fixed Configuration)

1. The Matrix Switcher shall be rack mountable
2. The Matrix Switcher shall have 8 inputs
3. The Matrix Switcher shall have 4 outputs
4. The Matrix Switcher shall support HDCP 1.4
5. The Matrix Switcher shall support HDMI 1.4
6. The Matrix Switcher shall support the following resolutions:
   a. 2560x1600 @ 60 Hz
   b. 4096x2160 @ 30 Hz (DCI 4K)
   c. 3840x2160 @ 30 Hz (UHD 4K)
   d. 4096x2160 @ 60 Hz (DCI 4K) – 4:2:0 Chroma Subsampling
   e. 3940x2160 @ 60 Hz (UHD 4K) – 4:2:0 Chroma Subsampling
7. The Matrix Switcher shall have the following inputs:
   a. HDMI
   b. RJ-45 (For HDBaseT)
   c. 3.5 mm captive screw
8. The Matrix Switcher shall have an embedded control processor
9. The Matrix Switcher shall be:
   a. Extron DXP 84 HD 4K PLUS
   b. Equal by Visionary Solutions, Crestron, AMX, Kramer, Altinex, Liberty AV, Aurora Multimedia or Atlona

W. Audio Visual Control Panel (Touch Screen)

1. The Control Panel shall be Tabletop/Wall Mount
2. The Control Panel shall have an ethernet connection
3. The Control Panel shall be capable of being powered via PoE
4. The Control Panel shall have a screen size of 7” for wall mount devices, and 10” for rack mount devices
5. The Control Panels shall be:
   a. Extron TLP Pro 725M and Extron TLP Pro 1025M
   b. Equal by Crestron, Biamp, AMX, Kramer or Atlona
6. Coordinate Control Panel color with Architect and Mounting type as indicated on drawings
7. Include necessary hardware for rack mount as indicated on plans.

X. Dante Audio Interface

1. The Dante Audio Interface shall be located as indicated on the plans and shall provide analog input with connection via Dante to the AV System Network.
2. The Dante Audio Interface shall be:
   a. Extron AXI 22 AT D
   b. Equal by Crestron, Biamp, AMX, Kramer or Atlona

PART 3 - EXECUTION

3.1 General

A. Installation shall follow industry standard wiring and installation practice, and shall meet or exceed industry standards for such work, with particular attention given to any installation instructions in Parts 1 and 2 of these Specifications.

B. Equipment shall be secured firmly with proper types of mounting hardware. All equipment affixed to the building structure must be self-supporting with a safety factor of at least three. All overhead or wall-mounted speaker systems or other devices shall be supported from the building structure utilizing the materials and methods recommended by the manufacturer and good rigging practices, providing a load-rated safety factor of six (6). All required rigging material and labor shall be deemed included in these specifications.

1. The rigging scheme shall provide a clean look with no unnecessary visible structural or support members.
2. Provide additional structural steel as needed to provide proper attachment points.
3. All flown speakers shall have internal mounting brackets and be certified by the manufacturer to be specifically designed for safe overhead suspension.

C. All equipment shall be installed so as to provide reasonable safety to the operator.

D. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable, or manufactured to UL standards.

E. All work shall be performed in accordance with the recommendations of the equipment manufacturers.

3.2 Labeling

A. Clearly and permanently label all jacks, controls and connections with engraved laminated plastic labels or with engraved and back-filled mounting plates. Attach laminated plastic labels with contact cement.

B. Identify and permanently label all wires and cables at every point of termination and connection point with industry-standard cable markers. All cable identifications shall be logged, marked on drawings where appropriate and included in the Owners' Manual.

3.3 Cabinets, Cables, Connectors and Miscellaneous Equipment

A. Equipment Cabinets

1. Locate freestanding equipment cabinet(s) where indicated and provide service access to both front and rear without having to move cabinets.
2. The 120 VAC power to the equipment racks shall be terminated inside the racks to plug mold plugstrips or quad convenience outlets.
3. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
4. Install equipment in cabinets using solid and vented panels and fans as required to provide adequate ventilation in accordance with industry standard principles of thermal management and recommendations of specific equipment manufacturers. Fill all unoccupied rack space with blank or ventilating panels finished to match cabinet color.
5. Connect all microphone, line level, DC control and speaker cables to equipment cabinets via approved audio terminal blocks. Use spade lugs with barrier strips. Do not buss commons together. Do not ground.
6. Locate patch panels and all frequently used controls at least 30 inches above floor.

7. Signal processing equipment with front panel controls that are to be permanently set (e.g. equalizers, limiters, digital delays) shall be furnished with security panels or sub-panel mounted behind blank panels. Provide plastic vision panels to allow viewing of operational indicators such as meters or clipping indicators.

B. Wiring and Interconnections

1. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to ensure that uniform polarity is maintained. Balanced audio connectors shall be wired with shield at Pin #1, hi/positive at Pin #2.
2. Build-out all link circuits containing active components where necessary to provide proper impedance matching and optimum gain structure for maximum operating headroom and signal-to-noise ratio. Record all pad values in the final documentation.
3. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the Engineer at the time of final equalization and testing. Shields of audio cables installed between active interconnected equipment components shall be grounded at the sending end only.
4. All cables shall be installed in conduit except above accessible ceilings, where they shall be installed utilizing J-hooks or bridle rings on minimum 4 ft. centers or cable tray, where available. Provide an electrical wall box with conduit stubbed above accessible ceilings for each wall-mounted peripheral device.
5. Separate conduits and/or cable harnesses shall be maintained for cables in the following categories:
   a. Levels below -20 dBm (microphone).
   b. Nominal line levels from -20 dBm to +30 dBm (line).
   c. Loudspeaker
   d. Control
   e. Power
6. Group and route all cables within equipment cabinets according to type and function and separate according to signal levels. All cables shall be continuous lengths without splices.
7. All system wire shall be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat shrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.
8. All solder joints and terminations shall be made with rosin-core silver solder.
9. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts are not acceptable except in the case of distributed, constant-voltage speaker systems.
10. All microphone level field wiring shall be mechanically terminated on mass punch panels or terminal strips and neatly dressed and labeled.

3.4 Grounding

A. Ground active components, equipment cabinets and audio line shields to independent audio system ground and to ground buss in the power panel.

B. Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from sound system, including audio equipment cabinets and audio system ground.

C. Insulate all conductors, including shields, from conduit, backboxes and from each other for the entire conduit length.

D. Take such precautions as may be necessary to prevent and guard against electro-magnetic and electro-static hum and to install the equipment so as to provide normal and reasonable safety for the operator.

3.5 Tests And Adjustments

A. The completed sound system is to be inspected and tested for compliance with the Specifications.

B. The testing and equalization work shall be performed after the installation work has been completed, but prior to any use of the system.

C. The process of equalizing and testing the system may necessitate moving, adjusting or re-aiming certain loudspeakers. Adjustments shall be performed without claim for additional payment.

D. Coordinate as necessary to ensure a totally quiet room during the sound reinforcement systems testing and balancing period.

E. Tests - Prior to requesting systems acceptance testing, verify the following tests have been performed and the results documented. Record the results in the final project documentation.

1. Polarity Test: Using a polarity checker, ensure that all input and output connections are consistent with regard to polarity.
2. Absolute Impedance:
   a. With loudspeaker level controls at zero attenuation and amplifiers disconnected, measure and record the absolute impedance value of each loudspeaker line at 250,1000 and 4000 Hz. For band-limited devices, use a frequency appropriate for the operating range of the transducer. Impedance shall be at least 90 percent of rated load impedance of respective amplifier. Correct any field readings that differ by more than 20 percent of the calculated impedance.
   b. Check and record resistance of all lines to input receptacles, with receptacles open and short-circuited.
3. Parasitic Oscillation And RFI Pickup
   a. Set up system for each mode of operation.
   b. Use 5MHz bandwidth oscilloscope and loudspeaker monitoring.
   c. Check to ensure that the system is free of spurious oscillation and RF pickup in the absence of any input signal and also with the system driven momentarily at full output at 160 Hz.
4. Buzzes, Rattles And Distortion
   a. Apply a high quality music signal to the system. Adjust for frequent peaks at the specified system maximum sound pressure level.
   b. Apply a sine-wave sweep from 30-5,000 Hz at 6 dB below full amplifier power.
   c. In both cases, listen carefully for buzzes, rattles and objectionable distortion.
   d. Correct all causes of such defects. If a cause is outside the system, promptly notify the Engineer of the cause and suggested corrective procedures.

F. Setup and Adjustments

1. Gain Structure: Adjust input sensitivity and output levels of interconnecting active devices in each signal chain for maximum headroom and signal-to-noise ratio. All devices in each signal chain should clip at the same time as gain is increased. Record electrical levels between all active devices.
2. Equalization
   a. Measure system acoustical performance using a calibrated sound level meter set for "slow" meter damping and flat response with random incidence. All interior furnishings shall be in place during testing.
   b. Using a precision calibrated 1/3 octave audio frequency analyzer and filtered pink noise, with all control equalization set for flat response, measure and record

loudspeaker frequency response in 1/3-octave bands. Measurement microphone shall be placed on-axis to the pertinent speaker, in the center of each seating area.

c. Adjust equalization to provide average system response within +/-3 dB of a response curve that is flat from 300-3000 Hz then sloped uniformly to -4dB at 12KHz. Record both equalizer settings and analyzer curves.

3. Amplifier Level Adjustment: Adjust the level of each system to achieve a volume level appropriate for the location and intended use. After setting the amplifier level for each system, use a pink noise input signal and a sound level meter to identify any areas where the SPL changes by more than 3dB. Identify the cause of the level discrepancy and correct the problem by adjusting amplifier levels or speaker taps. Record the amplifier settings in the final project documentation.
4. Assistive Listening frequency selection shall be coordinated with other assistive listening systems in the same or adjacent facility so as to avoid interference and cross talk between separate systems. Each discrete system consisting of a transmitter and associated receivers shall be set to operate on its own select frequency.

G. Should the performance testing show that the Contractor has not properly completed the systems, the Contractor shall make all necessary corrections or adjustments, and a second demonstration shall be arranged at the Contractor's additional expense.

H. Control Systems:

1. Contractor shall schedule and lead a minimum of (2) planning meetings with Owner for control system programming requirements, with system functionality outlined as follows:
   a. At minimum, the system shall include the following mode selections with description of operation as follows:
      1) Choral Mode
         a) The center channel speaker shall be disabled, and boundary microphones deployed on stage for vocal performances. The speaker system shall be operated in full mono mode.
      2) Presentation Mode
         a) The HDMI input locations or future OFOI equipment shall be utilized for input of presentation materials through video projection system
         b) Person Speaking on/near Stage through use of provided microphone system
         c) The center channel speaker shall be disabled if required. The speaker system shall be operated in full mono mode.
      3) Movie Mode
         a) The Blu-Ray Player or future OFOI equipment shall be utilized for input of videos, movies, etc. with support of 7.1 surround sound.
      4) Board Meeting Mode
         a) The speaker system shall be operated in full mono mode.
         b) Microphones shall be utilized as indicated by the owner.
   b. Lighting control integration shall be provided as coordinated with the owner through use of RS-232 serial communication. Relays shall be provided by the lighting control manufacturer.
2. Following the conclusion of planning meetings, contractor shall submit for Owner and Engineer review planned system programming, including, but not limited to, mock ups of all major pages and a general overview of system flow.
3. At the conclusion of the project, the contractor shall turn over to the Owner all system programming files to allow for ease of future potential changes to the system.
4. There shall be a total of (5) programming changes and (2) trips to the project site at (8) hours each, after final training with the owner, included in the bid.

3.6 System Performance

A. After equalization and testing, the sound system shall meet or exceed the following specifications:

1. System shall be free of short circuits, ground loops, parasitic oscillation, excessive system noise, hum, RF interference and instability of any form.
2. Maximum SPL with band limited pink noise input to the system shall be at least 103dB-SPL before audible distortion or clipping occurs.
3. Seat to seat variation of SPL at 2kHz octave band pink noise shall be within a tolerance of +/-3dB.
4. Acoustic response of the system shall be +/-3dB along a line which is flat from 300Hz to 3000Hz and which rolls off at 2dB per octave to 12kHz as measured in the seating area.

3.7 Systems Acceptance Testing And Training

A. A qualified technical representative of the System Contractor shall do systems acceptance testing. Installation must be complete in all respects before acceptance testing. Acceptance testing and training must be scheduled on separate dates to allow time for corrections, if necessary. Once all functions and devices within the system have been adequately demonstrated to be working properly, a complete Owner's Manual will be presented to the Owner's agent. It shall contain a comprehensive list of all supplied equipment, a complete point-to-point system wiring diagram with "as-built" wire numbers indicated, details of hook-up connections including build-out devices (active and passive), systems control settings record, the final test results including plotted frequency response curves, operation and maintenance manuals for each active device including schematic diagrams and parts list.

B. The contractor shall ensure that test equipment is on site during the testing period. He shall provide a listing of the specific equipment to be made available, prior to the testing appointment. The following minimal standard test equipment shall be provided:

1. Oscilloscope - 10 MHz bandwidth
2. 1/3 Octave real time analyzer
3. Three-dimensional, FFT-based measurement system (TEF, Smaart, SIM II, WINMLS, etc.)
4. Calibrated microphone with portable mic cord of sufficient length to reach all speaker measurement locations
5. Broadband random noise source
6. Low distortion sweepable sine wave generator
7. Distortion analyzer
8. AC impedance bridge
9. Sound level meter: Class 2 filters per ANSI S1.4; range 40 to 120 dBA
10. True RMS Multimeter – Minimum range: DC to 20kHz, 100mV to 300V, 10ma to 10A.

C. The Contractor shall be prepared to verify the performance of any portion of the system by demonstration, listening tests and/or instrument measurements.

D. Acceptance tests may include speech intelligibility surveys and subjective evaluations by observers listening at various positions under various conditions using speech, music, and live or recorded program material.

E. The Contractor shall make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Engineer as a result of acceptance tests.

F. Test Reports and Certification: Submit results of all tests conducted above and certification that the installation is complete and ready for checkout as specified.

3.8 Owner Training and Familiarization

A. Training of owner's personnel shall be done by the Contractor. The Owner and/or his designated representative shall be fully advised as to the function of all operating controls and in techniques necessary to ensure proper operation of the entire system. The training session may include more than one trainee. If possible, several people should be trained. Provide a minimum of sixteen (16) hours of instruction and familiarization for this purpose. Training shall be split into a minimum of (4) separate (4) hour sessions or as required by the Owner.

B. The AV system contractor shall include a training session during the first performance to assist the Owner.

C. The Engineer or his representative will participate during the training period and shall be present for a demonstration of system functionality.

D. The training phase shall be accompanied by complete as-built documentation and the custom Technical System Operation manual. Review of the owner's manual and demonstration of all systems functions is required.

E. Video record all training and provide two (2) copies to Owner.

END OF SECTION

DIVISION 28

ELECTRONIC SAFETY AND SECURITY

28 31 00 EXTENSION OF EXISTING FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 The fire alarm system and installation shall be in compliance with local, city, State, NFPA and IBC codes.

1.2 Required

A. The work required under this Section consists of providing a complete fire alarm and detection system and providing all interconnections as shown on drawings, as specified herein, for this project. THE CONTRACTOR/SUPPLIER SHALL CONTACT THE ARCHITECT/OWNER PRIOR TO BIDDING REGARDING ANY QUESTIONS / CONFLICTS CONCERNING THE FIRE ALARM SYSTEM DRAWINGS AND/OR SPECIFICATIONS.

1.3 Within the renovated space and the building addition, new fire alarm devices are to be added to the existing fire alarm system. All existing devices outside the renovated space shall remain active. The building will remain occupied during construction so the fire alarm system must remain active. Unless otherwise indicated, provide new devices as shown on plans along with any programming necessary to provide a complete functioning system. Existing devices to be removed are shown on the demolition sheet(s).

1.4 It is the intent to reuse the existing fire alarm devices that are removed during demolition. Care must be taken during removal to facilitate reinstallation in locations as indicated on the new construction drawings. In the event that the existing devices cannot be reused, refer to Part 2 below for device requirements.

1.5 See the Drawings and schedules for scope of work required.

1.6 The system shall be initially configured by the system manufacturer's representatives per the Specifications, schedules and Owner's written directions.

A. Programming

All active as well as spare points and hardware related points that are programmed into or activated by the system or other programming shall include numerical identification as well as a text description, i.e. smoke detector room #xxxx, spare etc.

1.7 Acceptance by the Owner – The system will not be accepted until all new and existing components and functions are demonstrated to be in full operation for a minimum of seven (7) consecutive days without any trouble conditions before claiming substantial completion. The system must be demonstrated in the presence of the Owner’s designated representative, the Architect/Engineer’s designated representative and the AHJ. During acceptance the Contractor shall demonstrate the following:

A. Alarm verification – identify device type and location.

B. Alarm/trouble per device and component.

The system will not be accepted until all new and existing devices are demonstrated to be in full operation.

1.8 System Baseline - Prior to any work on the existing fire alarm system, the system shall be witnessed by the Owner’s representative and the Contractor to be without any alarms, troubles, or faults in order to establish a baseline of responsibility for the Contractor.

1.9 General Description

A. The system is a microprocessor based, double supervised, closed circuit fire alarm system of modular design utilizing addressable technology for remote devices. Wiring shall be NFPA Style 4 (Class "B") for signaling and notification circuits. Smoke detectors shall be analog, addressable units with control panel adjustable sensitivity. All units of equipment shall be labeled by Underwriters' Laboratories for fire alarm signaling use.

1) Manufacturer: Siemens Cerberus Pro based fire alarm system

B. Inputs and/or Outputs:

1) Initiating device circuits shall be Class B (match existing initiating device circuit type).

a) Manual Stations

b) Spot-Type Smoke Detectors

c) Duct Mounted Type Smoke Detectors

2) Notification device circuits shall be Class B (match existing notification device circuit type).

a) Audible/Visual Signals

b) Audible Only Signals

c) Visual Only signals

1.10 System Operation

A. Upon an alarm activation by any manual station, building heat or smoke detector, fan or duct heat detector, fan or duct smoke detector, sprinkler or extinguishing system shall:

1) Cause all audible signals to sound (in appropriate buildings only)

2) Cause all visual signals to flash (in appropriate buildings only)

3) Cause the system to go into alarm condition

4) Cause all alarms to sound or flash until silenced and the actuating device reset (in appropriate buildings only)

5) The campus alarm receiving equipment shall display type of alarm/abnormality and level of priority.

6) The proper zone “LED” shall be lighted in the FACP, indicated on the “LCD” display and also on any remote building annunciator panel(s), when included in project.

7) All magnetic door holders shall be released.

8) All supply air fans shall be deactivated as well as all return air fans, ventilation fans, and major exhaust fans. (NOTE: Only when that specific units duct detector, located in return side duct, activates). See Mechanical Specifications and Drawings.

9) Smoke dampers shall close. If applicable, see Drawings and Specifications.

10) Electrically operated ventilation dampers shall close. If applicable, see Drawings and Specifications.

11) Elevators shall be recalled to the default floor.

1.11 Supervision (Where Device is Included in the Project)

A. Manual stations or other similar initiating device - to cause trouble signal if one of the following occurs:

1) Any initiating device circuitry is broken.

2) Any initiating device is removed.

B. Signal devices - to cause trouble signal if one of the following occurs:

1) Any signal device circuitry is broken.

2) Any signal device is removed.

C. Power supplies - to cause trouble signal if any of the following occurs:

1) The main power supply fails.

D. Sprinkler components - see Item #2.12

E. All relays, plug-in modules, etc., to cause trouble signal if one of the following occurs:

1) Relay, plug-in modules, etc., is removed from circuitry.

F. Connecting circuits from building fire alarm control panel to Owner's existing campus annunciator - to show distribution trouble signal (at building annunciator and existing campus receiving equipment) if any of the following occurs:

1) Connecting circuit open.

2) Connecting circuit wire to wire short.

G. All end-of line devices. See Section 2.4 END-OF-LINE DEVICES.

1.12 Emergency Control Functions and Interfaces

A. Operation of any addressable manual or automatic fire alarm initiating device shall interface with the components described herein.

B. Elevator Emergency Service Mode Controls

1) Initiate control signals for primary and alternate elevator recall, via programmable relays located in the elevator machine room, upon receipt of an alarm from associated smoke detectors. An alarm from any non-primary egress level elevator lobby or top of the shaft smoke detectors or elevator machine room, if located in non-primary level shall activate the primary recall function. An alarm from the elevator machine room or main egress level elevator lobby smoke detectors shall activate the alternate recall function. These smoke detectors shall conform to NFPA 72, ANSI / ASME A17.1, and the State Elevator Code.
2) Initiate a control signal for fireman’s elevator alert operation, via a programmable relay located in the elevator machine room, upon receipt of an alarm from smoke detectors in the elevator machine room or at the top of the elevator shaft.
3) Initiate a control signal to activate the elevator shunt trip, via a programmable relay located near the shunt trip breaker, upon receipt of an alarm from heat detectors located in the elevator machine room or at the top of the elevator shaft.
4) Initiate a supervisory signal to the control unit and remote annunciator(s), via an addressable monitoring module located near the elevator shunt trip, upon receipt of loss of voltage to the control circuit for the disconnecting means.
5) For each elevator, provide required interface modules in NEMA 1 enclosure located within 3 feet of the elevator controller for fire emergency service mode operation. Extend control wiring from elevator fire alarm programmable relays to each controller for final connections at the controller by the Elevator Contractor.
6) Provide required interface modules in NEMA I enclosure located within 3 feet of the shunt trip breaker for shunt trip control and voltage monitoring. Extend #12 AWG wiring to the shunt trip breaker and control voltage sensing in the elevator machine room

7) Coordinate all locations, control functions and wiring requirements with the Elevator Contractor prior to rough-in.
8) Coordinate conduit requirements with the Elevator Contractor prior to rough-in for First Responders Use Elevators and Elevators for Occupant-Controlled Evacuation displays.

C. HVAC Systems

1) Shut-down air handling unit fans serving that respective fire zone whenever the alarm occurs. Each air handling unit shall have a separate zone with separate signal for this use. The unit zone shall include all smoke detectors and all high limit stats associated with that unit. Provide a set of remote contacts for each air handling unit zone at location as coordinated with the ATC Contractor. Provide control panel mounted H-O-A / "softkey" override switch(es) to permit continuous operation of fan(s) during test of the fire alarm system.
2) Initiate smoke alarm signals to the Automatic Temperature Control System for smoke control operation of Air Handling Units, if applicable.

D. Door Controls

1) Release all electro-magnetic door holders, per selected initiating zones as indicated on the drawings.

2) Security Door System Interface

a. Provide fire alarm control interface with indicated doors to deactivate door controls (i.e. unlock doors) for a fire alarm condition. Verify programming of each door with fire alarm zones with Engineer prior to installation.
b. Refer to drawings for quantity and locations of door devices to be interfaced.

1.13 Shop Drawings

A. Provide catalog cuts of proposed equipment per General Conditions. Model and/or catalog numbers of proposed equipment to be used shall be highlighted/identified in a fashion that is reproducible, i.e. clearly visible on faxed or copied sheets.

B. Provide preliminary wiring, riser diagram(s) (see sec. #1.3 C), and floor layout plans as soon as possible after Award Of Contract for Architect's/Owner's comments. Note: Provide 2 additional sets above those required in General Conditions.

C. Shop drawings shall include calculations for sizing of signal power supplies, voltage drop calculations for audible and visual signal circuits (including provisions for future devices), speaker amplifiers and standby batteries. Voltage drop calculations will be based on each strobe drawing 110% of operating current and each audible device drawing 120% of operating current to allow for future devices.

D. A complete shop drawing submittal shall consist of all catalog cuts, floor plans, riser diagram(s), etc., as described in A and B above. All required shop drawing items shall be submitted together. Shop drawings will not be reviewed in parts. **SHOP DRAWINGS WILL BE REJECTED UNLESS THE SUBMITTAL INCLUDES ALL THIS REQUIRED INFORMATION.** Delays in construction schedules caused by incomplete drawings shall be the responsibility of this contractor**.**

E. The Contractor or their fire alarm supplier/installer shall submit shop drawings, after the Architect's and Engineer's review, to the State Fire Marshal's Office for their review and approval. Where buildings are not under the jurisdiction of the State Fire Marshal, the shop drawings shall be submitted to the local fire official for review and approval. The fire alarm supplier / installer shall provide sealed documents for submittal to the inspection authority.

1.14 As-Built Drawings

A. Provide floor plan showing location of all devices keyed to riser diagram.

B. Provide schematic wiring diagrams for the entire system showing termination points of all components.

C. Provide a riser diagram showing all components, such as Initiating devices, Notification Devices, Control Devices, Monitoring Devices, FACP (Fire Alarm Control/Annunciator Panel), FAPS (Fire Alarm Power Supply), FAAP (Fire Alarm Remote Annunciator Panel), FABC (Fire Alarm Battery Cabinet) etc., with number of conductors, zones, conduit sizes, etc.

D. As-Builts should be prepared only after satisfactory completion of the fire alarm system and shall include one (1) tracing and four (4) prints of each drawing. Maximum tracing size 24" x 36".

E. Provide at completion of final programming and acceptance of fire alarm system a downloading of the complete programming for the multiplex system to 3-1/2" PC computer diskettes and one 8 1/2" x 11" hard copy on reproducible paper.

F. Provide one hard copy on reproducible paper, 8 1/2" x 11", to the Owner, of defined address codes that are assigned for input-output points that are manually controlled in the system for each zone trouble, alarm, etc., after final programming and acceptance of the fire alarm system. Note: In some system configurations, if these codes are used, they will not give a trouble signal to the campus wide annunciator receiving equipment as per Owner's instructions.

1.15 Base bid includes three (3) additional combination audible/visual alarm signals 30 / 75 cd, two (2) additional ceiling mounted smoke detectors and one (1) additional duct mounted smoke detectors, complete with installation, power supplies, amplifiers, and fifty (50) feet of conduit with circuitry per device. These additional base bid devices shall also include the following:

A. Any related submissions to the AHJ, revised "as-builts", related system programming and revised Owner electronic copy.

B. Any related system commissioning efforts, all related interfaces to other systems, such as, the building automation system and all required additional trips to the site.

C. Any and all costs, not specifically identified in the above items, shall be included for a complete additional base bid devices installation.

D. The audible/visual signals and smoke detection shall be added where designated by the Engineer at the time of final acceptance.

PART 2 - PRODUCTS

2.1 The existing fire alarm system is a Siemens Cerberus PRO based fire alarm system. All products shall be by the manufacturer or certified by the manufacturer as compliant with the system.

A. The existing system throughout the school is horn/strobe based.

2.2 Equipment shall be equal in quality and performance to equipment as manufactured by Siemens. The equipment supplier shall have a service organization within 50 miles of the project site and be a U.L. certified company. All material and/or equipment necessary for proper operation of the system not specified or described herein shall be deemed part of these specifications.

A. The catalog numbers listed herein are for equipment as manufactured by Siemens and shall represent the type and quality required to meet this Specification. (Contractor to verify all catalog numbers listed herein with appropriate vendor, catalog numbers subject to change).

B. The system shall comply with all the applicable provisions of the most current NFPA 72 Standards and meet all requirements of the local authorities having jurisdiction.

C. All equipment and devices shall comply with all applicable standards of Underwriters Laboratories, NFPA and be listed by Underwriters Laboratories Inc. and/or Factory Mutual.

D. The system shall be installed in accordance with the requirements of the latest edition and supplements of the National Electrical Code (NEC), NFPA 72, ADA Accessibility Guidelines and the entire DIVISION 26 of this Specification.

2.3 Actuating Devices

A. Manual stations shall be Siemens #HMS-S addressable, surface mounting using back box surface or semi-flush mounted with applicable trim plate. Units shall be single-action non-break-glass type, having individual zone address and equipped with Fort #415 Key Lock (no exception). Mount devices at 4'0" above finished floor. Exception: Use back ring for surface mounting Siemens pull stations to a wiremold box.

1) Protective shields for all manual stations / manual stations where indicated on plans shall be tamperproof, clear Lexan covers with red frames that are designed to mount over manual pull stations. When the Lexan cover is lifted to gain access to the manual station, a battery powered horn that is mounted integrally in the protective shield's red frame sounds a loud, local, audible signal until the cover is returned to its normal, closed position. Exterior units shall be gasketed for all weather applications.

B. Photoelectric smoke detectors shall be Siemens #FDOT Series analog detector with #DB-11 addressable base. Detectors shall have pulsating "Power-On" LED indicator that locks onto steady burn in an alarm situation. See section #2.8 for additional requirements. It shall be possible to perform a functional test of the detector without the need of generating smoke. The test method shall meet the requirements of the latest edition of NFPA 72. Each detector shall have individual zone address.

1) The Contractor shall install all conduits, wiring, boxes, etc. for the elevator shaft smoke detectors, unless otherwise noted. However, a blank cover shall be installed on the box instead of the smoke detector and base. The wires shall be tagged in the FACP and the opposite end for future connection. The smoke detector(s) and base(s) shall be turned over to the Owner. If this detector is to control elevator shaft fire damper, this contractor shall install all conduit, wiring and make connections necessary. In this application this detector shall be on a separate zone and have its own defeat switch in FACP.

D. Photo-electric type, addressable duct mounted smoke detectors, shall utilize all solid-state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at 0.5% to 3.7% light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individually adjustable through the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. The detector shall contain an integrally mounted LED pilot lamp that indicates detector status. Siemens #FDBZ491 Series housing with Siemens #FDO421 Series detector.

D. A remote mounted test/reset switch with "status" pilot lamp shall be flush mounted at 54” mounting height in a convenient location within sight of air handling unit, Siemens #RSM-1 & #RL-HW. Provide auxiliary contact/relay in base of units to control smoke dampers.

E. Smoke detectors for elevator lobbies, elevator shafts, elevator machine rooms and elevator control room / closet shall be addressable, 2-wire photo-electric smoke detectors suitable for ceiling or wall mounting. Detectors shall utilize all solid state components operating on the light scatter principle and shall be factory set to detect smoke at a 2% light obscuration per foot. Detector shall have a 30-mesh insert screen, completely closed backs and shielded electronics to minimize false alarms from dust, insects, EMI or RFI.

Detectors at the top of elevator shafts shall be installed with a remote test switch at an accessible location.

F. Ceiling mounted heat detectors shall be addressable, combination rate-of-rise and fixed-temperature type set to alarm at 135 degrees F. or on a temperature rise of 15 degrees F. per minute. Unit shall also be capable of low temperature monitoring. Detector shall be white and low-profile style. Siemens #FDT421 Series.

G. Waterflow switches shall indicate the continuous flow of water in sprinkler pipes. Switches shall be furnished and installed by the Fire Suppression Contractor. Wiring and connection shall be by this Electrical Contractor. Unit shall be equipped with retard mechanism, adjustable up to two minutes, to minimize false alarms due to pressure changes. Coordinate pipe size with Fire Suppression Contractor. Units are to be turned over to Fire Suppression Contractor for installation. Each waterflow switch shall be connected to the fire alarm system through a dedicated address via a monitor module. Siemens #XTRI-S Series.

2.3 Notification Devices

A. Fire signal lights (strobe lights) for synchronized operation shall provide visual indication of all alarms and shall illuminate in a flashing mode whenever system is in alarm state. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 30 candela in all other areas unless specifically designated as 75 candela or 110 candela on the drawings. Semi-flush mount signal lights on walls where shown on the drawings. Lens shall be installed in a horizontal alignment on a red back plate labeled "FIRE" and shall produce 1 flash per second. Strobes shall be Siemens #ZR Series. Exterior units shall be gasketed and labeled for exterior use. Wheelock #WM3T.

B. Horns

1) Horns shall be surface mounted, with red grille and field selectable output levels of 90 or 95 dB at 10 ft. (based on UL 464 reverberant test requirements).
2) Horn operating power levels shall be set initially at 90 dB and adjusted up or down as required for proper sound coverage during the final check-out. Power calculations shall be made using the current draw for these units operating at 95 dBA.
3) Outside assemblies shall be weatherproof.
4) Combination (audible/visible) horn and fire signal lights shall utilize a compact, combination mounting base assemblies.
5) Horns shall be labeled "Fire". Siemens #ZH Series (utilize the continuous horn signal setting) with mounting accessories.
6) Exterior units shall be gasketed and labeled for exterior use.
7) Combination strobe/horn signal units shall be factory assembled.

C. Combination Horns

1) Combo horns with fire signal lights (strobe lights) for synchronized operation shall provide both audible and visual indication of all alarms and shall illuminate in a synchronized flashing mode whenever system is in alarm state.
2) Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 30 / 75 candela in all other areas unless specifically designated as 75 candela or 110 candela on the drawings. Surface mount signals on walls where shown on the drawings.
3) Lens shall be installed in a horizontal alignment and shall produce 1 flash per second.
4) Horns shall be supplied with a red grille / cover and labeled "FIRE" and shall have field selectable output levels of 90 or 95 dBA at 10 feet (based on UL 464 reverberant test requirements).

5) Horn operating power levels shall be set initially at 90 dB and adjusted up or down as required for proper sound coverage during the final checkout. Power calculations shall be made using the current draw for these units operating at 95 dB.
6) All strobes shall be synchronized throughout the entire building utilizing control circuitry within the main fire alarm panel (and extender panels if used), Siemens #ZH Series.
7) Exterior units shall be gasketed and labeled for exterior use.

D. Voice Grade Speakers

1) Voice grade speakers shall be semi-flush, wall / ceiling mounted, with white / red grille and field selectable output levels of 85 or 91 dB at 10 ft. (based on UL 464 reverberant test requirements). Speaker operating power levels shall be set initially at 85 dB and adjusted upward as required for proper sound coverage during the final check-out. Power calculations shall be made using the current draw for these units operating at 95 dBA.
2) Frequency response shall be 400 Hz to 4,000 Hz complying with UL 1480, for fire alarm and 125 to 12 kHZ for general signaling.
3) Speaker shall have dual voltage transformer and selectable power taps of ¼, ½, 1, 2 watts. At the 1.0 W tap, the speaker has minimum UL rated sound pressure level of 84 dBA at 10 feet.
4) Siemens #SE Series. Exterior units shall be gasketed for weatherproof rating.

E. Combination Voice Grade Speakers

1) Combo voice grade speakers shall be semi-flush, wall/ceiling mounted with fire signal lights (strobe lights) for synchronized operation, shall provide both audible and visual indication of all alarms and shall illuminate in a synchronized flashing mode whenever system is in alarm state.
2) Frequency response shall be 400 Hz to 4000 Hz complying with UL 1480, for fire alarm and 125 to 12 kHZ for general signaling.
3) Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 30 candela in all other areas unless specifically designated as 75 candela or 110 candela on the drawings.
4) Lens shall be installed in a horizontal alignment and shall produce 1 flash per second.
5) Speaker shall have dual voltage transformer and selectable power taps of ¼, ½, 1, 2 watts. At the 1.0 W tap, the speaker has minimum UL rated sound pressure level of 84 dBA at 10 feet.
6) Speakers shall be supplied with a white/red grille / cover and labeled “FIRE” and shall have field selectable output levels of 85 or 91 dBA at 10 feet (based on UL 464 reverberant test requirements). Speaker operating power levels shall be set initially at 85 dB and adjusted up or down as required for proper sound coverage during the final checkout. Power calculations shall be made using the current draw for these units operating at 95 dB.
7) All strobes shall be synchronized throughout the entire building utilizing control circuitry within the main fire alarm panel (and extender panels if used). Exterior units shall be gasketed and labeled for exterior use. Siemens #SE Series.

F. Bells

1) Bells shall have 10” red gong and shall be surface mounted, capable of minimum 92 db at 10 ft. (based on UL 464 test requirements). Outside assemblies shall be weatherproof. Combination (audible/visible) bell and fire signal lights shall utilize EST #340-10x5 Series.

2.5 Auxiliary Input/Output Devices

A. Unit shall be fast acting heavy-duty power relay with full floating movable contact carrier to assure ample wipe, high contact pressure and accurate alignment. Contacts shall be rated as required. Relay shall include die-formed cold rolled 16 gauge steel enclosure with screw-type cover, if not mounted in FACP.

B. Auxiliary Addressable System I/O devices:

1) Addressable Zone Monitor Module shall be Siemens #XTRI-S for interfacing conventional detectors, waterflow, tamper and security switches with data/communication circuit.

2) Addressable Zone Signal Module shall be Siemens #XTRI-R for supervising and operating 24VDC notification appliances, speakers or telephone circuits.

3) Addressable Zone Control Module shall be Siemens #XTRI-R for control of HVAC systems, elevator capture fire pumps, etc.

C. All Signal, Monitor, Control and Relay modules shall be installed in accessible locations (units mounted on walls shall be 6'0" max A.F.F., units mounted above t-bar ceilings shall have t-bars marked showing location). (Tags furnished by Owner). Modules shall be mounted in appropriately sized lift-off-cover JIC type boxes. Locate boxes away from water lines, drain lines, etc. to prevent possible "Water Damage" to modules.

D. All remotely mounted discrete input/output cards shall be installed in J-boxes such that all switches, fuses, LED's etc. shall be visible and readily accessible.

E. Magnetic door holders shall be voltage selectable for 12 VDC or 24/120VAC operation. Flush, semiflush or surface wall mounted as required, Siemens #SDH Series. Floor mount models for single door or double door applications where required.

F. Provide a recessed Knox-Box rapid entry system where indicated on drawings. Extend wiring from the Knox-Box tamper switch to the building security alarm system.

2.5 Supervisory Signal – Initiating Devices

A. Gate valve switches (OS&Y) shall monitor the status of sprinkler valves where indicated on drawings and shall signal a trouble alarm when respective valve is closed. Switches shall be furnished and installed by the Fire Suppression Contractor. Wiring and connection shall be by this Electrical Contractor. Each gate valve switch shall be connected to the fire alarm system through a dedicated address via a monitor module. Siemens #XTRI Series. Units are to be turned over to the Fire Suppression Contractor for installation.

B. Post indicator valve switches shall monitor the status of sprinkler valves where indicated on the drawings and shall signal a trouble alarm when valve is closed. Switches shall be furnished and installed by the Fire Suppression Contractor. Wiring and connection shall be by this Electrical Contractor. Siemens #XTRI Series. Units are to be turned over to the Fire Suppression Contractor for installation. Each PIV switch shall be connected to the fire alarm system through a dedicated address via a monitor module. Provide a Siemens #CP2297 Series surge suppressor where monitor wiring leaves the building.

2.6 End-Of-Line Devices

A. Terminate all end-of-line devices (ELD's) for hard-wired system in FACP cabinet, unless specifically noted otherwise, for all active, spare and future zones on terminal strips. Addressable system end-of-line devices (ELD's) on each floor are to be terminated in j-box with that specific addressable device or at the last device connected to an addressable auxiliary control/monitor card. They shall not be terminated to the addressable auxiliary control/monitor card, unless specifically noted otherwise by the Owner. Owner will provide I.D. tags for the "ELR" locations as necessary.

B. Label each zone terminated.

C. Terminate resistors and wiring on barrier type terminal strips.

2.7 Wire for Devices (Non-Addressable Types):

A. Provide wiring for each device as follows: (Sizes shown on Drawings increased for voltage drop.)

"Device type"	Devices Per Circuit Or Zone	Size	Number of Hardwire Device Conductors (1) Down	Back
Signals	7 max/cct(3)(4)	#12	2	2
Manual Stations	No limit/zone	#16	2	2
Ionization Smoke Det.	10/zone (2)(4)	#16	2	2
Photoelectric Smoke Det.	15/zone (2)(4)	#16	2	2
Beam Smoke Det.	1/zone	#16	4	4
PIV	1/zone	#16	2	2
Sprinkler Flow Switch/OS&Y	1/zone	#16	2	2
Magnetic Door Holders	15/cct	#12	2	0
Smoke Dampers	15/cct (4)	#12	2	0
Elevator Home	1/cct (4)	#16	2	0
Fan Shutdown	10 max/cct	#14	2	0
Heat Det. In Duct	1/fan system	#16	2	2
Smoke Det. In Duct	1/fan system	#16	2	2
Heat Det.	20/zone(4)	#16	2	2
Sprinkler Alarm Bell	1/system	#14	2	2

1. Conductors from FACP to device.
2. Or in accordance with manufacturer's recommendations.
3. Circuits of horn/strobes or combination circuits of horn/strobes and Strobe only devices. Circuits of Horns only and/or Strobe only devices shall be loaded to not more than 75% of the circuit power rating. Conductor size may need to be increased for voltage drop.
4. Does not apply to addressable system devices.

B. All Fire Alarm system wiring (non-addressable and addressable) shall be installed in conduit, unless specifically approved otherwise by the Owner. Provide conduit capacity for minimum 20% future conductors.

C. The Electrical Contractor shall verify specific requirements with fire alarm vendor and make necessary changes (both in sizes and quantities).

2.8 Wiring for System (Increase for Voltage Drop)

A. #12 for AC, power supply connections.

B. #14 for DC, power supply connections.

C. #12 for DC, Audio/Visual Device Power (non-addressable).

D. #14 for Discrete Control Circuits.

E. Mapnet/Data, and Network Communications (addressable systems) cable shall be 2/c #18AWG solid copper shielded cable "RED" jacket - Manhattan Cable Co. #M39124, West Penn Cat. #975 or equal.

F. All non-addressable signal and power cabling shall be of type FPL, solid or stranded copper conductor, with "RED" jacket of the correct wire gage, as indicated in Sections

2.14 and 2.15. West Penn #'s 994, 998, or Manhattan Cable Co. #'s M39070, M39069 may be used, or equal.

G. Plenum-rated cables (only when specifically approved by Owner) shall meet the same physical requirements as listed above in Section 2.15 E and F.

2.9 Grounding

A. Provide an insulated, isolated, grounding conductor from new FACP to building service ground (see Section 16450).

PART 3 - EXECUTION

3.1 Provide complete programming of the system. Verify nomenclature of building areas and devices with the Owner prior to program finalization.

3.2 Follow NFPA 72 and manufacturer's instructions regarding mounting, wiring and testing system. Installer(s) shall meet State of Indiana and local Municipality requirements for certification and as a minimum, have one installer certified as a NICET Level 2. In addition, the fire alarm system supplier shall have on staff, one NICET Level 3 certified individual and be an U.L. certified company.

3.3 Duct mounted smoke detectors shall be located per U.L. and manufacturer's guidelines to permit easy access for maintenance and testing. Provide access panels where required. Contractor shall ensure accessibility to the entire assembly.

3.4 All wiring shall be installed in conduit, 0.75" minimum size. Conduit system shall be independent of all other systems. All fire alarm wiring conduit shall be pre-colored (RED

3.5 Surface mounted fire alarm devices (when specifically permitted) mounted on walls - such as manual stations, bells, horns, chimes, fire signal lights, etc. shall utilize finished backboxes. These backboxes shall be red metal and shall be field punched for conduit entrance and shall not employ stamped K-O construction. Note that all devices in public or finished areas shall utilize recessed mounted boxes unless noted otherwise.

3.6 Coordinate door holder equipment connections with hardware supplier and supply necessary power supply from main control panel. Door holders shall not be maintained by integral control unit back up battery.

3.7 Provide protection, such as wire guards, which are listed for the specific use on all fire alarm devices within gyms, locker rooms, multi-purpose rooms and other areas subject to mechanical damage.

3.8 Provide a smoke detector at the location of each fire alarm control panel (main panel, auxiliary control panels and remote annunciators) and extend into the system.

3.9 Coordinate locations of any additional remote panels (i.e., transponders, extenders, etc.) with the Engineer during the submittal phase. Provide 120V emergency circuit to each remote panel.

3.10 The following wiring and conduit shall be included in the fire alarm system work in addition to that indicated above:

A. Wiring to supervisory monitor and control points such as generator alarm wiring, and clean agent system supervision, if applicable.

B. Empty conduit with pullwire from the FACP to the main telephone backboard. Telephone wiring from the telephone backboard to the digital communicator is the Owner's / Contractor's responsibility. Assist in making final connections at the digital communicator and verify transmission to and receipt by the Central Station, for telephone line(s) communication and the selected second transmission signal communication method.

C. From fire alarm panel, duct mounted smoke detector, or control relay module to each air handling unit and exhaust fan for shutdown.

D. From fire alarm panel or control relay module to each EP switch/control panel in ATC system for closing smoke dampers or smoke removal systems.

E. From fire alarm panel to electro-mechanical door holders. Coordinate power supply requirements with hardware supplier.

F. Provide surge suppressors on all wiring which extends outside the building by either underground or overhead wiring to other buildings or remote device locations. The fire alarm supplier shall provide suppressors that are compatible with their system.

3.11 All fire alarm wiring passing through rated compartments shall be fire alarm Circuit Integrity (CI) cable, complying with NFPA 72 and NEC 760 survivability requirements.

3.12 System Testing

A. System testing shall not commence until the installer provides written certification that the system is installed in compliance with the project plans and specifications. Within 14 days of completion of the system testing, the Contractor shall turn over to the Owner the “Record of Completion”. This document shall include:

1) Completed and certified NFPA 72 Inspection and Testing Form.

2) Original copies of Owner’s Manuals.

3) Original copies of installation instructions and record drawings. Record drawings are to indicate device locations, device addresses, settings and routing of conductors.

4) The “Record of Completion” shall be bound in 3-ring binders.

B. Upon completion and before acceptance, system performance shall be demonstrated in the presence of the Architect and/or Engineer that all specified functions are accomplished and that response is accomplished from all initiating and indicating devices. Provide step-by-step user instructions with graphics identifying operator controls for normal user operations such as silencing of alarms, resetting of system, locking and unlocking controlled doors, etc. Each normal operation shall be on a separate page and all pages shall be laminated for durability and assembled in a three ring "operators manual". This manual is in addition to shop drawings and maintenance manuals.

C. System Demonstration

1) The Contractor and/or system manufacturer's representative(s) shall demonstrate the operation of the complete fire alarm system as indicated in below.

2) The demonstration shall include normal, supervisory and trouble operations for all of the following functions: (when included in project).

a) Manual Stations.

b) Building Smoke Detectors (per manufacturer's recommendations).

c) Building Heat Detectors.

d) Fan or Duct Smoke Detectors.

e) Fan or Duct Heat Detectors.

f) Signals (audible and visual).

g) Sprinkler Components.

h) Magnetic Door Holders.

i) Supply and Exhaust Fan Operation.

j) Campus Annunciator.

k) Smoke Damper Operation.

l) Other components not specifically listed.

D. System shall be tested by a qualified manufacturer's representative or equipment vendor and a certificate of inspection and report shall be furnished indicating results to the Architect. This testing shall be done with the building HVAC systems in operation and the manufacturer's representative shall field check the dBA readings in accordance with levels established by NFPA. During this checkout period, adjust audible device output levels as needed.

3.13 Manuals and Parts

A. All parts, keys, four (4) copies of the Maintenance Manual including service and repair manuals, schematics, parts lists, etc., description of system operation, schedule of circuits and components by function, location and wire code shall be delivered to the Owner.

B. The Contractor shall furnish to the Owner spare fire horns with visual indication, heat detectors, smoke detectors, visual indication only devices, manual stations, etc. installed on the job.

1) The number shall be 6% of total units of each type installed on the site and no less than one (1) horn with visual indication, one (1) visual indication only device, one (1) smoke detector, one (1) heat detector, one (1) manual station, etc. of each type shall be furnished.

C. The Contractor shall furnish to the Owner one (1) of each type (Monitor, Signal, Control, Relay) modules installed on this job.

D. At the completion of the project and before final payment the Electrical Contractor shall turn over to the Owner all keys, parts, manuals, as-built drawings, recommended list of spare parts etc., required by these Specifications and certify in writing that the Fire Alarm System has been installed in conformance with all applicable codes and is operating properly.

3.14 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M manuals.

B. During the warranted operation, provide an annual inspection (for a total of 3). This work is inclusive with the warranty and shall be performed during regular working hours, Monday through Friday, excluding legal holidays, as coordinated with the Owner. Provide an inspection report to the Owner.

C. Make available a service contract offering continuing factory authorized service of this system after the initial 3-year warranty period.

D. Provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system components operation or the loss of the head-end equipment which renders the system un-usable. Provide an on-site authorized factory technician within 24 hours if required.

E. If equipment components cannot be repaired within 24 hours of service visit, provide “loaner” equipment components to the Owner at no charge.

END OF SECTION

DIVISION 31

EARTHWORK

END OF SECTION 31 31 16

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 32 12 16 - ASPHALT PAVING

PART I - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt paving as shown or implied by Contract Documents.
2. Asphalt paving required as a result of trenching through or demolition of existing asphalt.

B. Related Sections:

1. Division 32 Section “Pavement Marking”.

1.2 QUALITY ASSURANCE

A. All materials and work shall comply with the Indiana Department of Transportation Standard Specifications (INDOTSS), current edition.

B. Any work in public right-of-way or other areas subject to the jurisdiction of any body shall be performed either to the requirements of that jurisdiction or to the requirements of this Specification, whichever is more stringent.

C. Testing and Inspection:

1. All testing and inspection shall be performed by an independent Geotechnical Engineering Consultant ("Geotechnical Engineer").
2. The Geotechnical Engineer is responsible for all testing, sampling and inspection.
3. The Geotechnical Engineer is responsible for approving all materials, installation and procedures.
4. The Contractor is responsible for providing these services.
5. The Contractor is responsible for all coordination and scheduling with the Geotechnical Engineer.

1.3 SUBMITTALS

A. Materials Certificates:

1. Materials certificates must be signed by material supplier and Contractor.
2. Certificates must be submitted for all asphalt paving items.

3. Certificates must state that each material item meets or exceeds specified requirements.

B. Job Mix Formulas:

1. Submit a job mix formula (JMF) for all asphalt paving work.
2. The JMF must state that the mix meets the requirements of INDOTSS Section 402 as specified herein.
3. The JMF must include the following, at a minimum:

a. Aggregate type, source and gradation.
b. Type and percent of binder (actual and extracted).
c. Voids in mineral aggregate (VMA).
d. Voids filled with asphalt (VFA).
e. Percent of air voids.
f. Density.
g. Amount of recycled materials in intermediate course, if applicable.

C. Other:

1. Testing and inspection reports.

PART 2 - PRODUCTS

2.1 PAVING

A. Aggregates:

1. Fine aggregates: INDOTSS Section 904.02
2. Course aggregates: INDOTSS Section 904.03
3. All crushed stone for the aggregate base shall be per the INDOTSS gradations and CAPP specifications.
4. Commercial grade aggregates are not acceptable.

B. Asphalt Materials:

1. General: INDOTSS Section 402.
2. Binder: Performance Graded Asphalt Binder, INDOTSS 902.01 (a).
3. Prime coat: Asphalt Emulsion, AE-PMP, INDOTSS 902.01 (b).
4. Tack coat: Asphalt Emulsion, AE-PMT, INDOTSS 902.01 (b).
5. Recycled asphalt materials:

a. Per INDOTSS 401.06.
b. Maximum 15% in the surface course.
c. Maximum of 25% in the intermediate course.

C. Mixtures:

1. Percent of aggregates passing sieves.

Sieve Size	Surface	Intermediate
19.0 mm (3/4 in.)	100	100
12.5 mm (1/2 in.)	100	70-92
9.5 mm (3/8 in.)	96-100	50-75
4.75 mm (No. 4)	75±5	40±5
2.36 mm (No. 8)	36-66	18-45
1.18 mm (No. 16)	19-50	10-36
600 mm (No. 30)	10-38	6-26
300 µm (No. 50)	5-26	2-18
150 µm (No. 100)	2-17	0-11
75 µm (No. 200)	0-5	0-4
Percent of Bitumen	5.7 – 7.2	4.1 – 5.2
Percent Air Voids	4.0	4.0

2. Contractor is responsible for adjusting mix, if required for proper placement and performance. Any such modifications shall be approved by the Architect/Engineer.

D. Unless otherwise indicated or required by jurisdictions having authority, a prime coat is to be used at the discretion of the Contractor, as necessary and appropriate to ensure proper protection and placement of paving.

PART 3 - EXECUTION

3.1 GENERAL

A. Protection:

1. Provide all necessary barricades and markers in order to keep vehicular traffic off freshly placed paving until the paving has cooled and hardened for at least twelve hours.
2. During paving operations, exercise care not to chip, spall, scar or otherwise damage curbs, walks, buildings and other work. Any such damage shall be repaired to the Owner's satisfaction by the Contractor at the Contractor's expense.

B. Job Conditions:

1. Weather limitations:

a. Apply prime and tack coats when ambient temperature is above 50 degrees F, (10 degrees C), and when temperature has not been below 35 degrees F, (1 degree C), for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
b. Place intermediate course when air temperature is above 30 degrees F, (-1 degree C), and rising.
c. Place surface course when air temperature is above 40 degrees F, (4 degrees C), and when intermediate course is dry.

2. Asphalt temperature: The paving mixture shall be placed and compacted at a temperature between 250˚F (121˚C) and 300˚F (149˚C).

3.2 PAVING

A. Grading and Drainage:

1. Ensure positive and adequate grading for all work. Notify Architect/Engineer of any concerns or conflicts prior to installation.

B. Preparation:

1. Immediately prior to placing the base course, proof-roll the sub-base with a pneumatic tire roller.
2. Remove and replace all areas of failures, irregularities and roller marks in the sub-base so that it meets the compaction requirements of Division 31 Section “Earthwork”.

C. Placement:

1. Aggregate base course:

a. Place base course only on solid, dry and unfrozen subsurface.
b. Unless specified otherwise on the Drawings, the aggregate base shall consist of the following minimum requirements: a 4” layer of compacted No. 53 crushed stone on top of a 4” layer of compacted No. 2 crushed stone, for a minimum overall compacted thickness of 8”.

2. Intermediate course:

a. Immediately prior to the placing of the intermediate course, proofroll the aggregate base course by making a minimum of two passes over the entire areas with a pneumatic tire roller. Remove and replace all areas of failures, irregularities and roller marks in the base course.
b. Place intermediate course only on clean, solid, dry and unfrozen sub-course.
c. Spread each course concurrently, within practical limits, using mechanical spreaders.
d. Intermediate course shall have minimum 3” compacted thickness, unless specified otherwise on the Drawings.

3. Surface course:

a. Place surface course only on clean, solid, dry and unfrozen sub-course.
b. Apply tack coat to underlying surface as necessary to ensure proper placement.
c. Spread each course concurrently, within practical limits, using mechanical spreaders.
d. Surface course shall have minimum 1 1/2” compacted thickness, unless specified otherwise on the Drawings.

4. Abutting existing asphalt pavement:

    a. Saw cut the existing pavement straight and true.
    b. Ensure new pavement elevation matches existing.
    c. Ensure joint is clean and tight, with no gap or raveling.
    d. Refer to Drawings for abutment detail.

D. Compaction:

1. Aggregate base course:

    a. Prior to compacting, remove any foreign materials that have become incorporated into the base course.
    b. Thoroughly compact base course to the proper elevations and density.

2. Intermediate and surface courses:

    a. Prior compacting, remove any foreign materials that have become incorporated into the paving courses.
    b. Follow the spreading processes immediately with rollers of sufficient size to compact the paving courses to their proper densities and elevations.
    c. Ensure no low spots exist which might retain water.
    d. Perform additional rolling as required to produce a well compacted, crack-free, fissure-free surface of uniform texture, without evidence of tool or machine marks.
    e. Do not roll over the unprotected edge of a spread.

3.3 PATCHING

A. Saw cut around areas to be patched or repaired.

B. Remove existing pavement down to sound base, excavating with vertical faces.

C. Replace with full depth patch, making neat, even and crisp joint with adjacent areas.

D. Patched areas shall match adjacent areas in texture and grade.

3.4 FIELD QUALITY CONTROL

A. Coordination:

1. The Geotechnical Engineer shall be present to observe and perform tests at all times paving work is in progress.
2. Contractor shall provide minimum 72 hour notice to Geotechnical Engineer before each operation requiring testing or inspection.

B. Testing:

1. Geotechnical Engineer shall take one sample per lift of asphalt concrete for each 5,000 square feet of pavement area, with a minimum of two samples per lift of asphalt concrete each day before paving operation. The following laboratory tests shall be performed:

    a. Aggregate gradation.
    b. Binder content.
    c. Density.
    d. Percent air voids.

2. Geotechnical Engineer shall test in-place compacted asphalt for density with nuclear penetrometer (backscatter, no drilling of pavement). Geotechnical Engineer shall take one reading per lift of asphalt concrete for each 1,000 square feet of pavement area, with a minimum of two readings per lift of asphalt concrete each day. The in-place density shall be a minimum of 94% of the maximum theoretical density per the Job Mix Formula.

C. Thickness:

1. The in-place compacted thickness will not be acceptable if it exceeds the following allowable variation from the required thickness:

    a. Base course: ½".
    b. Intermediate course: ¼".
    c. Surface course: ¼".

D. Surface Smoothness:

1. The finished surface will not be acceptable if it exceeds the following tolerances, using 10' straightedge applied parallel with and at right angles to centerline of paved area:

    a. Base course: 1/4".
    b. Intermediate course: 1/8".
    c. Surface course: 1/8".
    d. Finished grade shall be within ½" of grade specified on the drawings.

E. Unsatisfactory Pavement:

1. Contractor is responsible for removing and replacing pavement that does not meet the Specifications herein, as well as any pavement deemed unacceptable by Architect/Engineer, Geotechnical Engineer or Owner.
2. The Contractor is responsible for the cost of any re-testing due to unsatisfactory pavement replacement.

3.5 COMPLETION OF WORK

A. At the completion of paving operations, the Contractor shall perform the following:

1. Remove all protective barricades and markers.
2. Clean paving materials from all structures, curbs, walks, mechanical and electrical items, and other surfaces to which the paving is incidental and not intended.

END OF SECTION 32 12 16

SECTION 32 13 00 - SITE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete outside of the building for site improvements including, but not limited to, the following:

    a. Curbing, gutters, walks and pavement.
    b. Equipment pads, light pole bases, utility trench protection and bollard anchorage.
    c. Retaining walls, vaults, utility structures.

2. Precast concrete wheel stops.

1.2 QUALITY ASSURANCE

A. Any work in public right-of-way or other areas subject to the jurisdiction of anybody shall be performed either to the requirements of that jurisdiction or to the requirements of this Specification, whichever is more stringent.

B. Qualifications of Workers:

1. Provide at least one person who shall be present at all times during execution of this portion of the work.
2. This person shall be thoroughly familiar with the type of materials being installed and the best methods for their installation.
3. This person shall direct all work performed under this Section.

C. Manufacturer: manufacturer of ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.

D. Codes and Standards:

1. In addition to complying with all pertinent codes and regulations, comply with all pertinent requirements of the following American Concrete Institute Publications:

    a. “Building Code Requirements for Reinforced Concrete” ACI 318-99.
    b. “Recommended Practice for Cold Weather Concreting” ACI 306 R-88.
    c. “Recommended Practice for Hot Weather Concreting” ACI 305 R-91.
    d. “Recommended Practice for Evaluation of Strength Test Result for Concrete” ACI 214-77.

e. "Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete" ACI 211.1-98.

2. Where provisions of pertinent codes and standards conflict with this Section, the more stringent provisions shall govern.

E. Testing and Inspection:

1. All testing and inspection shall be performed by an independent Geotechnical Engineering Consultant ("Geotechnical Engineer").
2. The Geotechnical Engineer is responsible for all testing, sampling and inspection.
3. The Geotechnical Engineer is responsible for approving all materials, installation and procedures.
4. The Contractor is responsible for providing these services.
5. The Contractor is responsible for all coordination and scheduling with the Geotechnical Engineer.

1.3 SUBMITTALS

A. Mix Designs.

B. Testing and inspection reports.

C. Chloride ion tests or total chloride tests (with generally accepted method to relate total chloride to chloride ion) to show compliance with maximum ion concentrations.

D. Mock-Ups:

1. Flatwork: Minimum 6'x6' panel showing proposed surface finishes, joints and sealants.
2. Exposed vertical surfaces (walls, steps, etc.): sufficient mock-up showing proposed finishes, joints, sealing, chamfering/radii, etc. as applicable.
3. Do not install concrete without approval of both the Owner and Architect/Engineer.

E. Detectable Warning Surface Paver.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete:

1. Cement: ASTM C150, Type I or III.
2. Fine aggregate: ASTM C33.
3. Coarse aggregate: ASTM C33.

a. Crushed stone shall be used for exterior concrete, unless otherwise noted.

b. Maximum aggregate size is 3/4 of the minimum clear spacing (per code) between reinforcing bars or between bars and forms.

4. Water: Clean, fresh, potable.
5. Air-entraining admixture: ASTM C260.
6. Fly ash: ASTM C618.
7. Fiber mesh:

   a. Fiber mesh shall be polypropylene fibrillated and mix shall contain minimum 1.5 lbs. of fiber per cubic yard of concrete, unless otherwise prescribed by manufacturer and approved by Architect/Engineer.
   b. Fiber shall be mixed at batch plant, field mixing is not acceptable.

8. Sealer/curing compound:

   a. ASTM C309, Type I, clear.
   b. Compatible with texture of surfaces.

B. Mix Design:

1. Strength: 4000 psi, ready mixed in accordance with ASTM C94.
2. Slump: 4” +/- 1”.
3. Minimum cement content: 517 pounds per cubic yard (adjust for air entrainment)
4. Fly ash shall not replace more than 20% of the cement.
5. Maximum water/cement ratio: 0.40.
6. Air entrainment: 6%. Percentage of air content shall be determined in accordance with the admixture manufacturer’s recommendations based on aggregate size and a moderate level of exposure.
7. White concrete must have a 3-year aged minimum SR value of 0.28, or initial SR value of at least 33.

C. Other Requirements:

1. Proportions of materials for concrete shall be established in accordance with Section 5.2 of ACI 318 (Latest edition).
2. Follow ACI 211 and ACI 301 to determine the water-cement ratios.
3. Concrete shall not exceed maximum chloride ion content for corrosion protection as defined in ACI 318 Table 4.4.1.
4. Do not use calcium chloride or admixtures containing soluble chlorides.
5. Do not use re-tempered concrete or concrete that has been contaminated by foreign materials.
6. All exterior concrete shall be air entrained.
7. Unless otherwise indicated, all reinforcing for concrete pavement shall be epoxy coated.

D. Isolation Joints: Unless specified otherwise on Drawings, use the following:

1. Cork isolation joints with sealant:

a. Joint material: AASHTO M213; 1/2 inch thick.
b. Joint sealer: AASHTO M173; polyurethane with color matching adjacent concrete
c. Application: Use cork isolation joint with sealant for isolation joints for sidewalks, drop-offs, decorative concrete pavement areas, areas adjacent to buildings, structures, and columns.

2. Asphalt saturated cellulosic fiber:

a. Joint material: AASHTO M213; 1/2 inch thick.
b. Do not place sealant on asphalt saturated cellulosic fiber isolation joints.
c. Application: Use this type of isolation joint for items such as curbs and walks, which are in areas not adjacent to buildings, structures and columns, etc. Do not use in areas of colored concrete.

3. Contact Architect/Engineer if further direction is needed for proper application in specific areas.

E. Detectable Warning Surface:

1. Concrete pavers:

a. Size: 12” x 12” x 2” thick excluding the dome height.
b. Pavers shall be resistant to road salts and common road pollutants.
c. Paver unit shall be suitable for traffic loads.
d. Truncated dome elements shall comply with current ADA requirements

2. Cast iron plates: Detectable warning surface paver:

a. Shall be manufactured from gray iron in accordance with AASHTO M105, Class 30A.
b. The tops of the domes and the space between domes shall have a non-slip textured surface.
c. The minimum thickness of the casting shall be 0.30 inches excluding the dome height.
d. Plates shall be resistant to road salts and common road pollutants.
e. Plates shall be suitable for traffic loads.

2.2 STEEL REINFORCING

A. Reinforcing Bars:

1. Reinforcing bars and dowels: ASTM A615, Grade 60.
2. Reinforcing to be welded: ASTM A615, Grade 40.
3. Epoxy coated bars and dowels: ASTM A884, Grade 60.

B. Welded Wire Fabric:

1. ASTM A185 6”x6”xW1.4xW1.4, unless otherwise indicated.
2. Provide in flat sheets, not rolled form.

C. Other Embedded Items: Provide standard manufactured products as approved by the Architect/Engineer.

D. Bar Supports:

1. Conform to the requirements of the “Manual of Standard Practice”, published by the Concrete Reinforcing Steel Institute.
2. Accessories shall be plastic protected Class “C” for all concrete exposed in the finished structure, except as specified below.
3. Accessories shall be Class “A”, bright basic, for unexposed concrete.
4. Utilize Call “E,” stainless steel bar supports, for exterior concrete to be finished by sand blasting.
5. Do not use continuous high chairs. Use individual high chairs laced with bottom cross bars plus #5 support bars. (Minimum of 2 rows of support for all reinforcing).
6. Supports must be capable of supporting construction loads without failing. Contractor to furnish additional supports at no cost to the Owner if in the Architect/Engineer estimation the supports are not adequate.

2.3 FORMWORK

A. Form Lumber:

1. All form lumber in contact with exposed concrete shall be new or of sufficient quality to insure an unblemished texture.
2. All form lumber shall be plywood, board lumber, hardwood or other material of grade or quality to best suit each particular usage.

B. Fiber Forms:

1. Fiber forms may be utilized to construct round columns/piers.
2. Seamless forms must be used for concrete exposed in the finished structure.
3. Standard seamed tubes are permissible for non-exposed concrete.

C. Form Release Agent:

1. Standards:

a. Release agent shall be similar to Symons Manufacturing Company Magic Kote.
b. Grace Construction Products Formshield Chemical Release Agent.

D. Bracing/Shoring/Studs:

1. Such supports shall be selected for economy consistent with safety requirements and the quality required in the finished work. The Contractor is responsible for the design, illustration, safety and serviceability of all formwork.

E. Other Materials: All other materials, not specifically described, but required for proper completion of concrete formwork, shall be as selected by the Contractor subject to advance acceptance by the Architect/Engineer.

2.4 OTHER

A. Precast Concrete Wheel Stops:

1. Reinforced, precast concrete units 6” high x 9” wide x 7’ long.
2. Provide minimum 2-#4 deformed bars 80” in length.
3. Provide chamfers on the top edges and drainage slots on the underside.
4. Anchor pins shall be 5/8” diameter deformed bars minimum 18” long.

PART 3 - EXECUTION

3.1 GENERAL

A. Job Conditions:

1. Extreme temperature conditions:

a. When extreme hot or cold weather conditions occur, or are expected to occur, which might detrimentally affect concrete, employ handling and placing techniques to guard against such effects.
b. Comply with the recommendations of American Concrete Institute for hot and cold weather concreting. ACI Publications ACI 306 and ACI 305.

2. Inclement weather: Unless adequate protection is provided, do not place exterior concrete during rain, sleet or snow.

B. Preparation and Verification:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly begin.
2. Verify all items to be embedded in concrete are in place.
3. Verify concrete may be placed to the lines and elevations indicated on the Drawings, with all required clearances for reinforcement.
4. Verify forms may be constructed in accordance with all pertinent codes and regulations, the referenced standards and the original design.
5. Remove all dirt, oil, paint, loose rust and other foreign materials from the concrete reinforcement prior to placement.
6. In the event of discrepancy, contact Architect/Engineer immediately and do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.
7. Verify approval of mock-ups by Owner and Architect/Engineer before beginning work.

C. Other: Unless otherwise indicated, all exterior concrete shall be placed on a compacted aggregate fill per the following:

1. Minimum depth equal to the concrete thickness for pavement, walks and other slabs on grade.
2. Minimum 6” depth of fill for curbing and other support bases.

3.2 FORMWORK

A. Protection:

1. Use all necessary and appropriate means to protect formwork materials before, during and after installation.
2. Protect the installed work and materials of all others trades.
3. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to Owner or other trades.

B. General:

1. Forms shall have sufficient strength and be sufficiently tight to prevent leakage of mortar.
2. The design and engineering of the formwork shall be the responsibility of the Contractor.
3. Refer to this Section for construction joint requirements.
4. Tolerances: Construct all forms straight, true, plumb and square within the tolerances recommended by ACI 347.
5. Embedded items: Set all required steel frames, angles, grilles, bolts, reglets, inserts, pipe, conduit and other such items required to be anchored in the concrete before the concrete is placed.
6. Wetting: Keep forms sufficiently wetted to prevent joints opening up before concrete is placed, except as recommended in ACI 306 R-78, “Recommended Practice for Cold Weather Concreting.”

C. Layout:

1. Form all required cast-in-place concrete to the shapes, sizes, lines and dimensions indicated on the Drawings.
2. Exercise particular care in the layout of forms to ensure the proper finish structure size and shape.
3. Make proper provision for all openings, offsets, recesses, anchorage, blocking and other features of the Work as shown or required.
4. Carefully examine the Contract Documents and consult with other trades as required to ensure proper provisions for openings, reglets, chases, and other items in the forms.

D. Bracing and Shoring:

1. Properly brace and tie the forms together so as to maintain position and shape and to ensure safety to personnel.

2. Construct all bracing, supporting members, and centering of ample size and strength to safely carry, without excessive deflection, all dead and live loads to which they may be subjected.
3. Properly space the forms apart and securely tie them together, using metal spreader ties that give positive tying and accurate spreading.
4. All shoring shall extend to adequate foundations.
5. The Contractor is responsible for both the proper design and installation of all bracing and shoring, to properly insure the safety and serviceability of the structure.

E. Plywood Forms:

1. Assembly: Nail the plywood panels directly to studs and apply in a manner to minimize the number of joints.
2. Joints: Make all panel joints tight butt joints with all edges true and square.

F. Reuse of forms:

1. Reuse of forms shall in no way delay or change the schedule for placement of concrete from the schedule obtainable if all forms were new.
2. Reuse of forms shall in no way impart less structural stability to the forms, nor less acceptable appearance to finished concrete.

G. Cleaning:

1. Before concrete is placed the forms shall be cleaned of all debris, ice, snow, frost, and standing water.
2. Remove all loose earth materials from the surfaces of earth forms.

H. Removal of Forms:

1. Forms shall be removed in such a manner to ensure complete safety of the structure.
2. Formwork for columns, walls, and other parts not supporting the weight of the concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations with the following minimums:

    a. Formwork for walls and columns shall remain in place a minimum of two (2) days during which the temperature of the air surrounding the concrete must be above 50˚ F.
    b. This minimum time period represents a cumulative number of days or fractions thereof.
    c. Such formwork for concrete placed during cold weather with surrounding air temperatures 50˚ F shall remain in place one day after the artificial heating and/or freeze protection is discontinued/removed.

3. Forms and false-work:

    a. Any supporting vertical loads shall remain in place until the members have acquired sufficient strength to safety support their weight and any superimposed loads.

b. Such forming shall remain in place until the concrete has attained its specified 28 day strength as indicated by the test cylinders unless re-shores are installed in sufficient quantities to transmit the loads to adequate foundations without over stressing the particularly cured structure.
c. The requirements of ACI 305 and 306 must also be met before forms may be removed.
d. Removal of forms and false-work is the responsibility of the Contractor, and the Contractor shall bear the full responsibility for this operation.
e. Concrete damaged by too early removal of forms or false-work shall be repaired or replaced as directed by the Architect/Engineer.

4. Concrete exposed by form removal during the curing period shall be cured by one of the methods specified in this Section.
5. Curing compound is not permitted in certain locations. In these cases, curing is to be by an alternate method. Refer alternate methods in this Section.
6. In no case shall the superimposed load or relatively new concrete exceed 50 pounds per square foot unless proper shoring to suitable foundations is installed as required by the Architect/Engineer.
7. Use all necessary and appropriate means to protect workman, public, the installed work and materials of other trades, and the complete safety of the structure.
8. Cut nails and similar fasteners off flush and leave all surfaces smooth and clean.

3.3 REINFORCEMENT

A. Protection:

1. Use all necessary and appropriate means necessary to protect concrete reinforcement before, during and after installation and to protect the installed work and materials of all other trades.
2. Store in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
3. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the Owner.

B. Placing:

1. Reinforcing bars:

a. Positively secure reinforcing to bar supports and tie or otherwise anchor bars to prevent displacement by construction loads or by the placing of concrete.
b. Splice bars with a minimum lap of 40 bar diameters, unless otherwise indicated.
c. Use mechanical splicers/couplers where quantity of reinforcement restricts placement of concrete if lapped splices are utilized.
d. Splice bars only at locations indicated on the Contract Documents and shop drawings.
e. Both shop and field bending shall be accomplished without heating the bars.

f. Minor placing adjustments can be made to avoid interference with other reinforcement and/or embedded devices. The final arrangement, however, is subject to review and acceptance of the Architect/Engineer.
g. Immediately notify the Architect/Engineer if reinforcing cannot be installed as shown on drawings. No cutting of reinforcing shall occur unless the Architect/Engineer has reviewed and approved such cuts.

2. Embedded devices:

a. Set hangers, anchor bolts, inserts, and other embedded devices accurately in place.
b. Make sure all such devices are installed so that work to be attached thereto will be properly received.
c. Keep devices straight and true-to-line.

3. Welded wire fabric:

a. Splice by lapping each section at least two meshes wide plus one wire with the adjacent section, but not less than 8".
b. Extend fabric into all openings, doorways, and the like, unless otherwise indicated.

C. Final Cleaning:

1. Prior to placing concrete, remove all loose mill and rust scale, oil, mud, ice, and other foreign coatings which destroy and/or reduce bond between the reinforcement and concrete.
2. Use wire brushing and/or other suitable methods to complete cleaning operations.

3.4 CONCRETE PLACEMENT

A. Preparation:

1. Remove all wood scraps, ice, snow, frost, standing water and debris from the area in which concrete will be placed.
2. Thoroughly wet the surface of excavations (except in freezing weather), coat forms with release agent and remove all standing water.

B. Method:

1. Convey concrete from mixer to place of final deposit by methods that will prevent separation and loss of materials.
2. For chuting, pumping and pneumatically conveying concrete, use only equipment of such size and design as to ensure a practically continuous flow of concrete at the delivery end without loss or separation of materials.
3. Deposit concrete as nearly as possible in its final position to avoid segregation due to re-handling and flowing.
4. Use screed poles or similar devices to ensure that all slabs are cast at the proper elevations and that specified tolerances are maintained.

C. Rate of Placement:

1. Place concrete at such a rate that concrete is at all times plastic and flows readily between reinforcement.
2. Once placing is started, carry it on as a continuous operation until placement of the panel or section is complete.
3. Do not pour a greater area at one time than can be properly finished. This is particularly important during hot or dry weather.

D. Consolidation:

1. Thoroughly consolidate all concrete by mechanical vibration, hand, and other suitable means during placement, working it around all embedded fixtures and into corners of forms.
2. Do not over-consolidate with when using mechanical vibration as to cause separation of the aggregate.

3.5 JOINTS

A. Unless otherwise shown on Drawings, joints shall meet the following minimum requirements. If questions or concerns exist, contact Architect/Engineer for direction.

B. Isolation Joints:

1. General:

a. Tool concrete on both sides of joint (1/4" radius).
b. Install joint material to full depth of concrete.
c. See Part 2 Products for type of joint material to be used.
d. Install sufficient smooth doweling reinforcing to prevent differential movement in curbing, walks and pavement.
e. Do not dowel into such items as columns and exterior building walls/foundations, unless specified on drawings. Refer to structural drawings also.
f. Unless otherwise indicated, install isolation joints per the following minimum requirements.

2. Curbing:

a. Provide each side of inlet castings.
b. Provide at all tangent points and changes in direction.

3. Walks:

a. For walks 6 feet in width and less, provide at intervals not exceeding 25 feet.
b. For larger walks and plaza areas, provide at intervals not exceeding 20 feet in any direction.

4. Pavement: Provide at intervals not exceeding 20 feet in any direction.

5. Retaining walls: Provide at intervals not exceeding 40 feet per linear length of wall.

6. Other:

    a. Provide at accessible ramps, buildings, columns, bollards, castings, drains and other locations as necessary to prevent excess cracking or displacement.
    b. Contact Architect/Engineer if any areas of question or concern are encountered.

C. Control Joints:

1. General:

    a. Control joint depth shall be minimum ¼ of the slab thickness.
    b. Continue one half of reinforcing through joint.
    c. Install joints by tooling or saw cutting as described below, unless otherwise indicated.
    d. Construction joints may be used where appropriate.

2. Curbing: Saw cut at intervals not exceeding 10 feet.
3. Walks: Tool joints at intervals not-to-exceed 5 feet in any direction.
4. Pavement: Saw cut at intervals not exceeding 18x pavement thickness feet in any direction.
5. Retaining walls: Provide at intervals not exceeding 20 feet per linear length of wall.
6. Other:

    a. Provide at accessible ramps, columns, bollards, castings, drains and other locations as necessary to prevent excess cracking.
    b. Contact Architect/Engineer if any areas of question or concern are encountered.

D. Construction Joints:

1. Joints shall be made with properly constructed bulkheads and formed keyways.
2. Extend reinforcing through construction joints, unless otherwise indicated.
3. The Contractor shall consult with the Architect/Engineer before starting concrete work to establish a satisfactory placing schedule and to confirm joint locations.
4. Retaining walls: Provide at intervals not exceeding 80 feet per linear length of wall.

E. Tooled Joints and Scoring:

1. Make straight, clean and non-ragged.
2. Tool or score concrete on both sides of joint (1/4” radius).
3. Provide window pane joint finish unless otherwise indicated.

F. Bond Break: 15# per 100 square foot building paper.

3.6 FINISHING

A. Unless otherwise indicated, provide a light-broom finish on all exterior slabs, walks and stairs.

B. Provide a dry-rub finish for all exposed concrete walls, curbs or edge surfaces.

3.7 CURING

A. Formed Surfaces:

1. Cure formed surfaces by either of the following methods:

   a. Leave forms in place until the cumulative number of days or fractions thereof, not necessarily consecutive, has totaled seven days during which the temperature of the air in contact with the concrete is 50˚F or above.
   b. Remove forms at an earlier time, but apply curing compound to concrete surfaces.
   c. Apply compound in accordance with manufacturer's recommendations.

2. If curing compound is not used and the forms are stripped prior to 7 days curing, the following methods are approved:

   a. Ponding or continuous sprinkling.
   b. Continuously wet mats.
   c. Sand kept continuously wet.

3.8 PATCHING

A. Patch existing concrete to receive new finish in a manner so that existing and patched surfaces are smooth and continuous and have a uniform appearance.

3.9 QUALITY ASSURANCE

A. Coordination:

1. A representative from the Geotechnical Engineer shall be present to observe and perform tests at all times site concrete work is in progress.
2. Contractor shall provide minimum 72 hour notice to Geotechnical Engineer before each operation requiring testing or inspection.

B. Inspection:

1. Immediately after forms and curing membranes have been removed, inspect all concrete surfaces and patch all pour joints, voids, rock pockets, form tie holds and other imperfections before the concrete is thoroughly dry.
2. If the defects are serious or affect the strength of the structure, or if patching does not satisfactorily restore the quality and appearance of the surface, the concrete shall be removed and replaced complete, at no additional cost to the Owner.

C. Testing: The Geotechnical Engineer shall perform the following:

1. Compression tests:

    a. Secure three standard cylinders from each pour of concrete, in accordance with ASTM C31, and cure under standard moisture and temperature conditions.
    b. Test in accordance with ASTM C39.
    c. Test one cylinder at 7 days and two cylinders at 28 days.
    d. Submit duplicate test reports of results from testing to Architect/Engineer.
    e. Take steps immediately to evaluate unsatisfactory test results.
    f. In the event of unsatisfactory test results, an investigation as outlined in Section 5.6.5 of ACI 318-99 shall be employed.

2. Slump and air entrainment:

    a. Perform slump tests in accordance with ASTM C143.
    b. Determine the air content of concrete in accordance with ASTM standards.
    c. Submit results of slump tests and air content on each compression test report.

3. Should additional testing be required because of unsatisfactory test results, the Contractor is responsible for the costs incurred for correcting any deficiencies and the cost of additional testing.

3.10 DETECTABLE WARNING SURFACE

A. Shall be installed per manufacturer requirements.

B. Contractor shall warranty installed system for a period of three years from the date of substantial completion.

C. Contractor shall provide owner with detectable warning surface units equal to 10% of the total units installed for future repairs.

END OF SECTION 32 13 00

SECTION 323300 - SITE FURNISHINGS

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. Seating.
2. Tables.
3. Bicycle racks.
4. Trash receptacles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For units with factory-applied finishes.

C. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Trash Receptacle Inner Containers: Five full-size units for each size indicated, but no fewer than two units.

PART 2 - PRODUCTS

2.1 SEATING AND TABLES

A. Refer to plan notes on Drawings for locations of specific Site Furnishings and Equipment.

B. Standalone Benches
   1. Apex Bench 72” length, Nominal 18” depth, 17” height.
   2. Anchored to concrete.
   3. Provide all stainless steel anchors required.
   4. Provide a quantity of (3) Benches. Location to be determined.

C. Frame Materials: Aluminum with Powder Coat finish. Color selection from manufacturer’s full range.

D. Bench Seat Materials: Hardwood Slats – FSC Hardwood

2.2 BICYCLE RACKS

A. Bicycle Racks:
   1. Capitol Bike Rack – Forms and Surfaces
   2. Cast aluminum with powder coat finish. Color selected by Architect.
   3. Surface mounted to concrete. Provide all stainless steel anchors required.
   4. Provide a quantity of (2) Racks. Location to be determined.

2.3 TRASH RECEPTACLES

A. Trash receptacles
   1. Knight – Forms and Surfaces
   2. Welded aluminum frame with powder coat finish.
   3. Free-standing with levelers
   4. Provide stainless steel security chains for lids.
   5. 34 inches high, 21 inches square.
   6. Provide polyethylene, replaceable liners. Provide two extra liners per trash receptacle.
   7. Provide a quantity of (2) Receptacles. Location to be determined.

2.4 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:

   1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B211 (ASTM B211M).
   2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B221 (ASTM B221M).
   3. Structural Pipe and Tube: ASTM B429/B429M.
   4. Sheet and Plate: ASTM B209 (ASTM B209M).
   5. Castings: ASTM B26/B26M.

B. Stainless Steel: Free of surface blemishes and complying with the following:

   1. Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M or ASTM A666.
   2. Pipe: Schedule 40 steel pipe complying with ASTM A312/A312M.
   3. Tubing: ASTM A554.

C. Anchors, Fasteners, Fittings, and Hardware: Stainless steel, commercial quality.

2.5 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

2.6 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true at locations selected.

END OF SECTION 323300

SECTION 32 80 00 - IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Design, furnish and install a complete underground irrigation system using the sprinklers, valves, piping, fittings, controllers, wiring, pumps, etc., of sizes and types as required for 100% coverage. The system shall be constructed to grades and conform to areas and locations as shown on site landscape plan.
2. Coordinate connections with Mechanical Contractor.
3. Lawn irrigation shall be tapped from public water service separately and include separate water meter and backflow preventer as requested by the water company.
4. The intent is to specify a complete and efficient sprinkler irrigation system ready for use in accordance with the manufacturer's recommendations.

B. Related Sections:

1. Division 32 Section “Planting”.
2. Division 32 Section “Seeding”.

C. Verification of Finish Grade:

1. The Contractor shall verify the correctness of all finished grades within the work area in order to insure proper soil coverage (as specified) of the sprinkler system pipes. All finish grading shall be completed in accordance with Contract Documents prior to installing irrigation system.

1.2 QUALITY ASSURANCE

A. Standard of Quality:

1. The Toro Company.

B. Acceptable Manufacturers:

1. Rain Bird Sprinkler Manufacturing, Inc.
2. The Toro Company.

C. Codes and Requirements:

1. Irrigation systems shall meet the requirements of all state and local codes.
2. Irrigation system shall meet the requirements of the water company.

1.3 SUBMITTALS

A. Submit the following:

1. Design and installation: Submit shop drawings showing layout of system and controls.
2. Certification: Submit all required certifications with shop drawings.
3. Maintenance Manuals: Submit three copies of maintenance and operating manuals complete with parts list.

1.4 QUALIFICATIONS

A. Contractor Qualifications:

1. The Contractor is responsible to engage an experienced Contractor who has completed irrigation work similar in material, design, and extent to that indicated for this project, and with a minimum 3 year record of successful irrigation installations, and be familiar with any and all methods of designing, assembling, joining, and installation of the various types of materials to be used. He will adhere in strict accordance with the manufacturer's recommended guide

1.5 WARRANTY

A. The entire sprinkler system shall be guaranteed by the Contractor as to design, material, and workmanship, including settling of backfilled areas below grade, for a period of two years following the date of Substantial Completion.

B. The Contractor shall, prior to final payment, supply a three (3) year maintenance bond by a surety approved by the Owner, in an amount equal to 100% of amount required to provide the materials and complete installation for the sprinkler system. The cost of the materials and installation of the sprinkler system shall be as established in the Schedule of Values.

C. If, within two years of the date of completion, settlement occurs in pipes, valves, and sprinkler heads, sod, or paving, the Contractor, as part of the work under his contract, shall make all adjustments without extra cost to the Owner including the complete restoration of all damaged planting, paving, or other improvements of any kind.

D. Should any operational difficulties in connection with the sprinkler system develop within the specified guarantee period, which, in the opinion of the Owner, may be due to inferior material and/or workmanship, said difficulties shall be immediately corrected by the Contractor to the satisfaction of the Owner at no additional cost to the Owner, including any and all other damage caused by such defects.

1.6 JOB CONDITIONS

A. Existing Utilities and Conditions:

1. Prior to excavation, the Contractor shall locate all cables, conduits, sewers, and other underground utilities and shall take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, the Contractor shall promptly notify the Architect/ Engineer. Where irrigation lines are required to cross drive areas, Contractor shall coordinate the placement sleeves prior to the pavement installation.
2. Where investigation of subsurface conditions have been made by a qualified firm in areas where work is to be performed or in areas in which local materials may be obtained, Contractor may request the use of such information, but will be directly responsible for its verification and accuracy.

B. Source of Water Supply:

1. The source of water supply shall be building water service line as approved by the Owner and Architect. The Contractor will start the pipe installation at the source.
2. Connections to the existing lines shall be at the approximate locations shown on the Drawings. Minor changes caused by the actual site conditions shall be made by the Contractor at no expense to the Owner.
3. Connection to potable water supply shall be through an approved reduced pressure principle backflow preventer provided by this Contractor.

C. Disruption of Services:

1. Permission to shut off existing water lines must be obtained from the Owner 72 hours in advance of intended disruption date.
2. Coordinate with appropriate utilities

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. The materials chosen for the design of the sprinkler system have been specifically referred to by manufacturer so as to enable the Owner to establish the level of quality and performance required by the system design.
2. Acceptable manufacturers are:

a. The Toro Company - Riverside California.
b. Rain Bird Sprinkler Manufacturing.

B. Main Line Piping: 2" Class 160 bell end PVC pipe.

C. Lateral Line Piping: Class 160 or Class 200 bell end PVC pipe.

D. Pipe Fittings: Schedule 40 PVC fittings.

E. Automatic Controller: Toro System C 16 station controller.

F. Valve Enclosures: Carson Model 910-12, 16" round valve box.

G. Automatic Valves: Toro Models 252-27-06 and 254-06-04 electric valves.

H. Valve: Controller communication – 18 gauge multi-strand wire.

I. Sprinkler Heads: Toro Model 570C-4P fixed spray head. Toro Model Super 700 rotor spray head. Toro Model 300 rotor spray head.

J. Sprinkler Risers: Toro Model 85005 funny pipe, 850-31, ½" male elbow, 850-32, ¾" male elbow.

K. Backflow Preventer: As approved by water company.

PART 3 - EXECUTION

3.1 OBSERVATION

A. Installation and operations must be reviewed by Architect/ Engineer prior to backfilling any trenches.

B. In no event shall the Contractor cover up or otherwise remove from view any work under this Contract until it has been observed by the Architect/Engineer. Any work covered prior to inspection shall be opened to view by the Contractor at his expense.

3.2 INSTALLATION

A. Trenches:

1. Trenches and backfill of trenches are described in Division 31 Section "Earthwork".
2. Minimum cover on system shall be 12".

B. Pipe:

1. The Contractor shall establish his own grades so that the entire system of piping can be drained free of water, by gravity to the drainage point shown on the Drawings. Where conditions warrant, and where reviewed by the Architect/Engineer, the Contractor may

relocate some of the drain locations and where necessary add to their number at no additional cost to the Owner.

2. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings.
3. All PVC pipe shall be installed in accordance with recommendations of the pipe manufacturer.
4. Where connections are made between new work and existing mains, the connections shall be made by using special fittings to suit the actual conditions.
5. Connections between different types of pipe accessories shall be made with transition fittings where recommended by manufacturers.
6. In the installation of PVC pipe, the installer will provide safeguards against the problem of contraction of the PVC by "snaking" the pipe as much as possible in the trench.
7. Where solvent weld joints are used, only the solvent recommended by the pipe manufacturer shall be used.
8. Material and workmanship shall be in accordance with local codes and ordinances of legally constituted authorities, except where provisions of these Specifications exceed such requirements, these Specifications shall govern.

C. Thrust Restraints:

1. Thrust restraints of adequate size must be provided on the thrust side whenever the line:

    a. Changes direction.
    b. Changes size, as at reducers.
    c. Stops, as at a dead end.
    d. Have valves where thrust may be expected.
    e. If ground is too soft to support thrust of pipe, provide concrete thrust blocks.

D. Standard of Installation of Pipe:

1. Material and workmanship shall be in accordance with local codes and ordinances of legally constituted authorities, except where provisions of these Specifications exceed such requirement, these Specifications shall govern.
2. All changes in direction of pipe shall be made with fittings, not by bending.

E. Sprinkler Heads:

1. Install heads at proper grade level as per manufacturer’s recommendations.
2. Use only Teflon tape for sealing all heads and riser assemblies.

F. Circuit Valves:

1. Install in valve box, arranged for easy adjustment and removal.
2. Adjust automatic control valves to provide flow at rated operating pressure required for each sprinkler circuit. If an over-pressure condition exists, contractor shall install, at his

expense, such pressure compensation devices as are necessary to bring the circuit or heads into proper operating range.

G. Dielectric Protection:

1. Use dielectric fittings at connections where pipe of dissimilar metal are joined.

H. Closing of Pipe and Flushing Lines:

1. Cap or plug all openings as soon as lines have been installed to prevent the entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of the installation.
2. Thoroughly flush out all main water lines and control tubes installing valves, and other hydrants.
3. Thoroughly flush out all lateral lines after installation and before attaching heads.
4. Test in accordance with industry standards and piping ratings.
5. Upon completion of the testing, the contractor shall complete assembly and adjust sprinkler heads for proper distribution.

I. Communication Circuitry:

1. All communication circuitry shall be run, wherever possible, with the main pipeline.
2. All splices shall be made at a valve box for easy access.
3. A minimum of 12 inches of either control wire or tubing shall be coiled at each valve and splice to provide slack.

3.3 TESTING AND TRAINING

A. Operational Testing:

1. Perform operational testing after backfill is completed and sprinkler heads are adjusted to final position.
2. Demonstrate to the Owner that system meets coverage requirements and that automatic controls function properly.
3. Coverage requirements are based on operation of one circuit at a time.

B. Personal Training:

1. Contractor shall be responsible for the training of as many personnel as the Owner shall deem necessary.
2. Contractor shall be responsible for 1 closing and 1 opening of the system during the appropriate times of the year as part of the training of the owner's personnel.
3. Contractor training shall include general trouble-shooting and operation of the system with reference to head, valve, and controller operation.

4. Contractor shall furnish three copies of a complete operation and maintenance manual to the Owner's personnel. This manual shall include repair parts lists, assembly instructions, trouble-shooting guides, programming instructions, and recommend precipitation rates.

3.4 ADJUSTMENT

A. After completion of grading, seeding or sodding, if applicable, contractor shall return to the jobsite to perform any final adjustments to the system, which might be deemed necessary.

END OF SECTION 32 80 00

SECTION 32 90 00 - PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnish and install all labor, material, and equipment necessary for planting as indicated or implied by the Contract Documents.

B. Related Sections:

1. Division 31 Section "Earthwork".
2. Division 32 Section "Irrigation".
3. Division 32 Section "Seeding".

1.2 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an experienced installer who has completed planting work similar in material, design, and extent to that indicated for this project and with a record of successful landscape establishment.
2. All work described in this Section is to be done by an installer specializing in such work with five (5) documented years of experience in similar work.

B. Refer to Division 31 Section "Earthwork" for topsoil requirements and amendment recommendations to bring soil to optimal condition for growing and maintaining planting.

C. Provide quality, size, genus, species, and variety of trees and shrubs indicated, complying with applicable requirements of ANSI Z60.1-"American Standard for Nursery Stock."

D. Inspection:

1. Furnish plant materials inspected by Architect/Engineer at the growing site and tagged or otherwise approved for delivery.
2. Inspection at growing site does not preclude right of rejection at the job site.
3. Follow guidelines established by American Association of Nurserymen.

E. Certification:

1. Furnish plant materials certified to be free from hazardous insects or apparent disease.
2. Furnish certification that plant materials provided are the species specified.

F. Nomenclature:

1. Species shall be true to Botanical and Common Name or Variety.
2. American Joint Committee on Horticulture Nomenclature-Standard Plant Names.
3. U.S.A. Standard for Nursery Stock
4. State Nurserymen's Association.

1.3 SUBMITTALS

A. One copy of Certificates of Inspection of regulatory agencies as specified herein.

B. One copy of each applicable publication.

C. Topsoil analysis: refer to Division 31 Section "Earthwork."

D. Maintenance instruction: Prior to the end of maintenance period, furnish three (3) copies of written maintenance instructions to the Architect/Engineer for maintenance and care of installed plants through their full growing season.

E. Samples:

1. Submit container sample of gravel showing a range of color and size for approval.
2. Submit sample of wood mulch for approval.

F. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and address of Owners, and other information specified.

1.4 PRODUCT HANDLING

A. Preparation for Delivery:

1. Balled and burlap (B & B) plants:

a. Dig and prepare for shipment in manner that will not damage roots, branches, shape, and future development after replanting. All plants shall be dug to retain as many fibrous roots as possible.
b. Ball with firm, natural balls of soil of at least minimum size recommended by ANSI 260.1. Broken, loose, or manufactured balls shall be rejected.
c. Each plant must be dug such that the trunk flare is visible at the top of the root ball. Plants where the trunk flare is not visible shall be rejected.
d. Wrap balls firmly with burlap and stout rope.
e. All plants shall be dug immediately before moving unless specified otherwise.
f. Immediately before digging, all evergreens shall be sprayed with anti-dessicant spray, applying an adequate film over trunks, branches, twigs and/or foliage.
g. All plant material shall be marked to indicate the north side at time of digging.

h. Do not prune prior to delivery.
i. Do not dig or transport after leaf buds are open unless directed by Architect/Engineer. If deciduous trees or shrubs are moved in full-leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.

2. Potted plants:

a. Dig with sufficient root structure and surrounding soil to maintain life.
b. Pot shall be of sufficient size to handle root spread.
c. Potting soil shall be humus mix.

B. Delivery:

1. Deliver fertilizer to site in original unopened containers bearing manufacturer's guarantee chemical analysis, name, trade name, trademark, and conformance to state law.
2. Protect during delivery to prevent damage to root balls or desiccation of leaves.
3. Notify Architect/engineer of delivery schedule in advance.
4. Each shipment shall be certified by State and Federal authorities to be free from disease and infestations.
5. All inspection certificates required by law to this effect shall accompany each shipment invoice or order to stock and/on arrival, the certificates shall be filed with the Architect/Engineer.
6. All plants shall be packed, transported, and handled with utmost care to insure adequate protection against injury.
7. Remove unacceptable plant material from the job site immediately.

C. Inspection:

1. All plants shall be subject to inspection in the nursery before any plants are dug.
2. The Contractor, or his representative, shall accompany the Architect/Engineer on the inspection trips.
3. Expenses of such inspections shall be included in the Bid Price.
4. All plant materials shall be protected by the Contractor until it is inspected and approved by the Architect/Engineer at the site of the project.
5. All rejected materials shall be immediately removed from the site and replaced with acceptable material at no additional cost.
6. The Architect/Engineer, or his representative, shall be the sole judge of the quality and acceptability of plant material.

D. Storage:

1. Balled and burlap plant stock:

a. Deliver direct from nursery.
b. Heel-in immediately upon delivery, if not to be planted within 24 hours.
c. Protect roots of plant materials from drying or other possible injury.

d. If planting is delayed more than 6 hours after delivery, set plants in shade, protected from weather and mechanical damage.

E. Handling:

1. Do not drop plants.
2. Do not pick up container or balled plants by stems or trunks.

1.5 JOB CONDITIONS

A. Time of planting:

1. The Contractor shall start his planting when other division of this work, including placing the topsoil to finish grade, has progressed sufficiently to permit planting. Planting operations shall be conducted under favorable weather conditions and during normal planting seasons which are suitable with locally accepted practice.

1.6 SCHEDULING

A. Coordination:

1. Install trees, shrubs, and ground cover plants before lawns are installed, unless specifically directed otherwise.
2. If planting of trees and shrubs occurs in existing lawns or after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

PART 2 - PRODUCTS

2.1 PLANTING MATERIALS

A. Plant List:

1. A complete list of plants, of height, caliper, and other requirements as shown in the Contract Documents. Refer to the Contract Documents.
2. Label at least one tree and one shrub of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.
3. Planting will be specimen quality.

B. Substitutions:

1. No substitutions shall be accepted, except with the written permission of the Architect/Engineer.

C. Quality:

1. All plants shall have normal, well-developed branches and vigorous root systems as recommended by ANSI Z60.1
2. Plants shall be sound, healthy, vigorous and free from defects, disfiguring knots, abrasions at the bark, sun-scald injuries, plant diseases, insect eggs, borers, and all other forms of infections.

D. Source of New Planting Materials:

1. All woody plants shall be nursery grown and shall have been growing under the same climatic conditions as the location of this project for a least 2 years prior to date of planting on this project.

E. Measurements:

1. A plant shall be measured as it stands in its natural position.
2. Stock furnish shall be a fair-average between the minimum and maximum size as specified.
3. Large plants which have been cut back to the specified sizes will not be accepted.
4. Guidelines of the American Association of Nurserymen shall govern handling and balling unless the specifications call for high priority.
5. Plant materials shall be specimen stock.
6. Ground cover plants shall be nursery grown, well established in 2-1/4 inch peat pots.

2.2 PLANTING SOIL FOR LANDSCAPE BEDS

A. Depth: Landscape beds shall be backfilled to a depth of 6 inches.

B. Mix:

1. Landscape beds shall be backfilled with a mixture of 2 parts topsoil and 1 part peat moss or compost as specified herein and as noted on the Drawings.
2. Apply soil amendments and fertilizer in amounts recommended by topsoil analysis.

2.3 PLANTING SOIL FOR TREE PITS/MOUNDS

A. Mix:

1. Tree pits shall be backfilled with a mixture of 2 parts topsoil and 1 part peat moss or compost as specified herein and as noted on the Drawings.
2. Apply soil amendments and fertilizer in amounts recommended by topsoil analysis.

2.4 INORGANIC SOIL AMENDMENTS

A. Lime:

1. ASTM C602 agricultural limestone containing a minimum 80 percent calcium carbonate equivalent as follows:
2. Class T with a minimum 99 percent passing through No 8 sieve and a minimum 75 percent passing through No 60 sieve.

B. Aluminum Sulfate: Commercial grade, unadulterated

C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.5 ORGANIC SOIL AMENDMENTS

A. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4-4.8.

B. Compost: Well composted, stable and weed free organic matter, pH range of 5.5 to 8; moisture content 35-55 percent by weight; 100 percent passing through 1 inch sieve; not exceeding 0.5 percent inert contaminants and free of substances toxic to humans and plantings.

2.6 FERTILIZER

A. Bone Meal: Commercial, raw or steamed, finely ground; minimum 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer:

1. Commercial grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
2. Composition: 12 percent of actual nitrogen, 12 percent phosphorous and 12 percent potassium by weight.

D. Slow-Release Fertilizer:

1. Granular or pelleted fertilizer consisting of 50 percent water insoluble nitrogen, phosphorous, and potassium in the following composition:
2. Composition: 20 percent nitrogen, 10 percent phosphorous and 10 percent potassium by weight.

2.7 GUYING AND STAKING MATERIAL

A. Stakes and Guys:

1. Provide stakes and dead-men of sound new hardwood free of knotholes and other defects.
2. Provide wire ties and guys of two-stranded, twisted, pliable galvanized iron wire not lighter than 12 gauge with zinc-coated turnbuckles.
3. Provide not less than 1/2" diameter black plastic hose, cut to required lengths, to protect tree trunks from damage by wires.
4. All other staking methods to be approved by Architect/Engineer prior to installation.
5. Remove stakes and guys no later than 12 months after installation.

B. Wrapping: For fall installations only: breathable fabric tree-wrap not less than 4 inches wide, designed to prevent bore damage and winter splitting. Wrap fabric from the bottom up with sufficient overlap to cover all bark. Apply from trunk flare to first branch. Remove no later than 12 months after planting.

2.8 WATER

A. Quality: Potable.

2.9 MULCH

A. Mulch shall be placed to 3" depth as shown on the planting details.

B. Mulch shall be shredded hardwood bark, free of sawdust and manufactured by the high-pressure water technique

2.10 STONE MULCH

A. Hard, durable stone, washed free of loam, sand, clay and other foreign substances.

B. Type: Uncrushed smooth river gravel.

C. Size: 1" minimum, 1 1/2" maximum.

2.11 SOIL SEPARATION

A. MIRAFI-140N-Mirafi, Inc. or approved equal, to separate soil from drainage material.

2.12 ANTI-DESSICCANT

A. Emulsion type film-forming agent designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.

2.13 EDGING

A. Metal:

1. Black painted steel with integral stakes: Sure-loc or approved equal.
2. Edge strip shall be 1/4 inch by 5 inch deep.
3. Stakes shall be painted steel in manufacturer's standard gauge and length.

B. Location:

1. Edging to be installed between lawn areas and planting beds.
2. Install at other locations designated on the Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Description:

1. Verify final grades have been established prior to beginning planting operations.
2. Planting shall be located where it is shown on the plan.
3. Prior to the excavation of planting areas or plant pits, or placing tree stakes, the Contractor shall ascertain the locations of all utility lines, electric cables, and conduits so that the proper precautions may be taken not to disturb or damage and subsurface improvement. Should there be obstructions; the Contractor shall promptly notify the Architect/Engineer.
4. Before planting, the Contractor shall ascertain that all holes drain, and in any which do not, Contractor shall provide 1 foot diameter French drain of sufficient depth to permit drainage or subsurface drain tile system.
5. After performing topsoil analysis, make all corrections to soil as required to bring the pH value between 6.0 and 7.2.
6. Stake out locations for plants and outline of planting beds on ground prior to installation.
7. Do not begin excavation until stake out of plant locations and plant beds are acceptable to the Architect/Engineer.
8. Planting beds and planting pits shall be prepared as shown on the Drawings and as noted on this Project Manual. Any damage to paving or other materials shall be removed and replaced at Contractor's expense.

3.2 EXCAVATION FOR PLANTING

A. Pits and Trenches:

1. Trench shape: 1:1 slope on sides and flat bottom.
2. Plant pits: circular in shape
3. Make excavations at least two times as wide as the ball diameter and equal to the ball depth.
4. Fill excavations with water and allow to percolate out before planting.

B. Planting Beds:

1. Bring beds to smooth, even surface conforming to established grades after full settlement has occurred.
2. Remove sticks, stones over 1/2 inch in any diameter, rubbish and other extraneous matter.

3.3 PLANTING

A. General:

1. Center plant in pit or trench on unexcavated or compacted soil.
2. Plant so that the north side of the plant as marked faces north.
3. Set plant plumb and hold rigidly in position until soil has been tamped firmly around ball or roots.
4. Use planting mix as specified for backfill.
5. Place sufficient planting soil (compacted) under plant to bring top of root ball 1 inch above surrounding grade.
6. When pit is 2/3 filled, water thoroughly and allow water to soak away before placing remained of backfill.
7. If settling of the backfill occurs after watering, add more backfill to bring to finish grade up to top of root ball.

B. Bindings:

1. Remove all bindings and burlap from top 1/3 of root ball. If plant is shipped with a wire basket, cut the wire basket in four places and fold down into the planting hole. All balls with frayed roots shall be cut off cleanly.
2. After soil settles, fill pit with planting soil, water, and leave pit surface even with finished grade of surrounding ground.

C. Watering Basin:

1. Construct a soil berm, 3 inches above finish grade, forming a watering basin with a level bottom around each deciduous and evergreen tree.
2. Size: Greater than diameter of ball or spread of roots if bare-rooted.
3. All water basins shall be removed prior to final inspection.

D. Balled Plants (B & B):

1. Center plant in pit on unexcavated or compacted soil.
2. Plant top of root ball 1" higher than surrounding grade.
3. Cut burlap or ropes, wires, and other wrapping materials.
4. Do no pull wrapping from under ball.
5. Do not plant if ball is cracked or broken before or during planting process.

3.4 MULCHING

A. General:

1. Mulch tree rings and landscape beds within three (3) days after planting.
2. Cover watering basin or bed evenly to depth shown on the Drawings.
3. Water thoroughly immediately after mulching.

3.5 GUYING AND STAKING OF TREES

A. Immediately after planting, unless otherwise directed by the Architect/Engineer, all trees shall be guyed, staked, and protected.

B. At end of warranty period, remove all guying and staking material from site, unless otherwise directed by Architect/Engineer.

3.6 PRUNING AND REPAIR

A. Description:

1. Do not heavily prune plants at the time of planting.
2. Prune only crossover limbs, co-dominant leaders, and broken or dead branches.
3. No plants shall be pruned or clipped prior to delivery except at the permission of the Architect/Engineer.
4. Broken or badly bruised branches shall be removed with a clean cut.
5. All pruning shall be done to trees during the course of planting operations shall promptly be treated as required in accordance with recognized horticultural practices and the instructions of the Architect/Engineer

3.7 CLEANING

A. Description:

1. Sweep and wash paved surfaces.
2. Immediately clean spills from paved and finished surface areas.
3. Remove debris and excess materials from project site.

3.8 WARRANTY AND MAINTENANCE

A. Begin maintenance immediately after each area is landscaped and continue until acceptable landscape is established, but not less than 60 days after date of Substantial Completion.

1. If full maintenance period has not elapsed before the end of planting season, continue maintenance during the next planting season.
2. Maintenance includes watering, fertilizing, weeding, trimming, replanting, and other operations to provide a healthy landscape.
3. Keep planting saucers and beds free of weeds, grass, and other undesired vegetation growth.

B. Begin warranty period after date of Substantial Completion and continue for a period of one full year.

1. The Warranty specified in this section does not deprive the Owner of other rights he may have in these specifications.
2. The Warranty period for new landscape areas shall be for one full year after date of Substantial Completion against defects including death and unsatisfactory growth except for defects resulting from Owner abuse or neglect or incidents beyond Contractor's control.
3. Replacement plants under this warranty shall be granted for one full year from date of installation and acceptance.
4. The Contractor shall, at no cost to the Owner, repair damage done to walks, buildings, roads, and other plants or lawns during plant replacement.

3.9 FINAL INSPECTION AND ACCEPTANCE

A. Description:

1. Request final inspection in writing for acceptance at least 10 days before end of warranty period.
2. At the end of the warranty period on the completed landscape and on written notice from the Contractor, the Architect/Engineer will, within 15 days of such written notice, make an inspection of the landscape to determine if a satisfactory planting has been produced. If a satisfactory landscape has not been established, another inspection will be made after written notice from the Contractor that the landscape is ready for inspection following the next growing season.

END OF SECTION 32 90 00

SECTION 32 92 19 - SEEDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnish and install all labor, material, and equipment necessary for seeding all areas as indicated or implied by the Contract Documents.

B. Related Sections:

1. Division 31 Section "Earthwork".

1.2 QUALITY ASSURANCE:

A. Installer Qualifications:

1. Engage an experienced installer who has completed seeding work similar in material, design, and extent to that indicated for this project and with a record of successful lawn establishment.
2. All work described in this Section is to be done by an installer specializing in such work within the five (5) documented years of experience in similar work.

B. Refer to Division 31 Section "Earthwork" for topsoil requirements and amendment recommendations to bring soil to optimal condition for growing lawn grass seed.

C. Applicable Publications:

1. Publications of the following institutes, associations, societies, and agencies are referred to in this Section.
2. American Joint Committee on Horticulture Nomenclature Standard: Standardized Plant Names, 1942 Edition and Additions.

D. Requirements of Regulatory Agencies:

1. Certificates of inspection: All shipments of orders of seed shall be properly inspected at the nursery or at the growing site by the authorized Federal and State authorities. All necessary inspection certificates shall accompany the invoice for each shipment or order of stock, as may be required by law for the necessary transportation. Certificates shall be filed with the Architect/Engineer, prior to acceptance of the materials.

1.3 SUBMITTALS

A. Certification of grass seed from seed vendor for each grass seed mixture stating the botanical name, common name, and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for lawn seeding identifying source including name and telephone number of supplier.

B. Topsoil analysis: Refer to Division 31 Section "Earthwork".

C. One copy of Certificates of Inspection of Regulatory Agencies as specified herein.

D. Qualification data for firms and persons specified in the "Quality Assurance" articles to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses; names and address of Owners and other information specified.

1.4 SCHEDULING

A. Seasonal Requirements:

1. Perform the seeding work between 1 March and 15 May or between 15 August and 15 October, or both, unless otherwise approved by the Architect/Engineer; and at such time that the seeding work will not be damaged by freezing temperatures, rain or high winds.

B. Scheduling:

1. Seeding operations shall not commence in any area until other trades no longer need machine access to these areas.
2. Begin installation of seeding after preceding related work is accepted.

1.5 PRODUCT HANDLING

A. Storage:

1. Store in a dry, secure location off the ground, free from physical abuse.
2. Protect from adverse weather conditions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 98 percent pure seed, not less than 85 percent germination, and not more than 0.3 percent weed seed:

1. Permanent seed: Full sun or partial shade:

a. 90% Hybrid Bluegrass blend – a minimum of 3 varieties evenly blended, such as Midnight II, Rugby II, Nuglade, or as approved by Architect/Engineer..
b. 10% Perennial Rye Grass.

2. Permanent seed: Full shade:

a. 20% Hybrid Bluegrass.
b. 40% Creeping Red Fescue.
c. 20% Hard Fescue.
d. 20% Chewings Fescue.

3. Temporary seed:

a. 100% Annual Rye Grass.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602 agricultural limestone containing a minimum 80 percent calcium carbonate equivalent as follows:

1. Class: Class T with a minimum 99 percent passing through No 8 sieve and a minimum 75 percent passing through No 60 sieve.

B. Aluminum Sulfate: Commercial grade, unadulterated

C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate

D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.3 ORGANIC SOIL AMENDMENTS

A. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 – 4.8.

B. Compost: Well-composted, stable and weed free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1 inch sieve; not exceeding 0.5 percent inert contaminants and free of substances toxic to humans and plantings.

2.4 MULCHES

A. Straw Mulch: Provide air dry, clean mildew and seed free, salt hay or thrashed straw of wheat, rye, oats, or barley.

B. Non-Asphaltic Tackifier: Colloidal tackifier recommended by fiber mulch manufacturer for slurry application; nontoxic and free of plant material or germination inhibitors.

C. Asphalt Emulsion: ASTM D977, Grade SS-1 nontoxic and free of plant-growth or germination inhibitors.

2.5 FERTILIZER

A. Bone Meal: Commercial, raw or steamed, finely ground; a minimum 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 12 percent of actual nitrogen, 12 percent phosphorous, and 12 percent potassium by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water insoluble nitrogen, phosphorous, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous and 10 percent potassium by weight.

2.6 WATER

A. Potable.

PART 3 - EXECUTION

3.1 GENERAL

A. Inspection:

1. Verify soil preparation and related preceding work have been completed.
2. Do not start work until other trades no longer need machine access to these areas.
3. Do not start work until conditions are satisfactory.

B. Preparation:

1. Protect structures, utilities, sidewalks, pavements and other facilities, trees, shrubs and plantings from damage caused by planting operations.
2. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties or walkways.

3.2 LAWN PREPARATION

A. Limit lawn preparation to areas to be planted.

B. Newly Graded Subgrades:

1. Loosen subgrade to a minimum depth of 6”.
2. Remove stones larger than 1” in any dimension, sticks, roots, trash, and other extraneous matter.
3. Apply soil amendments and fertilizer as recommended by topsoil analyst directly to topsoil before loosening.

C. Unchanged Sub-grades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a minimum depth of 6”.
   Remove stones larger than 1” any dimension, sticks, roots, trash, and other extraneous matter.
3. Apply soil amendments and fertilizers according to topsoil analysis and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.

D. Finish Grading:

1. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture.
2. Grade to within plus or minus 1/2 inch of finish elevation.
3. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

G. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

3.3 SEEDING

A. General:

1. Sow seed with spreader or seeding machine.
2. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
3. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
4. Do not use wet seed or seed that is moldy or otherwise damaged.
5. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
6. Unless otherwise indicated, sow seed at the rate of 4 to 6 lb/1000 sq. ft.

B. Slope Protection:

1. On slopes 5:1 and steeper, install erosion control blanket.
2. On slopes less than 5:1, install straw mulch.

    a. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas.
    b. Spread by hand, blower, or other suitable equipment.
    c. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.

3.4 HYDROSEEDING

A. Hydro-seeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydro-seed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with non-asphaltic or asphalt-emulsion tackifier.

B. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.5 PROTECTION

A. Description:

1. Erect temporary barricades and warning signs to protect against pedestrians and vehicular traffic.

3.6 CLEANING

A. Description:

1. Immediately clean spills from paved and finished surface areas.
2. Remove debris and excess materials from project site.

3. Dispose of protective barricades and warning signs at termination of lawn establishment.
4. Remove erosion control measures after lawn establishment period.

3.7 LAWN ESTABLISHMENT

A. Watering:

1. Water daily for the first 14 days after seeding.
2. After first 14 days, supplement rainfall to produce a total of 2 inches water per week until lawn is clearly established and growing healthy.

B. Mowing:

1. When grass reaches 2-1/2 inches in height, mow to 1-3/4 inch in height.
2. Maintain grass between 1-3/4 inch and 2-1/2 inch height.
3. Do not cut off more than 40% of grass leaf in single mowing.
4. Remove grass clippings.
5. Re-seed spots larger than 1 square foot not having uniform strands of grass.

C. Weed Eradication:

1. Between second and third mowing, apply herbicide uniformly at manufacturer recommended rate.

D. Fertilizer:

1. Apply fertilizer uniformly at 1 lb of nitrogen per 1000 square feet 30 days and 60 days after seeding and water immediately.

E. Satisfactory Seeded Lawn:

1. At end of maintenance period, a healthy, uniform, close stand of grass has been established free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 inches by 5 inches.

3.8 WARRANTY AND MAINTENANCE

A. Begin maintenance of lawns immediately after each area is seeded and continue until acceptable lawn is established, but not less than 60 days after date of Substantial Completion.

1. If full maintenance period has not elapsed before the end of planting season, or if lawn is not fully established, continue maintenance during the next planting season.
2. Maintenance includes watering, fertilizing, weeding, mowing, trimming, replanting, and other operations to provide a uniform, weed free, smooth lawn.

B. Begin warranty period after date of Substantial Completion and continue for a period of (one full year).

1. Warranty specified in this section does not deprive the Owner of other rights; he may have in these specifications.
2. The warranty period for new lawn areas shall be for (one full year) after date of Substantial Completion against defects including death and unsatisfactory growth except for defects resulting from Owner abuse or neglect or incidents beyond Contractor's control.
3. Replacement seeding under this warranty shall be granted for (one full year) from date of installation and acceptance.
4. The Contractor shall, at no cost to the Owner, repair damage done to walks, buildings, roads, and other plants or lawns during reseeding.
5. Inspection of the lawn to determine its completion for the beginning of the warranty period will be made by the Architect/Engineer upon notice requesting such inspection by the Contractor at least seven (7) days prior to the anticipated inspection date.

3.9 FINAL INSPECTION AND ACCEPTANCE

A. Description:

1. Request final inspection in writing for acceptance at least ten (10) days before end of warranty period.
2. At the end of the warranty period on the completed lawn, and on written notice from the Contractor, the Architect/Engineer will, within 15 days of such written notice, make an inspection of the lawn to determine if a satisfactory stand of grass has been produced.
3. If a satisfactory lawn has not been established, another inspection will be made after written notice from the Contractor that the lawn is ready for inspection following the next growing season.

END OF SECTION 32 92 19

DIVISION 33

UTILITIES

SECTION 33 05 00 – COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. All utility systems 5 feet outside the building line, as shown or implied in the Contract Documents and as required for the Work, including but not limited to:

    a. Water distribution.
    b. Sanitary sewerage.
    c. Storm drainage.
    d. Chilled water distribution.
    e. Sub-drainage.

2. Contractor is responsible for all utility work as shown on contract documents or as required, unless specifically indicated otherwise.

B. Related Sections:

1. Division 02 Section “Maintenance of Existing Conditions”.
2. Division 33 Section “Site Water Distribution”.
3. Division 33 Section “Storm Drainage”.

1.2 SUBMITTALS

A. Warning Tape System.

1.3 DEFINITIONS

A. Utilities include all underground and above ground piping, conduits, cables and related structures and appurtenances. Utilities also include sewers.

B. “Utility Companies” as referenced herein includes all public, private and other companies and agencies supplying utility services or having jurisdiction over such services.

1.4 QUALITY ASSURANCE

A. All materials and installation shall meet the requirements of utility companies.

B. All installation shall meet the requirements and recommendations of the material manufacturers and suppliers.

C. All installation shall meet the requirements and recommendations of the material manufacturers and suppliers.

1.5 COORDINATION

A. All installation shall meet the requirements and recommendations of the material manufacturers and suppliers.

B. Verify all proposed utility work with utility companies prior to beginning work.

C. Provide sufficient notice to utility companies for all work affecting services of utility companies.

D. Contractor shall maintain complete and operable utility services at all times.

E. Coordinate timing of utility work and temporary measures with Owner and Utility Companies.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Warning Tape:

1. Verify warning tape requirements with Utility Companies, Owner and Architect/Engineer prior to installation. Unless otherwise indicated or required, provide per the following.
2. Color:

a. Blue: Water, fire and chilled water lines.
b. Red: Electric.
c. Orange: Telecommunications.
d. Yellow: Gas, oil, steam, dangerous materials.
e. Green: Sanitary laterals

3. Use one of the following systems:

a. Non-detectable warning tape with toning wire below:
1) Acid- and alkali-resistant polyethylene warning tape manufactured for marking and identifying underground utilities, 6” inches wide and 4 mils thick.
2) Label: continuous “CAUTION—BURIED (name of utility) BELOW”. Toning wire: 12 gauge copper wire with protective jacket for corrosion protection.
3) Unless otherwise indicated, install warning tape 18” below finished grade with toning wire 12” below warning tape.

4) Turn up and tie toning wire as indicated or as required by Utility Companies and Owner.

b. Detectable warning tape:

1) Acid- and alkali-resistant polyethylene warning tape manufactured for marking and identifying underground utilities, 6" inches wide and 4 mils thick with metallic core with protective jacket for corrosion protection.
2) Label: continuous "CAUTION—BURIED (name of utility) BELOW".
3) Unless otherwise indicated, install warning tape 18" below finished grade.

B. Unless otherwise indicated or required, warning tape does not apply to sewers or subsurface drains.

C. Refer to individual Sections for further utility product specifications.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. General:

1. New utilities shall be installed and operational prior to displacing existing utilities. Service must be maintained at all times.
2. All work shall be made readily accessible for inspection by Utility Companies and Owner at all times during working hours.
3. Refer to Division 31 Section "Earthwork" for excavation, trenching and backfilling.

B. Preparation:

1. Verify existing utilities and topographic conditions prior to trenching, excavation or installation.
2. If existing field conditions prevent installation per the contract documents, notify the Architect/Engineer immediately.
3. Review proposed utility work prior to installation and notify Architect/Engineer immediately of any conflicts or concerns.
4. Mark underground utilities prior to beginning any excavation or other underground work in area of proposed activity.

C. Installation:

1. Provide and maintain all necessary stakes, benchmarks and batter boards for installing utilities to alignment and grades.
2. During backfilling, install continuous warning tape over all utilities. Install tape full length of utility and terminate properly to allow for charging of tape or toning wire. If utility is installed by Utility Companies, provide warning tape and coordinate installation.

END OF SECTION 33 05 00

SECTION 33 40 00 – STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Storm sewers and drainage structures outside of the building.

B. Related Sections:

1. Division 33 Section “Common Work Results for Utilities”.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All materials and work within the right-of-way or easement of any local government or other agency having jurisdiction over storm drainage, shall meet the requirements of such agency.

1.3 SUBMITTALS

A. Each item in submittal must state that the item meets or exceeds the specified standards referenced herein. If multiple sizes or types are included in the submittal, clearly indicate which are to be used, and where, if applicable.

B. Product Data:

1. Sewer pipe, fittings and joint materials.
2. Frames and grates.
3. Steps.
4. Cleanouts.
5. End sections.

C. Shop Drawings: Reinforced concrete manholes, inlets, and any other structures, including steps, sealing materials and any other required appurtenances.

D. Test Reports: Submit results for all testing and inspections to Architect/Engineer.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Unless otherwise indicated, pipe sizes refer to the nominal inside diameter.

B. Unless otherwise indicated, the following materials shall be used as described below.

1. Reinforced concrete pipe (RCP):

a. ASTM C76, Class III, Wall B.
b. Bell and spigot joints with rubber gaskets ASTM C443.
c. Application: Storm sewers 12” and larger.

2. High density polyethylene (HDPE) pipe and fittings:

a. ASTM D3350 and AASHTO M294 Type S, corrugated with smooth interior wall.
b. Silt-tight joints ASTM D3212 with ASTM F477 gaskets.
c. Application: Storm sewer 12” to 36” where sewer has a minimum cover of 3 feet from top of pipe to top of finished grade.

3. Polyvinyl chloride (PVC) pipe and fittings:

a. SDR 35 ASTM D1784, ASTM D3034.
b. Compression type bell and spigot joints ASTM D3212 with ASTM F477 gaskets.
c. Application: Storm sewer 12” and smaller which runs directly from building. Do not use in between storm structures or for culverts.

4. Ductile iron (DI) pipe and fittings:

a. Pipe: AWWA C151, pressure class 350.
b. Fittings: AWWA C110, standard pattern or AWWA C153 compact pattern.
c. Joints: bell and spigot with push-on joints and gaskets.
d. Gaskets: AWWA C111, rubber.
e. Interior lining: epoxy coating (do not use cement mortar lining).
f. Polyethylene encasement: AWWA C105 tube or sheet, Linear Low Density (LLD, minimum 8 mil) or High Density Cross Laminated (HDCL, minimum 4 mil) with 2” polyethylene tape (minimum 12 mil).
g. Application: Sewers 6” and larger. Required when crossing water lines with less than 18” vertical or 10’ horizontal clearance.

C. End Sections:

1. Precast reinforced concrete for RCP piping.
2. Metal end sections for HDPE.

2.2 EXTERIOR CLEANOUTS

A. General:

1. Unless otherwise indicated, cleanouts shall be the same diameter as the sewer they serve for pipe sizes up to 8", pipes greater than 8" shall use an 8" cleanout.
2. Unless otherwise indicated, riser pipes and cleanout bodies shall be the same material as the sewer they serve.
3. Each cleanout shall have an exterior housing to prevent transfer of load to the cleanout.
4. Medium duty housings may be used in non-vehicular areas, all others shall be heavy duty.
5. Exterior housing:

    a. ASME A112.36.2M gray iron with round, secured, scoriae and gray iron cover.
    b. Refer to Part 3 for concrete anchorage.

6. Cast iron cleanouts:

    a. Gray iron ferrule with tapered-thread, brass closure plug, ASME A112.36.2M.
    b. Riser pipe and fittings: cast iron soil pipe, ASTM A74.
    c. Ferrule connection may be inside caulk, spigot or no-hub; however, connection must be water and air-tight.

7. Plastic cleanouts:

    a. PVC body with PVC tapered-thread plug.
    b. Riser pipe and fittings: SDR 35, ASTM D3034.

2.3 MANHOLES AND CATCH BASINS

A. General:

1. Precast concrete per ASTM C478.
2. Manhole base shall be minimum 8" thick. To prevent flotation, increase thickness of precast sections or add concrete to base section as required.
3. Steps: Polypropylene encased #4 rebar per ASTM D4101, meeting OSHA requirements.
4. Castings: All frames and castings shall be heavy duty and constructed of gray iron free from blowholes, porosity, hard spots, shrinkage distortion, etc. They shall be smooth and clean.
5. Adjusting rings: Precast concrete, interlocking with ½ butyl rubber base or extrudable preformed gasket material. Bricks, blocks or other means are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping:

1. Cleanouts and manholes shall be installed in sewer where shown on the Drawings and as required by applicable Codes and/or field conditions.
2. Install manholes and cleanouts at all changes in direction. Blind turns or gradual deflection of pipe is not permitted.
3. The maximum distance between manholes is 400’.
4. Verify existing and proposed grades, connections and pipe sizes before installing any pipe. Notify Architect/Engineer of any conflicts with Drawings or Specifications.
5. Pipe installation shall proceed upgrade with spigot ends of bell and spigot pipe pointing into direction of flow.
6. Each pipe shall be laid true to line and grade and in such a manner as to form a close concentric joint with adjoining pipe and to prevent sudden offset in the flow line.
7. During backfilling, install detectable warning tape. See Division 33 Section “Common Work Results for Utilities” for warning tape requirements.
8. Pipe trenches shall be excavated parallel to the specified pipe, slope and grade.
9. The bottom of the pipe shall be supported by a minimum 6" thick layer of #8 crushed stone. The #8 crushed stone shall extend 6" on each side of the pipe and 12" above the top of the pipe unless indicated otherwise.
10. The remaining backfill in lawn and non-pavement areas shall be suitable fill material approved by the soils testing laboratory.
11. Pipes under and within 5' of pavements, slabs, sidewalks and other hard surfaces shall be backfilled with compacted granular fill.
12. All backfilling and compaction shall be in accordance with Division 31 Section ”Earthwork"
13. Any breaks or defects in pipe must be immediately repaired. Any pipe which has been disturbed after being laid must be taken up, joints cleaned and properly relaid.
14. Interior of all pipe shall be cleaned of all dirt and superfluous materials as the work progresses. After pipe installation, install erosion control measures as shown on Drawings and as necessary to prevent sediment or other materials from entering or building up in pipe.
15. Water and sewer minimum clearances:

    a. Where minimum 18” vertical or 10’ horizontal separation cannot be provided between sewers and water lines, the sewer shall be ductile iron, refer to Part 2.
    b. At crossings, extend ductile iron sewer pipe a minimum of 10 feet on both sides of the water line.
    c. Do not install water and sewer lines in the same trench under any circumstances.

B. Manholes and Catch Basins:

1. Set solid lid castings flush with grade in pavement areas and 1” above grade in other areas. Set inlet castings at elevation grades per Drawings.
2. Install 2 to 4 precast adjusting rings for an overall 6” to 12” adjustment height.
3. Grade to drain into inlet castings positively and adequately.
4. Install steps from 12” below top to 12” above bottom at 16” on center.
5. Bench bottom of structures per Drawings.

C. Cleanouts:

1. Install piping so cleanouts open in direction of flow in sewer pipe.
2. Set cleanout covers flush with grade.
3. In areas other than concrete walks and concrete pavements, install concrete anchor pad.
4. Unless otherwise indicated, pad dimensions are 12” height with a diameter of the cleanout housing diameter + 12”, to provide a 6” ring around the cleanout frame. Place on properly compacted subgrade and stone per Division 31 Section “Earthwork” and Division 32 Section “Site Concrete”.

END OF SECTION 33 40 00