Project Manual:

Union County Public Library

Library Addition and Renovation

PROJECT SITE:	Library Addition and Renovation 2 South Seminary Street Liberty, IN 47353
OWNER	Union County Public Library 2 South Seminary Street Liberty, IN 47353
ARCHITECT	LWC Incorporated 712 East Main Street Richmond, IN 47374

VOLUME 2 (Division 20 – 32)

DATE November 10, 2023

SPECIFICATION

For

Addition and Renovation
Union County Public Library

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001031 – A101 – 2017 Standard Form of Agreement	X	
001031A – A101 – 2017 Exhibit A Insurance and Bonds	X	
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001070 – A312 – 2010 Performance Bond	X	
001071 – A201 – 2017 General Conditions	X	
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012600 – Contract Modification Procedures	X	
012900 – Payment Procedures	X	
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013200 – Construction Progress Documentation	X	
013233 – Photographic Documentation	X	
013300 – Submittal Procedures - Shop Drawings, Product Data and Samples	X	
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016000 – Product Requirements	X	
017300 - Execution	X	
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072414 – EIFS Recoat Systems	**X**	
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075323 – EPDM Roofing	**X**	
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077100 – Roof Specialties	**X**	
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220505 – Firestopping	**X**	
220507 – Piping Materials and Methods	**X**	
220509 – Excavation, Backfill and Surface Restoration	**X**	
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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 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 Architect 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 Engineer'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 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 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 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 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 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, 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 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. Gauges.
5. Pipe insulation.
6. Drainage structures and accessories.
7. Supply system specialties.
8. Backflow preventers.
9. Drainage system specialties.
10. Plumbing fixtures and trim.
11. Sump pumps, basin and controls.
12. Water heating equipment.

13. Kitchen waste interceptor/grease trap.

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. Underground domestic water service - hydrostatic at 125 psig or 1.5 times the maximum operation pressure, whichever is higher, for 6 hours, and in conformance with AWWA procedures.
2. 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.
3. Soil, waste and vent piping and storm piping - rough test and final test, in conformance to Plumbing Code requirements.
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 any existing domestic water piping, tanks 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.

F. Domestic water systems shall be disinfected and bacteriologically analyzed within 14 days of the established date of substantial completion. Systems disinfected and analyzed more than 14 days prior to substantial completion shall be disinfected and analyzed again, or an Owner approved total system flushing procedure shall be implemented.

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, 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: Union County Public Library – Library Addition and Renovation
2 East Seminary Street
Liberty, IN 47353

Owner: Union County Public Library

Heapy Engineering Project Number: 2023-07083

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/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 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. 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 “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. Work shall be conducted in strict adherence to the facility Construction and Renovation Infection Control Standards.

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 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. 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, including kitchen 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.

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

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

1.9 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.

1.10 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.

1.11 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.

D. In core drilled openings in solid concrete not requiring water protection.

E. 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.

1.12 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".

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.

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 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.

3.3 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.

3.4 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.

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

3.6 Installation of plastic piping shall be in full compliance with manufacturer's recommendations and code requirements, with specific consideration given to expansion compensation and pipe hanger spacing. Plastic pipe is not permitted in air plenum spaces.

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 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 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 Plastic piping for sewers and drain shall be installed in compliance with ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-flow Applications.

3.5 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.

3.6 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.

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

END OF SECTION

22 05 19 METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 Thermometers and pressure gauges shall be provided as specified herein.

1.2 Meters related to combination balancing - shutoff valves are specified in Section 22 05 23 – General Duty Valves for Plumbing Piping.

1.3 Gauges and meters furnished as a part of factory assembled equipment are specified with such equipment.

1.4 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 portable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Manufacturers products listed below are basis of design. Other acceptable manufacturers are Winters, Milijoco or Palmer Instruments.

2.2 Thermometers

A. Thermometers shall be 4.5 inches diameter dial face, vapor actuation type with aluminum case, glass lens, adjustable angle hinge, stainless steel insertion stem and adjustable pointer equal to Trerice V80742 with 316 stainless steel thermowell.

B. Separable socket insertion well, with graphite fill, shall be furnished with each thermometer. An extension neck socket, with appropriate increase in thermometer stem length, shall also 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.

2.3 Pressure Gauges

A. Pressure gauges shall be Bourdon tube type with 4.50 inches dial and cast aluminum case, equal to Trerice 600CB-PBF Series. Accuracy shall be 1 percent at mid-range.

B. Pressure gauges for low pressure application, 4” diameter, calibrated in inches of water gauge, ounces per sq. in. or 0 - 5 psi, as appropriate, shall be equal to Trerice 760B.

C. Pressure gauges at pumps shall be liquid filled Bourdon tube type with 4 inches dial and stainless steel case and internals, equal to Trerice 700-PBF Series.

D. 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.

PART 3 - EXECUTION

3.1 Meters shall be installed with manufacturer required upstream and downstream straight length requirements.

3.2 Thermometers shall be installed where shown on the drawings and also at:

A. Each water heater and recirculating water pump.

3.3 Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:

A. The incoming water service; downstream of the reduced pressure backflow preventer; inlet of water heater.

3.4 Thermometers and gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.

3.5 Install thermometer wells in piping tees in the vertical position. Fill the well with graphite and secure the thermometer in position.

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 Valves; Aaberts-IPS, Milwaukee, Watts, Legend, Jomar, Crane

1. Type B1. 3 inches and smaller.
NIBCO T 585-66-LF, 600 c.w.p.., two piece bronze body, ASTM B584 threaded ends, full port, stainless steel stem, stainless steel ball, packing nut with adjustable stem packing, TFE seat and seal, handle.

2. Type B4. 2 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, 200 non shock c.w.p., silicon bronze body (ASTM B584), threaded ends, renewable bronze swing disc with PTFE 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, removable stainless steel body seat, and removable aluminum bronze disk seat.

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

4. Type C4. 2.50 inches and larger. In-line spring
Val-Matic Series 1400/1800 A or approved equal, 200 c.w.p., in line spring actuated center guided silent check, globe style, iron body for installation between flanges, NSF/ANSI 372 interior and exterior fused bonded epoxy coating, bronze seat and disc.

2.2 Balancing Shutoff Valves - manufacturers as stated

A. Type E1.
NIBCO 1810 LF Series, Caleffi 142 series, Bell and Gossett circuit Setter Plus, Victaulic TA 78BL or Watts LFCSM-61. Positive shutoff design, 125 psi construction, with adjustment shutoff handwheel/ball valve, memory stop and pressure temperature gauge ports with brass caps and security bands.

B. A portable differential pressure gauge with cocks, hoses and connectors shall be provided in conjunction with the combination balancing valves and flow controllers.

C. A molded polyurethane container shall be provided with each valve on cold services, to be utilized as an insulating cover.

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

2.4 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.

3.5 Furnish duplicate packing gland wrenches for all applicable valves and turn over to Owner at project completion.

END OF SECTION

22 05 29 HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

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

B. 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.

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

D. 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 The first two hangers on piping connecting to both the suction and discharge of motor driven equipment shall be fitted with steel spring and neoprene isolators.

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

END OF SECTION

22 05 30 BASES AND SUPPORTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 Equipment shall be supported on concrete bases, roof curbs and structural steel supports as shown on drawings.

PART 2 - PRODUCTS

2.1 Support for equipment shall be by the following method:

A. Concrete bases and pads with anchor bolts cast in place. Bases shall be formed on all sides and hand troweled to a smooth, dense finish with neatly chamfered corners. Bases shall extend at least 6" beyond outer extents of equipment.

2.2 Provide exact dimensions, locations and other detail for the specific equipment installed on concrete bases. Set anchor bolts as required for the equipment.

PART 3 - EXECUTION

3.1 Concrete based shall be in conformance with the requirements of Division 03 Concrete.

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, water heaters, 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 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.

2.4 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 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”
Domestic hot water recirculating	1”	1”	1.50”	1.50”	1.50”
Storm drainage (1) (3)	-----	-----	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.

3. Interior pumped discharge piping from sump pumps, including vertical rise and horizontal above ground piping.

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. Exposed chrome plated piping and pipe line devices in kitchens, etc.

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

E. Condensate drains other than as noted above.

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 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 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.

2.5 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.

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

2.7 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.

2.8 Removable reusable covers for hot water accessories such as automatic flow controllers and balancing valves shall be insulated type with a factory fabricated removable and reusable cover. Insulation shall have a minimum k-factor .26, using fiberglass blanket. Flame and smoke spread for the assembly shall meet 25/50 per ASTM E-84. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined by tabs made from hook and loop fasteners (Velcro). Butt ends shall have sewn-in-place elastic. Outer jacket shall overlap adjoining sections of pipe insulation. Installation shall not require the use of any special hand tools. Removable re-usable covers shall be manufactured by No Sweat Valve Wraps, Inc., or approved 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.

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. Installation of insulation on non-metallic piping systems in plenums shall be in strict accordance with manufacturer's written instructions, as shown on the approved shop drawings.

H. 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.

I. 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.

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 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. 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, C6
2. In-line spring	C3, C4
C. Balancing-shutoff	E1

2.3 Flow controllers shall be automatic pressure compensating devices factory manufactured for the flow rates listed on the drawings and selected to maintain a factory set GPM accuracy within +/- 10 percent. Flow controller shall have lead-free stainless steel / brass elastomeric and/or polyphenylsulfone internals. The controller shall have a guided diaphragm, cartridge or piston, with orifice openings and two measurement taps, one for pressure and temperature and the other for pressure (two P-T’s are acceptable). Controller GPM, Valve Tag Identifier and PSID range shall be permanently marked on a label affixed to the controller. Measurement taps shall be designed to accept gauges for test plugs specified above or one pressure gauge and one thermometer shall be furnished with the flow controllers. A downstream ball valve, and upstream ball valve and strainer with blow-down cock shall be furnished with each flow controller assembly. Ball valves shall be as specified in Section 22 05 23 General Duty Valves for Plumbing Piping and shall be independent of the flow controller assembly. Provide a cartridge exchange warranty for 18 months from the date of purchase or minimum 12 months from date of Owner beneficial use. Stainless steel cartridges shall have a 5-year material defect warranty. Flow controllers shall be Hays Fluid Controls 2517LF or manufactured by Griswold or Flow Design “Autoflow”.

A. A portable differential pressure gauge with cocks, hoses and connectors shall be provided in conjunction with the flow controllers for verification of flow rates.

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 Rigid support sway bracing shall be provided at changes in direction greater than 45 degrees for pipe sizes 4 inches and larger.

3.3 The hot water recirculating system shall be balanced to flow rates indicated on the drawings for each combination balancing - shutoff valve. Valves and differential pressure gauges for this purpose are specified in Section 22 05 23 General Duty Valves for Plumbing Piping.

3.4 The hot water recirculating system shall be verified to the flow rates indicated on the drawings for each flow controller.

3.5 Supply piping and supply stops exposed to view in the warming kitchen shall be chrome plated. Insulation is to be omitted.

3.6 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 Reduced Pressure Backflow Preventer Assembly

A. Reduced pressure backflow preventer assembly shall be designed for high-hazard cross-connections and shall consist of:

1. Two spring loaded check valves and an intermediate automatic pressure differential relief valve assembly with air inlet, relief outlet and unit mounted (factory supplied) discharge air gap fitting.

2. Shutoff valves, one upstream and one downstream, ball type (2 inches and smaller) or resilient seated O.S.&Y. gate type (2.5 inches and larger). Refer to 22 05 23 General Duty Valves for Plumbing Piping for valve specifications.

3. Ball type test cocks.

4. Strainer upstream of the assembly. Refer to strainers specified in this Section.

5. Check valve upstream of the backflow preventer assembly to prevent nuisance discharge due to fluctuation in service line pressure.

B. 2 inch and smaller units shall have bronze body and screwed ends. 2.50 inch and larger units shall have coated cast iron bodies and flanged ends.

C. All components of the assembly shall be constructed of corrosion resistant materials or waterways shall be coated with FDA approved epoxy or other equivalent corrosion protection. The assembly shall be listed and labeled per ASSE Standard 1013, conform to AWWA Standard C511, and shall be listed by the U.S. Public Health Service.

D. Backflow preventers shall be Watts Series LF909 or equal by Apollo Valves; Aalberts - IPS, Beeco, Wilkins, AMES or FEBCO.

2.2 Hot Water Recirculating Pump

A. Pump shall be system lubricated (wet rotor) horizontal in-line pipe mounted centrifugal type with bronze pump casing and motor with internal overload protection. Pump shall be Bell & Gossett, Grundfos, Taco or Armstrong.

B. Temperature controller for pump cycling shall be a Honeywell L4006A1017 commercial grade aquastat controller with insertion element, 100 – 240 deg. range and 5 - 30 deg. adjustable differential.

2.3 Thermal Expansion Tank

A. Thermal expansion tank for expansion compensation in the domestic hot water system shall be pressurized diaphragm type, NSF or FDA approved and specifically constructed for domestic hot water systems.

B. The tank shall be welded steel constructed and shall be fitted with a butyl rubber diaphragm (to separate water from the pressurized air section of the tank), stainless steel tapping for system connection and a standard tire air charging valve. Diaphragm type tank shall have a rigid polypropylene interior liner in the water section. Tank exterior shall be prime coat or finish painted.

C. Tank shall be equal to Amtrol, Wessels or equal by Watts of configuration and acceptance volume as indicated on the drawings.

2.4 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. Refer to Part 3 for blow down valves.

2.5 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 Apollo, Acorn, Bradley, Cash Acme, Leonard, Wilkins Caleffi, or Watts.

2.6 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.

2.7 Water hammer arresters shall be precharged sealed stainless steel gas bellows or diaphragm type conforming to PDI Standard WH-201 and ASSE 1010. Units shall be of sized and installed per PDI requirements. Units shall be by Smith, Wade, Josam, Mifab, Watts, Sioux Chief or Zurn.

PART 3 - EXECUTION

3.1 Backflow preventers shall be located and installed in accordance with the manufacturer's recommendations and the Water Departments requirements. Clearances and elevation shall afford easy access for testing and servicing. Extend full size drain piping from the air gap fitting to a floor drain. Devices shall be tested at the time of being put into service. Submit test data in O & M manuals.

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

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

3.4 Wall hydrants shall be located approximately 18 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 Schedule 40 PVC, ASTM D2665. Fittings shall be drainage type, ASTM D2665. Joints shall be solvent welded ASTM D 2564. Primer shall meet ASTM F656.

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, and type 304 corrugated stainless steel shield and clamp assembly, ASTM C1540 complaint. No-hub couplings shall be Ideal “Heavy Duty MD”, Clamp-All 80, Husky “SD 2000”, Mission “Heavy Weight” or Mifab “Extra-Heavy Duty”.

2.2 Storm Drainage Piping

C. Pipe in grade below the floor slab shall be Schedule 40 PVC, ASTM D2665. Fittings shall be drainage type, ASTM D2665. Joints shall be solvent welded ASTM D2564. Primer shall meet ASTM F656.

D. 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, and type 304 corrugated stainless steel shield and clamp assembly, ASTM C1540 complaint. No-hub couplings shall be Ideal “Heavy Duty HD”, Clamp-All 125, or Husky “SD 4000”.

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 Above grade piping, in sizes 4 inches and larger, shall be anchored at all changes in direction, at all changes in diameter greater than two pipe sizes, and to prevent axial movement and/or joint separation at each branch opening. Bracing methods shall be as recommended by pipe and/or coupling manufacturer's installation instructions and/or the Cast Iron Soil Pipe Institute (CISPI) Handbook.

3.7 Vent piping shall extend thru the roof to at least 12 inches above the roofline. The pipe penetration shall be flashed and made watertight.

3.8 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.

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.

3.9 PVC drainage piping shall not be used for equipment that wastes water above 120 deg. (commercial dishwasher).

3.10 Drainage and vent piping exposed to view in the warming kitchen area shall be painted with an aluminum enamel paint.

3.11 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. Installation, bedding and backfill for plastic pipe shall conform to ASTM D2321.

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 Drainage system specialties shall be manufactured by J.R. Smith, Zurn, Sioux Chief, Watts, Mifab, Wade, or Josam.

2.2 Floor drains shall be as shown and scheduled on the drawings. Drains shall be equal to listed catalog numbers, type, size, materials and features.

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

2.3 Carriers for Wall Hung Fixtures

A. Unless indicated otherwise, provide carriers for all wall mounted fixtures.

B. 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.

C. 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.

D. Urinal chair carriers, ASME A112.6, shall be hanger plate type, steel construction, upper and lower bearing plate, welded footplates, designed for thin wall construction.

E. 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.

F. 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.

G. Clinical sink chair carrier shall be adjustable type, cast iron and steel construction with neoprene gasket, adjustable coupling, cast iron waste and vent fitting and anchor foot assembly, Wax gaskets are not acceptable.

H. 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.

2.4 Cleanouts

A. Cleanouts shall be of the same manufacturer as floor 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. Refer to Part 3 for installation and concrete anchorage of exterior cleanout covers at grade.

2.5 Mechanical Trap Seal Device

A. Device shall comply with ASSE 1072 and be rubber insertable assembly which forms a watertight seal that opens to allow drainage and closes when there is no flow.

B. Design basis: JR Smith Quad-Close Model 2962 or equal by Zurn, Mifab, Josam, Sureseal,"

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 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.

3.3 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.

3.4 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 Sump pumps - Zoeller, Weil, Crane, Hydromatic, or Liberty

A. Type A3 - Submersible - Duplex (Zoeller Series 160 or 180)

1. Pumps shall be non-automatic submersible type, UL listed. Pump construction shall be all cast iron. Impeller shall be non-clogging vortex design constructed of cast iron. 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 hermetically sealed with high quality dielectric oil or air for cooling the motor 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 0.5 inch solids, maximum 130 degrees F. dewatering discharge temperature with a 3 inch threaded discharge connection.
2. Provide slide rail system for all basins 6 feet or deeper, or as otherwise noted. Slide rail system to be supplied by pump manufacturer to allow removal of pumps without entering basin. Slide rail system components and hardware shall be stainless steel.
3. Control panel to contain an electrical alternator relay controlled by four mechanical type float switches. Bottom switch to end pumping cycle, second switch to turn on lead pump, third switch to turn on lag pump and fourth switch to activate high water alarm. Control panel to include circuit breakers, alarm bell or horn, H-O-A switches, auxiliary set of contacts for remote alarm and shall be rated for NEMA 4X service. When required for 3 phase pumps, control panel will include separate magnetic contactors with overload protection. Control panel to be supplied as a package by pump supplier.

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

A. Type “L” or “M” hard copper tubing, ASTM B-88. Fittings shall be DWV drainage type with socket ends. Joints shall be soldered or brazed with lead-free alloy, 95-5 tin-antimony or tin-silver equal to Harris “Stay-Brite”, “Stay-Brite 8” or “Bridgit”. Solder shall meet ASTM B32.

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 any one of the several following type, subject to conditions stated under each 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 minimum 0.25 inch thick epoxy coated hinged access door and lock for pump removal and inspection, and flanged openings for vent piping, discharge piping and wiring, all sealed gas tight (gas tight seals are not required for open sump pumps). Cover shall be furnished with Series 300 stainless steel bolts and washers minimum 0.25 inch diameter for all access openings and for cover attachment to basin.

2.4 Refer to Section 22 05 23 for shutoff and check valves for the discharge piping of each sump pump. Valves shall be Type B4 and C1, respectively.

2.5 Conduit from control panel to sump shall be per 26 05 33 – Raceways and Boxes for Electrical Systems.

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. 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 all required accessories to complete pump slide rail systems including Schedule 40, 304 stainless steel piping, anchors, bolts, nuts, washers, false pit bottom with studs, etc. not furnished with manufacturer's slide rail systems. All components shall be stainless steel. Rail system shall be positively secured to both the bottom and side of the basin.

3.6 Provide all field wiring between control and/or alarm panel(s) and pump(s). Provide cord conduit seals at conduit / basin / cover interface.

3.7 Provide factory authorized start-up service for pump installation.

END OF SECTION

22 33 00 DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 Domestic water heating system complete, ready for operation including water heater, and all accessories shall be provided as shown on the drawings and as specified.

1.2 Each storage type heater shall be supplied with a T & P relief valve.

1.3 Refer to 22 05 12 Electrical Requirements for Plumbing Equipment, 22 05 19 Meters and Gauges for Plumbing Piping, 22 05 30 Bases and Supports for Plumbing Equipment, and 22 05 53 Identification of Plumbing Piping and Equipment and other sections for work related to this section.

1.4 Refer to Section 22 11 19 Interior Domestic Water Piping Specialties for recirculating pumps.

1.5 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 Electric Water Heater – Storage Type

A. Heater shall be listed by Underwriters’ Laboratories (UL 1453), ASME HLW construction and shall meet or exceed the standby loss requirements of the U.S. Department of energy and current edition of ASHRAE/IESNA 90.1. Heater shall have 150 psi working pressure and be equipped with extruded high density anode rod. All internal surfaces of the heater exposed to water shall be glass-lined that has been fused to steel by firing at a high temperature range. Electric heating elements shall be medium watt density with zinc plated copper sheath. Unit shall be completely prewired with controls, high limit and adjustable range operating thermostats, requiring only the connections of a power source at one location. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panels. The outer jacket shall enclose the tank over non-CFC foam insulation. Electrical junction box with heavy duty terminal block shall be provided. Heater drain size shall conform to ASME. Heater tank shall have a 3-year limited warranty as outlined in the written warranty. Fully illustrated instruction manual shall be included.

B. Water heaters shall be manufactured by A.O. Smith, Bradford White, Lochinvar, PVI, RheemRuud, Bock, or State.

PART 3 - EXECUTION

3.1 Installation

A. Provide a concrete base under all floor mounted storage heaters.

B. Maintain manufacturer's recommended clearances around and over water heaters.

C. Provide unobstructed drain from T & P relief valve to the floor drain.

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/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. 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 acrylic latex, ASTM C-834, silicone additive, paintable, white, equal to Pecora AC-20.

C. One-part polyurethane security sealant, ASTM C-920-98, Type S, Grade NS, Class 12.5, tamper resistant, Shore A hardness of 45, white, equal to Pecora Dynaflex SC.

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 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 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 Architect 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 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 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 Construction Manager. 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 one electronic copy each of operating and maintenance manuals for the HVAC 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. Final air and water balance reports and as-built automatic temperature controls drawings and specifications 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 Division 23 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 their work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer 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 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 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. 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. 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, 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 set 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. Pipe insulation.
4. Ductwork insulation.
5. Refrigerant piping schematic and components.
6. Rooftop heating and cooling units.
7. Cooling coils.

8. Unit heaters.
9. Fans.
10. Air outlets and inlets.
11. Automatic Temperature Controls.
12. Fabric duct.

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. Condensate drainage piping, same as for plumbing drainage piping.
2. Refrigerant piping - refer to appropriate Refrigeration 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.

3.2 Pipe Cleaning

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

B. Condensate 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 and 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.

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: Union County Public Library – Library Addition and Renovation
2 East Seminary Street
Liberty, IN 47353

Owner: Union County Public Library

Heapy Engineering Project Number: 2023-07083

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.

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. 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 shutdown shall be bid as being done outside of normal working hours.

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 shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with screwdriver lock. 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.

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 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.

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.

B. 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.

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

D. 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.

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

A. 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".

2.2 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 inches thickness full face compressed sheet suitable for temperature and pressure ranges of the application.

2.3 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.

2.4 Pipe sleeves shall be:

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

2.5 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.

2.6 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 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 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).

3.9 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.

3.10 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.

3.11 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.

3.12 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).

3.13 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.

3.14 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.

3.15 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 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"

2.4 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 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. Structural steel angles, beams or channels, unistrut type channels or pipe. Supports shall be fabricated into a rigid framework with welded or bolted connections and cross bracing or sway bracing. Supports shall be set on slab with base plates, or attached to the building structure as required. Brackets for relatively lightweight equipment may be attached to the wall. Equipment shall be set on and attached to the framework.

B. Solid steel hanger rods supported from the structure above similar to pipe hangers. Provide sway bracing for equipment supported in this manner.

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.

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 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.

2.2 .

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 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 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 Ducted return air systems require balancing dampers for each return air device (grille or register). Recommend a balance damper in duct branch, not in grille or register.

1.4 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.

1.5 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.

1.6 When project is in phases and partial occupancy is planned, determine process to allow balancing work to be completed before occupancy.

1.7 Refer to Section 23 05 31 HVAC Equipment Drives and other Sections of Division 23 for requirements related to the balancing work.

1.8 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, same as for new.

1. Existing AHU: 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, except when more stringent requirements are required as defined below. 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. Adjust drive pulleys to attain fan speed required for the installed conditionPulleys and belts of fixed drives and of adjustable drives not having sufficient adjustment range shall be changed out, at the direction of the balancer or Engineer, to obtain fan speed required for the installed condition. Labor /or materials required to make the recommended changes shall be included in Division 23.

I. Measure velocity reading across coils, filters, and dampers on the intake side of the fan. Include data in the report.

J. Coordinate with the Temperature Controls Installer in setting variable frequency drives. Supply air systems shall have ampere reading measured in the full heating, full cooling and economizer modes to determine the maximum brake horsepower.

K. Witness all duct pressure and leakage tests. Refer to 23 31 13 and coordinate accordingly.

L. 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 Refer to item F. above for drive changeout requirements and the items below.

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. Contractor shall seal all existing ductwork and test to verify it has been sealed.

Q. In balancing of variable air volume systems, the total air quantity of the devices generally exceeds the fan air quantity due to the nature of the VAV system. The fan speed shall be set to deliver the required maximum fan cfm (not the total cfm of all of the devices) with duct static pressure sufficient (and yet not excessive) for proper operation. Terminal air control units shall be repositioned for fan balancing to deliver the maximum fan cfm.

R. 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.

S. 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 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.

3.3 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 supply air ductwork 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 return air ductwork 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 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.

1.7 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 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.

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. 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.

E. 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 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”
Refrigerant suction	1”	1.50”	1.50”
Refrigerant liquid (2)	1”	1”	1”
Cooling condensate drainage (1)	0.50”	0.50”	0.50”

Notes:
(1) Cooling condensate drainage – from cooling coil drain pans, associated floor drain sumps, traps and horizontal above ground piping to vertical stack (coordinate with plumbing).
(2) Insulate refrigerant liquid line when recommended or required by equipment manufacturer (such as for variable refrigerant volume / flow systems).

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 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 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.

2.2 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.

2.3 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.

2.4 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 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.

2.5 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. Insulation saddles (shields) shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.6 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).

2.7 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.

2.8 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.

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. Johnson Controls, Jackson Systems, OCS, Trane.

B. All systems shall be integrated into existing control system and visible on current graphics.

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)
Relative Humidity	±5% RH (0 – 90% 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.]
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. 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. 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.

K. 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.

L. 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.

M. 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.

N. 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.

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 and 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. Cooling Condensate drainage.

1. Copper – Type C4.

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.

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.

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, fire 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.

1.3 Fire dampers shall be provided where shown on the drawings and where otherwise required to conform to the NFPA 90A and Building Code requirements.

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.

2.4 Fire dampers shall be as follows:

A. Dampers shall be constructed and tested to conform with UL 555, shall be UL labeled and shall be rated for use in static or dynamic systems, as indicated on the drawings, or as required by the Mechanical Code All fire dampers installed in corridor walls shall be dynamic rated, even when indicated as static on drawings, and shall demonstrate acceptable closure performance when subjected to minimum 150 feet per minute velocity across the face of the damper in conformance with the UL 555 fire exposure test.

B. Review the architectural drawings to determine wall ratings and select dampers accordingly.

C. Dampers shall be as manufactured by Ruskin, Greenheck, Nailor or Carnes, equipped with a 165 degree (unless otherwise noted) fusible link. Pressure level construction shall conform to that of the duct as indicated in the Duct Construction Schedule on the drawings.

D. The following is a description of fire damper types:

1. TYPE "B" STATIC AND DYNAMIC

2.5 Low velocity (below 2000 fpm) with folded blade curtains stored out of air stream.

PART 3 - EXECUTION

3.1 Fire dampers shall be installed in conformance with manufacturer's instructions and SMACNA recommendations. Dampers shall be installed in sheet metal wall or floor sleeves along with retaining angles and duct access doors or panels. Sleeve and duct connections shall be breakaway type or rigid type with corresponding gauge requirements in accordance with the manufacturer's instructions and SMACNA recommendations. Provide a duct access door for each damper, minimum 12"x12" or removable duct section (bolted and gasketed double wall duct section) per NFPA 80 and labeled "FIRE DAMPER", "SMOKE DAMPER", or "FIRE–SMOKE DAMPER" as appropriate.

3.2 Fire dampers and associated access doors shall be so arranged and located such that the spring catch and fusible link, are accessible when the damper is closed.

3.3 Accessibility of each fire damper shall be demonstrated to the Owner by disconnecting the link, closing the damper, reopening and re-attachment of the fusible link.

END OF SECTION

23 34 00 HVAC FANS

PART 1 - GENERAL

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

1.2 Fans shall be constructed, rated and labeled in accordance with AMCA Standard 210 67 and AMCA 300. Fans shall be statically and dynamically balanced throughout the operating range. Submittals shall include fan curves showing operating point(s), system curves, and surge lines.

1.3 Fans with Electronically Commutated Motors (ECM's) shall be selected such that the maximum available motor RPM shall at minimum accommodate 10% additional fan CFM at a 21% increase in fan static pressure, over what is specified as the duty point. This elevated performance point shall also not exceed the motor's Hp limitations or the fan's construction class. Shop drawing information shall reflect these requirements. Motor speeds shall be adjustable in the field, and any hard programmed limitations of motor speed or fan performance shall be based on the required elevated performance stated above.

1.4 Classification for Spark Resistant Construction shall conform with AMCA 99.

1.5 Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment and Section 23 05 31 HVAC Equipment Drives for required provisions.

1.6 Refer to Section 23 05 49 Vibration Control for HVAC for vibration isolator types.

1.7 Provide dimensional drawings and product data on each exhaust fan assembly. Provide fan curves for each fan at the specified operation point with the flow, static pressure, and horsepower clearly plotted. For multiple fan assemblies, fan curves shall be adjusted to show assembly operation.

1.8 Dampers shall be tested and licensed for air performance and leakage in accordance with ANSI/AMCA standard 500-D and AMCA publication 511.

1.9 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 Construction Manager. 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.

1.10 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 Electronically Commutated Motors (ECM's) shall be maximum 1750 rpm unless specifically noted otherwise. Refer to 1.3 above and Section 23 05 13 Electrical Requirements for HVAC Equipment. ECM's shall be variable speed motors with motor-mounted interface with manual potentiometer that allows minimum 5:1 turn down of motor speed, setting of minimum motor speed, and can accept a 0-10VDC signal from an external source to vary the motor speed.

2.2 The following lists types of fans, related construction features and manufacturers. All fans of any one listed type shall be of the same manufacturer.

A. Type D1 – Direct Drive Power Roof Ventilator
Power roof ventilator shall consist of a spun aluminum weather hood, counterflashing base, vertical shaft open centrifugal wheel, ECM, motor disconnecting means in the motor compartment, motorized backdraft damper and bird screen.

A metal roof curb with straight sides and wood nailer on top shall be provided with each fan. Provide wood cant strips around the curb only if recommended for the roofing system. Curb shall be insulated type. Curb height shall be such that top of curb extends 12" above the finished roof surface. For sloped roofs, the curb shall have a built-in slope to match roof slope so that top of curb is level.

Fans shall be manufactured by Greenheck, PennBarry, Twin City, Cook.

B. Type F1 - Ceiling Fan
Ceiling fan shall consist of a centrifugal fan or fans with forwardly curved blades, direct connected motor with internal overload protection, motor disconnecting plug, sheet metal housing with 0.50 inch acoustical liner, discharge duct collar with gravity damper and finished metal or plastic ceiling grille.

Provide a solid state speed controller with off position and cover plate. Coordinate installation with Division 26.

Fan shall be manufactured by Greenheck, PennBarry, Twin City, Cook.

2.3 Motorized backdraft dampers, where specified, shall be furnished with an electronic damper actuator with voltage compatible with the fan motor voltage and electric service to the fan. If not compatible, a transformer shall be provided with the fan and damper actuator to afford the appropriate voltage. Where the fan motor is fed from a Variable Frequency Drive controller (VFD) provide a control contactor or relay and extend the control from the VFD damper control output relay to open/close the damper when associated fan motor is started/stopped.

2.4 Motorized backdraft dampers shall be insulated damper with extruded aluminum thermally broken airfoil blades with an AMCA air leakage class rating of class 1A at 1 in. wg and class 1 at 4 in. wg. Damper shall be parallel blade configuration with the motor actuator mounted outside of the airstream. Dampers shall be Greenheck ICD-44, Ruskin TED50, Tamco 9000 SC, or approved equal.

2.5 Gravity backdraft dampers shall be non-motorized dampers that open and remain open under low velocity conditions. Dampers shall be tested in accordance with AMCA standard 500 and at 1 in. wg have a maximum leakage rating of 20 cfm/ft^2, except dampers where the largest dimension is smaller than 24" air leakage shall be a maximum of 40 cfm/ft^2. Damper provided shall be appropriate for the mounting (vertical or horizontal) and application (exhaust or intake) and shall be parallel blade configuration. Dampers shall be Greenheck WD series, Ruskin BD2 or equal by Tamco 7000 CW, or approved equal.

PART 3 - EXECUTION

3.1 Install fans and roof curbs level and plumb, in accordance with manufacturer's written instructions. Support units as described below using the vibration control devices specified in Section 23 05 49 Vibration Control for HVAC.

A. Roof curb mounted units: Set unit on the curb and fasten the fan base to the curb. Roof support curbs shall be installed and leveled and secured to the roof deck/structure. Roof insulation and roofing shall be installed at the curbs by the roofing Contractor. Provide wood cant strips around the curb only if recommended for the roofing system.

3.2 Arrange installation of fans to provide access space around fans for service and maintenance.

3.3 Adjust damper linkages for proper damper operation. Motorized backdraft dampers are to be wired to open when the fan operates. Coordinate with Division 26.

3.4 Fans 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.

3.5 Factory furnished devices which are not installed and wired in the factory shall be field installed and wired by Division 23, complete and ready for operation.

3.6 Perform the following operations and checks before start-up.

A. Remove shipping blocking and bracing.

B. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork and electrical are complete. Verify proper thermal overload protection is installed in motor starters and disconnects.

C. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation. Align belts and reinstall belt guards.

D. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.

E. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

END OF SECTION

23 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 37 16 FABRIC DUCTWORK

PART 1 - GENERAL

1.1 Fabric ductwork shall be utilized as shown on the drawings and as specified herein.

1.2 The fabric duct manufacturer shall study the floor plans and application and the design data noted on the floor plans, and shall provide engineered to scale drawings showing the supports layout, duct runs, orifice layout and performance data, including throws.

The fabric duct supplier shall participate in coordination meetings due to the very limited and congested installation area and complex coordination issues with the other trades such as conduit, sprinkler pipes, dry agent piping, etc..

1.3 Fabric ducts shall be listed and labeled in compliance with UL 2518.

1.4 Fabric ducts shall be treated with an EPA registered antimicrobial agent.

1.5 Manufacturer shall have documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length and suspension. Parameters for design, including maximum air temperature, velocity, pressure and fabric permeability, shall be considered and documented in the shop drawing submittal.

1.6 Manufacturer shall provide a 10-year warranty for products supplied for the fabric portion of this system.

PART 2 - PRODUCTS

2.1 Fabric ducts shall be DuctSox Sedona-Xm or equal by FabricAir, KE Fibertec, SoftDucts, or NanoSox, constructed of woven fire-retardant fabric complying with the following physical characteristics:

A. Fabric Construction: 100 percent Flame Retardant and treated with a machine washable anti-microbial agent from the manufacturer.

B. Weight: 6.75 oz./yd. per ASTM D3776

C. Color: determined by Architect (Custom color)

D. Custom Graphics: Determined by Architect with coordination with Owner.

E. Air Permeability: 2 (+2/-1) cfm/ft. per ASTM D737, Frazier

F. Temperature Range: 0 degrees F to 180 degrees F.

G. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements of NFPA 90-A and ICC AC167.

H. Antimicrobial agent shall be proven 99 percent effective after 10 laundry cycles per AATCC Test Method 100.

2.2 Systems Fabrication Requirements:

A. Air dispersion accomplished by linear vent and permeable fabric, linear vent to consist of many .187 inch diameter open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents.

B. Size of and location of linear vents to be specified and approved by manufacturer.

C. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener.

D. Inlet connection includes zipper for easy removal / maintenance.

E. Lengths to include required zippers as specified by manufacturer.

F. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.

G. End cap includes zipper for easy maintenance.

H. Fabric system shall include connectors to accommodate suspension system listed below.

I. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows are 5 gores and the radius of the elbow is 1.5 times the diameter of the fabric duct.

J. Provide ring support system, full round to keep the fabric duct system at 98% full round with no air supply.

2.3 Design Parameters:

K. Fabric diffusers shall be designed from 0.25 inch water gage minimum to 3.0 inches maximum.

L. Fabric air diffusers shall be limited to design temperatures between 0 degrees F. and 180 degrees F.

M. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer, in accordance with the plans and specs.

2.4 Suspension Hardware

N. Tension Cable: System shall be installed using a tension cable system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

PART 3 - EXECUTION

3.1 Delivery, Storage and Handling

A. Protect fabric air dispersion systems from damage during shipping, storage and handling.

B. Where possible, store products inside and protect form weather. Where necessary to store outside, store above grade and enclose with a vented water proof wrapping.

3.2 Installation shall be in strict accordance with the manufacturer's instructions, including stretching the fabric duct to be wrinkle free.

3.3 Cleaning And Protection:

C. Clean air handling unit and ductwork prior to the fabric duct system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.

D. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.

E. If fabric duct systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION

23 62 15 CONDENSING UNIT - AIR COOLED

PART 1 - GENERAL

1.1 Condensing unit shall be factory assembled air cooled type couple to new coil in existing AHU, complete with safeties and operating controls. Refer to drawings for locations and configurations.

1.2 Each unit shall be UL listed. Capacities shall be certified in accordance with AHRI.

1.3 Design saturated condensing temperatures for air-cooled condensers shall be less than or equal to the design dry-bulb temperature plus 10°F for low-temperature refrigeration systems and less than or equal to design dry-bulb temperature plus 15°F for medium-temperature refrigeration systems. Note that the saturated condensing temperature for blend refrigerants shall be determined using the average of liquid and vapor temperatures The minimum condensing temperature setpoint shall be no greater than 70°F.

1.4 Refer to Section 23 23 00 Refrigerant Piping.

1.5 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 or Construction Manager. 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.

1.6 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 condensing unit shall be air cooled type designed for outdoor installation. Each unit shall be factory wired and piped complete with the following components and accessories.

A. Two or more scroll type compressors. Each compressor shall be complete with motor, suction and discharge service valves, winding thermostat, oil pump, oil level sight glass, oil charging valve, crankcase heater and vibration isolators. Units of 40 tons capacity and greater shall have minimum 2 independent refrigeration circuits, with discharge and liquid line service valves and gauge taps on each circuit. Each refrigerant circuit shall also include a sub-cooling circuit.

B. Condenser section with aluminum finned copper tubes, upblast propeller fan(s) each with variable speed fan control and a direct drive ECM motor, wire fan guards galvanized or PVC coated for corrosion protection, and liquid line service valves. Condenser coils shall be similarly protected with hail guards. Coils shall be factory pressure and leak tested.

C. Cabinet constructed of galvanized steel, bonderized and coated with baked enamel. Access panels shall be hinged for compressor and control panel access.

D. Refrigerant components, including hot gas muffler, high side pressure relief devices, liquid line service valves, and liquid line filter driers. Each refrigerant circuit shall be fitted with panel mounted suction, discharge and oil pressure gauges, each with a shutoff valve.

E. Microprocessor based controls, safeties and electrical components, including:

1. Power and control terminal blocks with single point electric power service connection and fused control transformer.
2. Motor disconnecting means (switch or breaker) for each motor.
3. Motor starter or power contactor and motor overload protection for each motor.
4. Capacity control by compressor staging. Capacity unloading shall be capable of reducing unit capacity to 20 percent of full load. Condenser fans shall be controlled in unison.
5. Hot gas bypass shall be provided for additional modulating control, but shall be limited to 15% of unit rating for 20 ton and smaller units, 10% of unit rating for larger units.
6. Compressor short cycle time delay.
7. Head pressure control system to work in conjunction with the cooling coil hot gas bypass system. Provide head pressure controls and accessory equipment to maintain head pressure at 150 psig minimum with evaporator entering air temperatures as low as 55 degrees F.
8. Low ambient lockout thermostat set at 55 degrees F.
9. High and low pressure and temperature cut outs, and start relay. All safety controls, except low pressure, shall be manual reset or wired into a reset relay circuit to avoid cycling on safeties. Multi-fan condensers shall be controlled in unison. Controls shall also include variable setpoint control logic to reset the condensing temperature setpoint in response to ambient dry-bulb temperature.
10. Refrigerant pump down initiation at system shut down on each refrigerant circuit. Provide associated liquid line solenoid valve near the evaporator.
11. BACnet (Coordinate with controls contractor)

2.2 Condensing Units shall be rated under AHRI 210/240 and 340/360 and shall have minimum Energy Efficiency Ratings as specified below. Multiple or variable speed compressor units shall achieve this rating at high speed.

Size (cooling)	Indoor Unit Heat Source	Rating Condition	Min Efficiency
240,000 – <760,000 Btuh	Gas	AHRI 340/360	11.4 IEER

2.3 Each unit shall be factory charged with R-410a or R407c refrigerant and lubricating oil.

2.4 Condensing unit shall be sized for 3 degree lower suction temperature than that of the evaporator coil.

2.5 Condensing units shall be manufactured by Carrier, Trane, or JCI.

2.6 Provide rubber-in-shear/steel spring vibration isolators, coated for outdoor application with each condensing unit.

PART 3 - EXECUTION

3.1 Provide a wiring diagram showing all necessary operating and safety controls which are specified, and any additional items which are required for the proper and safe operation of the system. Also furnish two sets of wiring diagrams to the automatic temperature controls installer and coordinate

with him in the preparation of integrated control diagrams. These wiring diagrams shall be furnished as soon as possible after notice of intent is given, to expedite preparation of submittals. If additional controls, safety devices, piping circuits or other accessories are recommended by the manufacturer for the proper operation or safety of the equipment, for the specific application specified, they shall be included with the equipment proposal.

3.2 Unit supplier shall size all refrigeration piping and devices in accordance with the path, and distances of refrigeration piping shown on the drawings. If any changes are deemed necessary in the refrigeration piping shown on the plans, they shall be brought to the attention of the Contractor during bidding by the unit supplier. Complete refrigeration piping diagram shall be submitted with the equipment submittals.

3.3 Grade-set condensing units shall be set on and secured to a 6” high reinforced concrete pad.

3.4 Roof-mounted condensing unit shall be set on and secured to equipment roof curbs/steel framework. Refer to the drawings and Section 23 05 30 Bases and Supports for HVAC Equipment. Coordinate location, dimensions and required, structural support and roofing work.

3.5 Provide all control wiring required to operate the system, including all interlocks to ensure that unit cannot operate until the room air fan operates.

3.6 All work in connection with refrigerant piping and accessories, including complete charging, start-up, test and demonstration of the proper functioning of the refrigeration system shall be included.

3.7 System checkout, testing and starting shall be provided by the manufacturer's factory trained service technician.

END OF SECTION

23 82 16 COOLING COIL

PART 1 - GENERAL

1.1 DX cooling coil shall be installed in existing AHU as shown on the drawings.

1.2 Coil capacities shall be ARI certified. Coils shall be hydrostatically tested at 450 psi and leak tested to 300 psi air pressure under water.

1.3 Refer to the drawings for size, capacity and water and air pressure drop limitations.

PART 2 - PRODUCTS

2.1 DX cooling coils shall be direct expansion refrigerant type with copper tubes, aluminum fins, liquid distributors, suction headers, intertwined circuits and galvanized steel casing. Tube wall thickness shall be 0.020 inch minimum. Coils shall have same end pipe connections. Casing shall be designed for mounting in existing unit.

2.2 Coil cleaned dehydrated and sealed while holding a charge of dry nitrogen.

2.3 Provide thermal overload protection of motor and adjustable time, to prevent short cycling, safety controls shall include high and low pressure cutouts and rest delay.

2.4 Coils shall be manufactured by Carrier, Trane, Coil Company, USA Coil or Heatcraft.

PART 3 - EXECUTION

3.1 Install coils level and plumb and in accordance with manufacturer’s instructions.

3.2 Provide refrigerant components that are required per manufacturer's instructions.

3.3 Provide casing around coil for a complete and finished look to the existing AHU.

END OF SECTION

23 82 39 UNIT HEATERS

PART 1 - GENERAL

1.1 Unit heaters shall be electric cabinet units. Refer to the drawings for arrangement, type, capacity, motor characteristics and other requirements.

1.2 Provide electric components of terminal units which have been listed and labeled by UL.

PART 2 - PRODUCTS

2.1 Electric cabinet unit heaters shall consist of:

A. Direct driven centrifugal fans in a blow thru arrangement with multi speed permanent split capacitor motor having internal overload protection. A fan speed switch with "off" position shall be mounted behind a hinged access door and factory wired.

B. Heating coil shall be finned steel sheaths helically wound, individually removable, with corrosion resistant finish.

C. Electrical power and control devices shall be factory mounted and wired in a compartment within the unit enclosure, and factory tested. Devices shall include a terminal block, dead front disconnect switch, contactors, high temperature limit switch, fan limit switch, transformer for controls, transformer for fan motor if voltage is not compatible with service feed, fuses and other devices to complete the package.

D. Thermostat to cycle the fan and coil on a call for heat shall be integral with floor or wall units. A wall mounted thermostat shall be provided with each unit mounted at or above the ceiling.

E. Cabinets of exposed heaters shall be constructed of bonderized steel, 16 gauge front and 20 gauge back and sides, with outlet grille and inlet grille as appropriate. Recessed units shall have overlapping cabinet or wall flange on all four sides. Concealed units shall have a discharge duct collar and where return ductwork is required, a return duct collar. Exposed cabinets shall be finished with baked enamel of colors selected by the Architect from the manufacturer's standard decorator colors. Exposed and recessed cabinets shall have a lockable access door.

F. Electric cabinet unit heaters shall be manufactured by TPI Corporation (Ray-Wall, Markel, or Redd-i), Trane, or Q-Mark/Chromalox.

1.2 Electric wall heaters with finished cabinet, propeller fan, motor, finned steel sheathed heating elements, fan delay switch, thermal limit switch, integral thermostat with accessible adjustment and accessible on off switch which serves as a unit disconnect.

A. Heaters shall be manufactured by Q-Mark/Chromalox (Type AWH) or Ray-Wall.

PART 3 - EXECUTION

3.1 Suspended units shall be hung from the building structure with steel hanger rods and auxiliary angles and fastening devices.

3.2 Provide all required wiring between the unit and wall mounted thermostats, in conduit per Division 26 and the N.E.C..

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, and 28 work and complete systems as shown on the Division 26, and 28 drawings and as specified in Division 26, 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 Coordination Drawings

A. Refer to Divisions 00 and 01 for additional requirements.

1.8 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.

1.9 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.

1.10 Operating and Maintenance Manuals

A. Assemble three 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. Panelboards.
2. Motor controllers.
3. Specialty equipment.
4. Fire alarm systems.
5. Lighting equipment and lighting controls.

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.

1.11 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 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.

1.12 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 Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

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, 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.
4. Wiring devices and coverplates.
5. Overcurrent protective device coordination study.
6. Secondary metering enclosure.
7. Panelboards.
8. Cabinets and enclosures.
9. Fuses.
10. Motor controllers and disconnects.
11. Lighting fixtures and lamps.
12. Lighting standards.
13. Lighting controls/contactor.
14. Fire alarm system.

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, Architect, and 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.
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.

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, 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: Union County Public Library Additions and Renovations
2 East Seminary Street
Liberty, Indiana

Owner: Union County Public Library

Heapy Engineering Project Number: 2023-07083

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): _____

    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:
☐ 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 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 Temporary Electric Services

A. The temporary service and temporary lighting for construction is provided by the Contractor. Refer to Division 01 - General Requirements.

B. The Contractor is cautioned to carefully consider the possible sources of temporary electric service and the probable location of the General Contractor's office.

C. The General Contractor will make application to the local utility company for the temporary electric service and will pay for all electric power used during construction, including electric heating.

D. The Contractor shall furnish, install and pay for all necessary conduit, wire, metering, poles, switches, receptacles, lights and accessories to provide a 400 amp, 120/208 volt, 3 phase, 4 wire temporary electric service with the main disconnect switch, meter, and a 42 circuit load center at a location specified by the General Contractor.

E. Consult the utility company for fees required and include same in Electrical Contract.

F. Labor, receptacles, boxes, fixtures, wire, etc. required by the various Contractors inside their offices shall be paid for by the respective Contractors.

G. Lighting fixtures shall be placed every 40 ft. along each corridor or, where corridors do not occur, along the long axis of all rooms and areas greater than 25 ft. in length. Provide a 200 watt (or LED equivalent) lamp in a rubber coated socket with wire guard, spliced into branch feeder conductor at every 20 ft. The branch circuit wiring may be 3 wire type "NMC" and the wire guard shall be bonded to the ground conductor. Receptacle circuits shall consist of 1 gang handy box with grounded duplex receptacles a maximum of 50 ft. on center with a maximum of 4 per circuit. All receptacle circuits shall be protected by its own overcurrent device in a panelboard. Install wiring and equipment above 6 feet 6 inches and below the finished ceiling. Extend circuits as required and protect in an appropriate panelboard on each floor level. Provide GFCI protected receptacles and circuits as required by NEC and OSHA.

H. Contractors requiring extension cords shall provide their own cords and plugs up to capacity of 20 amperes. For services to larger items of equipment and welders, this Contractor shall extend proper feeders as requested at the expense of the Contractors requiring the service.

I. The Contractor shall maintain the temporary light and power system for the duration of the work and shall remove it from the site when directed or no longer required as coordinated with the construction team. Temporary wiring and equipment shall remain the property of the Contractor.

J. The use of the permanent electrical system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.

K. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.

L. The complete temporary service shall comply with Power Company, OSHA, and all Code requirements.

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 (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 / be institutional grade locksets. 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 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 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 existing 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.

D. Panels with recessed doors are to be fitted with insert panels of drywall. Caution the Installing Contractor to 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 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 inch 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 inches 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 inch 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 compactt.

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 600 volts.

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. Equipment grounding conductors shall be green, or for 4 AWG and larger may be completely taped green, at all accessible points.

C. All control circuits shall be red with individual wire identification on each conductor.

D. 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 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 Grounding rods shall be copper clad, molten-welded copper to steel; unless otherwise designated, 0.625 inch diameter x 10 ft. long.

2.2 Clamps and continuity devices shall be non-ferrous material, UL approved. Connections to ground rods and all underground connections shall be "Thermoweld" or "Cadweld".

2.3 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 Provide a listed intersystem bonding termination system with capacity for a minimum of 5 - #4 - 4awg and 1 - #6 – 2 awg bonding conductor terminations. Locate external to the service entrance equipment and connect to the grounding electrode system.

3.2 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.

3.3 Extend a minimum #4/0 copper ground cable from the ground bus in the primary service entrance equipment to the street side of the main water meter and to building steel, foundation footing steel (minimum 20 ft. length .50 inch or provide 20 foot #2 AWG, bare copper), driven ground rods outside or buried electrodes; increase ground conductor sizes where required.

3.4 Pad-Mount Transformer Grounding: Bond the high voltage neutral, pothead cases, cable shields, instrument transformer neutrals, low voltage system neutral, all conduits, frame of the transformer, and driven ground rods with copper connections.

3.5 Main service neutral shall be grounded to the street side of the building water service. A bonding jumper shall be installed around the water meter. In addition to using the water service as a grounding electrode, effectively grounded building steel, foundation footing steel (minimum 20 ft. length ½ in. or provide 20 ft. #2 AWG. bare copper) and driven ground rods outside or buried electrode shall be provided and connected. Bond to interior metallic water, gas and all other metallic lines. Conductors minimum size shall be sized per NEC Tables 250.66 and 250.102

3.6 Grounding Bus: Install in electrical service equipment space, telephone equipment rooms, generator room, battery rooms, below raised floors, and elsewhere as indicated.

A. Bus shall be minimum 3/8 inch x 2 inches x 12 inches L. solid copper.

B. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

C. The grounding bars shall be bonded to the building grounding electrode system and the building ground ring.

3.7 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 primary switchgear, pad-mount transformers, and main breaker panel, and secondary service entrance panelboard 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.

3.8 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.

3.9 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.

3.10 Cord connected appliance frames shall be grounded to the equipment grounding system thru a green wire in the cord.

3.11 Equipment mounted on vibration isolation hanger and supports shall be bonded so bond does not transmit vibration. Size bond to match equipment ground conductor.

3.12 A green grounding conductor shall be installed in each non-metallic conduit and all flexible conduits, including exterior underground conduits.

3.13 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 panelboard enclosure shall be by means of bonding jumpers.

3.14 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.

3.15 A minimum #6 ground wire shall be run from each telephone backboard back to the main building ground.

3.16 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.

3.17 Where metal covers on pull boxes and junction boxes are used, they shall comply with the grounding and bonding requirements of NEC Article 250.

3.18 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.

3.19 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 - Thinwall 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 - PVC, NEMA Type TC 6, rigid, conforming to ANSI, NEMA specifications and each length UL labeled.
Application - use limited to:

1. Exterior use when encased in 3 inch concrete, for duct bank use only.

E. Conduit - Flexible Metal (Greenfield type), galvanized steel.
Application - use limited to:

1. Connection to lighting fixtures; not over 6 ft. in length. Note: Metal-Clad Cable: Type MC may be used for fixture whips only; must contain green insulated ground conductor, be limited to 6 ft. in length and must use UL approved connectors.
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.

F. 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.

G. Conduit Reinforced Thermosetting Resin RTRC shall meet UL 1684 for extinguishing flame and shall not contain any compounds that release halogens.
Application use limited to:

1. In or under concrete slabs on grade where permitted by electric legend on drawings.
2. Exterior uses when encased in 3" concrete.
3. Direct buried, underground when indicated on drawings.
4. Exposed corrosive atmospheres including pool equipment rooms, chlorine storage areas, etc. and other areas as noted on drawings.
5. Where subject to physical damage shall be identified for use i.e., types RTRC-X W.

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.
6. RTRC
   - Coupling and fittings socket type adhesive jointing. Coupling and adhesive by same manufacturer as conduit. Gasketed jointing system may be used underground where encased in 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. Provide water tight boxes, slip expansions and bonding jumpers where dictated by construction conditions.

D. 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 or RTRC (equal to

Champion Fiberglass) elbows with all necessary fittings and couplers. (NOTE: Where not required to be run overhead, branch circuits may be installed in 1 inch or smaller Schedule 40 PVC conduit below the vapor barrier, shall have a minimum of 6-inch fill over the conduit below the vapor barrier without concrete encasing the PVC. This PVC conduit shall not stub up more than 18 inches above the finished floor and shall be concealed in walls./ The 90 degree elbow and stub up shall be galvanized rigid steel).

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 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.

3.10 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.

3.11 Surface mounted horizontal and vertical conduit supports on walls up to a height of 7 feet-0 inches 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 feet-0 inches. The use of pinch type hangers similar to Minerallac type are expressly prohibited on ductwork, air handling units and other mechanical equipment below 8 feet-0 inches.

3.12 During construction temporarily cap open ends of conduit. Caution trades to take special care of runs in concrete slabs during pouring.

3.13 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.

3.14 Pull mandrel or large swab thru conduit to ensure freedom from debris before pulling wires. Use pulling lubricants sparingly.

3.15 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.

3.16 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.

3.17 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.

3.18 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.

3.19 Where permitted by OBC Section 712 Penetrations, metallic conduits requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls and 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).

3.20 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. Provide cast iron pipe or schedule 40 galvanized steel conduit sleeves in exterior walls below grade, with intermediate wall stop and anchor collar set in place before concrete pouring. Sleeve shall be a part of the sealing assembly. When the wall opening is core drilled the wall sleeve may be omitted. A mechanically compressed rubber sealing assembly equal to Thunderline Corp. "Link-Seal" shall be placed in the annular space between conduit and sleeve or core drilling.

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 (the company who presently holds the warranty on the roof) 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 feet-0 inches (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 MANHOLES, PULLBOXES, HANDHOLES, UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEM

PART 1 - GENERAL

1.1 Work includes manholes, pullboxes, handholes and underground duct banks complete as shown, including excavation, backfill and accessories.

PART 2 - PRODUCTS

2.1 Manholes

A. Manholes 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 Department of Transportation Specifications H 20.

B. Precast manholes including moving and setting installation requirement shall be submitted for approval.

C. Refer to the drawings for number and sizes of manholes required.

D. Furnish ground rod for each manhole and bond all exposed metal parts, including the ring for the manhole cover, to rod with minimum #8 copper conductor.

E. Cables thru manholes shall follow the walls and be supported with insulators. Diagonal or straight thru cable runs are not acceptable.

F. The use of precast concrete manholes is encouraged. Acceptable manufacturers: Oldcastle Infrastructure, Mack Industries, Norwalk Concrete Industries , E.G. Babbert or approved equal.

G. 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.

H. Provide pulling rings on each side of manhole.

I. Cable Racks

1. Hot dipped galvanized, heavy-duty rack consisting of heavy gauge sheet steel piece anchored to wall with four (4) insulation support arms. Insulators to the white glazed saddle type. Support arms shall be 18 inches long.
2. Provide sufficient cable supports on walls for feeding being installed under this contract, plug additional supports on other walls for future use.
3. Manufacturers: Rack Hubbell #DU13B7, Supports-Hubbell #DU353 and Insulators – Hubbell #DE3U1 or approved equal

2.2 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 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.

2.3 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.

2.4 Duct Banks

A. Duct material, where concrete encased, shall be concrete encasement type PVC with 3 inches 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.

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. Manholes, 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, handhole and manhole 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 inches 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, pullboxes and manholes: Install a driven ground rod through floor, close to wall and set rod depth so 4 inches 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 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

B. Grounding Connections to Handhole, Pullbox and Manhole 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. Individual motor starters.

B. Nameplate on motor controllers, disconnect switches, and panelboards 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
   d. Telephone - Yellow

E. Wire identification:

1. 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.
2. 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 20 ampere, 120/277 volt AC and gray (to match existing) 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 1000 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. Power pack for remote mounting to match occupancy sensor.

F. Verify color with Architect.

G. All components to have 5-year warranty.

H. 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 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. Dimmer 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 inches 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 inch 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 ft. 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 24 16 A 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 100 amp shall be minimum 10,000 amp, I.C. 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.

2.2 Refer to "Identification for Electrical System" 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, included extra width (3” minimum 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.

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 120 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.

2.4 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.

2.5 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.

2.6 A short circuit and coordination study complete with curves shall be furnished by either the panelboard manufacturer or an approved Engineering firm which demonstrate proper interrupting ratings, coordination between the main secondary breakers, the feeder breakers and fuses and ground fault protection. Provide recommended settings for the breakers and the ground fault protection. In addition to the Short Circuit and Over-Current Coordination Studies, include Arc Flash Evaluation Studies using the NFPA 70E or IEEE 1584 Standard to comply with NEC paragraph 110.16. Provide in report form, the results of the calculations and install labels/marking on panelboards, control panels and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.

A. The protective device analysis shall include:

1. A determination of settings or ratings for the overcurrent protective devices supplied.
2. An evaluation of the degree of system protection and service continuity possible with the overcurrent devices supplied. System is to be fully rated, selectively coordinated. Provide equipment to provide this level of operation.
3. Eight copies of the protective device time-current coordination analysis shall be submitted.
4. Time current characteristic curve drawings on log-log paper which illustrate:
   a. Suggested settings of the adjustable overcurrent protective devices supplied.
   b. The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the settings or ratings of the overcurrent protective devices supplied.
   c. The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
5. A tabulation of the suggested settings for the adjustable overcurrent protective devices supplied.

6. An analysis of the results in which any inadequacies shall be called to the attention of the (engineer) and recommendations made for improvement.

B. The short-circuit analysis shall include:

1. A calculation of the maximum RMS symmetrical three-phase short-circuit current available at significant locations in the electrical system.
   The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. Appropriate motor short-circuit contribution shall be included in the calculations.
2. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer.
3. Eight copies of the short-circuit analysis shall be submitted for approval. This submittal shall include:
   a. A computer printout of input of input data, a computer printout of calculated results and an explanation of how to interpret the printouts.
   b. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
   c. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X and R ration of that fault current.
   d. A table of equipment short-circuit ratings versus calculated short-circuit current values.
   e. An analysis of the results in which any inadequacies shall be called to the attention of the (engineer) and recommendations made for improvement.

C. Arc-Flash analysis shall include: In addition to the short circuit and over-current coordination studies, include arc flash evaluation studies using the NFPA 70E or IEEE 1584 Standard to comply with NEC paragraph 110.16. Provide in report form the results of the calculations and install labels/marking on each panelboard, control panels and motor control centers that are likely to require examination, adjustment, servicing or maintenance while energized.

1. Emergency side distribution overcurrent protection shall be fully coordinated including use of manufacturer's selectivity tables and charts. Circuit breaker models shown on plans are selectively coordinated, manufacturers of equal selectively coordinated equipment shall be supplied at no additional charge.

D. Copies of the analysis shall be submitted with the panelboard shop drawings.

E. The primary panelboard manufacturer shall coordinate relay settings of the high voltage switchgear breakers and fuses, and secondary circuit breakers setting with the Power Company relaying including instantaneous and ground fault protection.

F. The desired settings shall be calibrated and set in the field by an authorized representative of the panelboard manufacturer.

G. Post a durable copy of the "as-left" relay settings and fuse ratings in a convenient location within each panelboard assembly. Deliver four additional copies of the settings and fuse ratings to the Engineer.

Note: These studies must be submitted with the shop drawings. Shop drawings cannot be reviewed without these studies. The Contractor shall make all proper settings before energizing the equipment.

PART 3 - EXECUTION

3.1 Mount top of wall mounted cabinets 6 feet 0 inches 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 inch 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 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 20-ampere, 125 volt, NEMA configuration 5 20R and gray (to match existing) 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 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in the following areas shall be listed tamper-resistant receptacles.

A. All public spaces within the library. Areas not required to have tamper resistant devices are as follows:

1. Private offices
2. Meeting rooms
3. Conference rooms
4. Reception desk

2.5 Transient voltage surge suppressors (SPD-ANSI/IEEE Category A and B), UL 1449 suppression (clamping) rating of 400 V, 3 mode protection (LN/LG/NG) for 120 V branch circuits:

A. Duplex receptacles, 120 V, 20 A shall be LeGrand 5362-ISP, Hubbell HBL5362ISA, Leviton 5380-I, Bryant SP53-TIGIA or Eaton 5350S. Receptacle to be listed UL 1449 Type 3.

B. Suppression strip with a heavy duty 6 ft. 14-2 AWG power cord, 6 electrical NEMA 5-15R 120V, 15 A outlets, computer grade on/off 20 A switch, resettable circuit breakers, internal thermal fusing, hybrid suppression circuit and comprehensive diagnostics. Strip to be listed UL 1449 Type 3.

EFI Electronics Corp. - Model 453 (15 A Overload Protection)
Joslyn Electronic Systems - Model 1203-03 (15 A Overload Protection)
Pass and Seymour - Model PS7 (15 A Overload Protection)
Hubbell Model HBL6PS350A (15A Overload Protection)
Leviton Model 5300-PS

2.6 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.

2.7 In finished spaces, wall plates shall be unbreakable lexan or nylon, non-combustible, minimum 0.100 inch thick, with color matching metal screws; "smooth" styling. Plates shall match color of devices.

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 to match orientation of existing outlets in existing portion of the building.

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 amperes interrupting capacity, all shall be UL labeled.

2.3 Fuses, 601 ampere to 6,000 ampere (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 1 ampere to 600 ampere (standard dimensions) shall be UL Class RK 1. The size and type is indicated on drawings. Bussmann LOW PEAK Time Delay fuse LPN RK (250 volts) or LPS RK (600 volts).

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.

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 Those portions of interlock and control wiring which are required but not prewired, shall be done in the field.

3.3 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.

3.4 Refer to "Identification for Electrical Systems" section for nameplate requirements.

3.5 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 51 13 INTERIOR LUMINAIRES, LAMPS AND BALLASTS

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. 2.4 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, ballasts and individual components shall bear UL label. All ballasts including compact fluorescents shall be high efficiency and high-power factor (HPF).

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 LED luminaire complete assembly shall be submitted for approval with shop drawings. Identifying pertinent information such as the manufacturer, frequency operation, THD, crest and ballast factor, reset thermal protection, 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 percent 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 277 volt 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. The LED luminaire assembly shall be Design Lights Consortium (DLC) approved.

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. 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. In addition, all recessed LED luminaires for lay in ceilings shall be equipped with at least two 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. Install safety cable / chain support for gymnasium luminaires per manufacturer's direction. Coordinate structural connection with Architect.

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.)

2.3 Stairwell Luminaires, Control Features

Fluorescent electronic dual voltage ballasts, high power factor. (LED modules dual voltage drivers, (optional one-lamp (module) 90 minute nickel-cadmium battery pack (EL) includes inverter charger, test switch and charging indicator lamp.). Super high frequency occupancy sensor: Controls line voltage to operate luminaire. Detects motion via electromagnetic waves, so sensor can be used behind luminaire lenses. 120/277 VAC operation. 20 foot radius of operation. Time delay from 30 seconds – 30 minutes, sensitivity adjustable, dims down to 30%.

PART 3 - EXECUTION

3.1 All circuits shall have dedicated neutral conductor.

3.2 Adjust coverage of occupancy sensors and dimming control.

3.3 Test system operation for full 90 minutes witnessed by the AHJ. Provide report of required corrections, of any.

3.4 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 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.

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 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 inches 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 ballast 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 28

ELECTRONIC SAFETY AND SECURITY

28 31 00 FIRE DETECTION AND ALARM ADDRESSABLE

PART 1 - GENERAL

1.1 Fire Alarm System

A. System shall be a microprocessor based double supervised, closed circuit fire alarm system of modular design utilizing addressable technology for remote devices. Wiring shall be Class "B" for signaling and notification circuits. Smoke detectors shall be analog, addressable units with control panel adjustable sensitivity. All units of equipment shall be labeled by Underwriters' Laboratories for fire alarm signaling use and shall comply with UL 864 Ninth Edition.

B. The fire alarm system and installation shall be in compliance with local, city, state, NFPA, ADAAG and IBC Codes.

C. The system shall also be UL listed for simultaneous supervisory service to provide supervised monitoring of building safety, security and other building alarms as described herein.

D. Operation of any addressable manual or automatic fire alarm initiating device shall initiate the following:

1. Sound a Code-3 temporal pattern (non-coded, continuous,) audible fire alarm signal and illuminate fire signal lights in a synchronous mode until alarms have been silenced at the main fire alarm system control panel or at a remote operator's control panel by means of the "alarm silence" switch or the device returned to normal and a "reset" switch is manually actuated.
2. Display alarm condition on integral alphanumeric LCD displays in the control panel(s), and remote annunciator(s), indicating the alarming device and its location. Each manual and automatic alarm initiating device shall be individually addressed.
3. Print the assigned English language message and activate control-by-event functions, with time and date, for the monitored point in alarm at the printer at the control panel.
4. Initiate a separate trouble and alarm signal for connection to the municipal fire department or remote monitoring service organization via two leased telephone lines.
5. Transmit a signal over two supervised telephone lines to a central station operation for fire alarm trouble and alarm conditions via the fire alarm digital communicator.

E. In the event of operating power failure or an open or a grounded circuit in the system, a trouble signal and trouble LED shall be activated until the system is restored to normal. The trouble event shall be recorded within the control panel historical trouble log, and printed on the system printer (when applicable). The trouble signal may be silenced by means of a button located on the control panel operator’s interface. Upon restoration of the system to normal condition, the trouble indicators shall automatically extinguish.

F. Supervised Monitoring

1. Operation of the supervisory service of the fire alarm system shall provide for the central monitoring and programmed control of various pieces of equipment and/or systems. These pieces of equipment shall be interfaced with the fire alarm system via dry contacts and supervised circuitry utilizing individual addressable modules (Monitor IAM) and programmable relay control module (Relay IAM) that are connected to the fire alarm systems data wiring.
2. The fire alarm supplier shall provide individual programming for each monitor point and control point for customized response. As a minimum, programmed response shall

include the ability to sound the system trouble alarm at any or all operator control panels and annunciators, display unique alpha-numeric messages, re-initiate a silenced alarm that has not been corrected after a programmed time and initiate a higher alarm status for designated alarms that have not been acknowledged in a programmed time.

1.2 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. All existing monitoring and control circuits that are connected to the existing elevator from the existing fire alarm control panel shall be extended to the new fire alarm control panel and remote annunciator. Contractor shall field verify all existing connections and include in his bid. Some of the typical monitoring and control items are listed below.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.

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.

D. Door Controls

1. Release all electro-magnetic door holders.
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 drawing for quantity and location of door devices to be interfaced.

3. Release fire shutter.

PART 2 - PRODUCTS

2.1 Equipment shall be manufactured by Simplex Grinnell (to be compatible with existing fire alarm devices that remain and are to be reconnected to new fire alarm control panel. 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. Remote system components as manufactured by Wheelock, Gentex or System Sensor are acceptable if UL listed and warranted as part of the total fire alarm system, provided by the fire alarm equipment supplier.

B. All fire alarm initiating devices and notification appliances shall be of the same manufacturer, and under the same branding, as the fire alarm control panel.

2.2 Fire Alarm Control Panel (FACP)

A. Control panel shall contain all necessary components to provide complete control, testing and indicating facilities for the entire fire alarm system. Relays, where employed, shall be pluggable type sealed in dustproof containers to prevent failure from dust, dirt, tampering and accidents. Unit shall facilitate silencing of alarm from one addressable device and shall resound on subsequent alarm from another addressable device. Unit shall be double supervised, individually annunciated by addressable point with, test switch, silencing switches, reset switches, control switches, power "on" lamp, 80 character LCD display, "Alarm" lamp, and a means of simultaneously testing all indicator lamps. Trouble signal shall be integrally mounted "Sonalert" signal with a SPL of 80 db at four feet, trouble alarm silence switch shall have ring back feature.

B. An alarm shall be displayed on an 80-character LCD display. This display shall indicate alarms, supervisory service conditions and any troubles. The top line of 40 characters shall be the point label and the second line shall be the device type identifier. The system alarm red LED shall flash on the control panel and the remote Operator Control Panels until the alarm has been acknowledged at the control panel or the remote Operator Control Panels. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another point after acknowledged, shall flash the system alarm LED on the control panels. The LCD display shall show the new alarm information. A pulsing alarm tone shall occur within the control panel and the remote operator control Panels until the alarm is acknowledged.

C. The control panel shall be sized to accommodate 250 addressable devices. Power supplies shall be supplied with 100 percent capacity including provisions for 10 percent additional strobe lights and 20 percent additional audible devices. Provisions for spare capacity shall include additional data loop cards or signaling cards to support the specified capacity. Audible signals shall be master controlled from the fire alarm panel to permit continuous signaling or master coded signaling in a Code-3 temporal pattern. All visual alarm signals (strobe lights) shall be synchronized at the fire alarm panel. Audible signals shall be capable of being canceled independently of the visual alarm signals. Simplex #4100ES series with accessories.

D. Cabinet shall be modular construction, shall be semi-flush mounted and shall accommodate all the modules, relays, terminal connections, and batteries necessary for system operation.

Provide an outer door and frame assembly equipped with a lock and transparent door panel; manufacturer's standard enameled finish.

E. The control panel shall communicate individually with addressable initiating and control devices. Each device shall be individually annunciated at control panel.

1. Annunciation shall include the following:
   a. Alarm
   b. Trouble
   c. Open
   d. Short
   e. Device missing/failed
2. All addressable devices shall be capable of being disabled or enabled individually.
3. Smoke detectors shall utilize "Alarm Verification" operation.
4. Smoke sensor sensitivity shall be field-adjustable from the control panel for the analog style detectors. Control panel shall have self-test function such that each sensor is automatically tested once every 24 hours. Sensor shall notify control panel when maintenance is required. System shall automatically compensate for variations in environmental conditions.

F. Control Panel shall have a "Walk Test" feature.

G. The control panel shall be capable of providing system information via web pages to browser based monitoring systems through an Ethernet connection.

H. Digital Alarm Communicator Transmitter (DACT)

1. A Digital Alarm Communicator Transmitter (DACT) shall be located within the main fire alarm control panel and automatically transmit designated alarms and supervisory signals to a central station via two telephone lines.
2. The DACT shall be compatible with the communications protocol of all major Central Station receivers, including: ADCOR, ADEMCO, FBI, Franklin, Osborne Hoffman, Radionics, SESCOA, Silent Knight, Varitech, DCI, Vertex, etc.
3. The DACT shall be connected to two telephone lines, shall supervise both telephone line(s), and shall be capable of sending alarm signals on both line(s). The DACT shall be connected to the fire alarm panel to indicate a trouble alarm on any digital communicator equipment failure including loss of the telephone line(s) for longer than 45 seconds.
4. The DACT shall be programmed to automatically transmit a test signal to the central station every 24 hours.
5. The DACT shall be powered and maintained by a standby battery power supply. Provide surge suppressors on the DACT 120-volt power circuit and telephone line(s).
6. A monitoring contract shall be provided by the Owner, to allow programming and testing of the DACT telephone line connection.
7. Provide all power and control wiring, receptacle, power supplies, etc. for a complete system per F.A. suppliers requirements.
8. The DACT shall transmit the following event level information:
   a. Fire Alarm Condition
   b. Supervisory Condition
   c. Trouble Condition
   d. Daily Test Signal

I. Power Source

1. Operating power shall be supplied from a 120 volt, 60 Hz circuit while the supervisory power shall be supplied from an integral DC power supply. The low voltage DC power

supply shall consist of power limited, filtered and regulated power supplies with maintenance-free, lead-calcium battery back-up with automatic recharger; indication for normal supply and power supply trouble.

2. Batteries shall be sized to maintain system operation, including trouble alarm, for 24 hours with sufficient reserve capacity to power all alarm sounding devices for 5 minutes. Battery capacities shall be sized to include provisions for the spare strobe light and audible devices listed in the Part 3 - Execution section of this spec. All batteries shall be supervised.
3. Provide remote cabinet for batteries where size dictates need.
4. Door holders are not required to be maintained by the standby batteries.
5. The power source and batteries shall be sized to serve FACP as a complete system, including spare capacity per NFPA 72 requirements.

J. Provide surge suppressors ahead of all 120 volt power connections to the fire alarm equipment. Locate suppressors within equipment enclosure or in a junction box directly above the unit. Suppressors shall be Leviton #51020-WM or equal. These suppressors are in addition to internal protection provided with the fire alarm system's internal electronics.

K. Control panel shall have capability to communicate with miniplex transponders, if transponders are provided.

2.3 Remote Fire Alarm System Components

A. Miniplex transponders will communicate with the Main Fire Alarm Control Panel to provide for centralized control of alarm and trouble signaling as well as output signaling. The transponder shall be capable of limited stand-alone operation in the event the communication link to the central system is lost. Each transponder shall be furnished with all necessary controls, power supplies and battery back-up.

B. Individual addressable monitor module shall be an addressable module used for monitoring N.O. contact devices such as water flow, tamper switches, the kitchen hood fire extinguishing system, etc. Simplex IAM #4090-9001.

C. Programmable relay control module shall be an individual addressable module used for control of auxiliary functions such as elevator control, door release, smoke damper shutdown, air handling unit shutdown, etc. Simplex IAM #4090-9002.

D. Remote Annunciator shall be flush wall mounted where shown on plans. Each shall consist of an 80-character LCD display with primary control features similar to the main controller located in the fire alarm control panel. Control buttons are behind a locked window to prevent unauthorized operation. Simplex #4603-9101.

E. Notification appliance power extender control panels shall be provided as required. These panels shall communicate with and be completely supervised from the main fire alarm panel and shall be capable of powering additional synchronized visual alarm signals and/or audible alarm signal circuits. Each panel shall include supervisory modules, power supplies, batteries and chargers. At the Contractor's option, additional extender panels may be utilized. Coordinate exact locations of these additional remote panels with the Architect/Engineer during the submittal phase. Simplex #4009-9201 Series panel with accessories.

F. Provide a recessed Knox-Box rapid entry system located at the new main entry doors. Extend wiring from the Knox-Box tamper switch to the building security alarm system.

G. Magnetic door holders shall be voltage selectable for 24 VDC or 24/120 VAC operation. Flush (Simplex #2088-9607), semiflush (Simplex #2088-9608) or surface wall mounted (Simplex

#2088-9609) as required. Floor mount models for single door (Simplex #2088-9610) or double door (Simplex #2088-9611) applications where required.

2.4 Alarm Signal – Initiating Devices

A. Photo-electric type, addressable, ceiling mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at .5 percent to 3.7 percent 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. Detector head shall have a white finish, shall contain an integrally mounted LED pilot lamp that indicates detector status. Simplex #4098-9714 with #9792 base. Provide remote LED alarm indicators where indicated.

B. 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 .5 percent to 3.7 percent 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. Simplex #4098 Series housing with #4098-9756 detector.

1. A remote mounted test/reset switch with "status" pilot lamp shall be flush mounted at 54 inch mounting height in a convenient location within sight of air handling unit, Simplex #2098-9806.

C. 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 percent 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.

D. 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. Simplex #4098-9733 with #4098-9792 base.

E. Manual Stations shall be addressable communicating devices, shall have a red finish and shall be non-coded, single action with breakrod operation (glass rod not required to reset station), semi-flush mounted with keyed reset switch. Simplex #4099-9001.

2.5 Notification Appliances

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 75 / 115 candela in all other areas. 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 Simplex non-addressable #4906 Truealert Series with appropriate mounting hardware. Exterior units shall

be gasketed and labeled for exterior use. Wheelock #WM3T / Notifier – System Sensor SpectrAlert Series (UL 1638 compliant).

B. Horns shall be semi-flush mounted, with red grille and field selectable output levels of 90 or 95 dB at 10 ft. (based on UL 464 reverberant test requirements). 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. Outside assemblies shall be weatherproof. Combination (audible/visible) horn and fire signal lights shall utilize a compact, combination mounting base assemblies. Horns shall be labeled "Fire". Wheelock #MT Series (utilize the continuous horn signal setting) with mounting accessories. Exterior units shall be gasketed and labeled for exterior use. Combination strobe/horn signal units shall be factory assembled Wheelock #MT+ Series.

C. 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. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 75 / 115 candela in all other areas.. Semi-flush mount signals on walls where shown on the drawings. Lens shall be installed in a horizontal alignment and shall produce 1 flash per second. 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). 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. 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. Simplex non-addressable #4906 True Alert series.

PART 3 - EXECUTION

3.1 Submittals

A. The fire alarm supplier shall submit for approval with shop drawings, floor plans, schematic and point to point wiring diagrams showing all manual and automatic devices, control panels, sounding devices, conduit sizes, number and size of wires, etc. 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), and standby batteries. Voltage drop calculations will be based on each strobe drawing 110 percent of operating current and each audible device drawing 120 percent of operating current to allow for future devices. Submittal shall include copies of personnel certification as required in PART 3. **SHOP DRAWINGS WILL BE REJECTED UNLESS THE SUBMITTAL INCLUDES ALL THIS REQUIRED INFORMATION.**

B. 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 where applicable 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.

C. At completion of the project, the floor plans and wiring diagrams shall be revised "as built" and included as part of the maintenance manuals. The fire alarm supplier shall also furnish a hard copy printout of each detector's address, operating routines, etc. as part of the as-built drawings. Additionally, the supplier shall include an electronic copy (in a digital media format

acceptable to the Owner) of the system's operating program with the as-builts for the Owner's records.

3.2 Provide complete programming of the system. Verify nomenclature of building areas and devices with the Owner prior to program finalization.

3.3 Follow NFPA 72 and manufacturer's instructions regarding mounting, wiring and testing system. Installer(s) shall meet project's respective State 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.

3.4 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.

3.5 Coordinate door holder equipment connections with hardware supplier. Door holders shall not be maintained by integral control unit back up battery.

3.6 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. Assure accessibility to the entire assembly.

3.7 Provide protection, such as wire guards, which are listed for the specific use on all fire alarm devices within 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 120 volt emergency circuit to each remote panel.

3.10 Wiring, #14 AWG minimum, shall be installed in accordance with manufacturer's wiring diagrams, recommendations and in compliance with practices set forth by local, state and national fire codes. Color code and tag all wires at all junction points. #18 AWG conductors may be utilized when installed as a multi-conductor cable with an overall protective jacket when approved by manufacturer. All fire alarm system wiring shall comply with NEC Article 760.

A. All wiring shall be tagged and labeled to correspond with the final record drawings.

3.11 All wiring shall be installed in red conduit; conduit system shall be independent of all other systems.

3.12 The following wiring and conduit shall be included in the fire alarm system work in addition to that indicated above:

A. Empty conduit with pullwire from the digital communicator to the main telephone backboard. Telephone wiring from the telephone backboard to the digital communicator is the 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.

B. From fire alarm panel, duct mounted smoke detector, or control relay module to each air handling unit and exhaust fan for shutdown.

C. 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.

D. For each elevator:

1. Extend 2-#14 from the primary recall control relay module to the elevator controller (or group of controllers) for elevator "primary floor" emergency service mode signaling.
2. Extend a second pair of #14 conductors from the alternate recall control relay module to the elevator controller (or group of controllers) for elevator "alternate floor" service mode signaling.
3. Elevator emergency service mode signal wiring shall be wired to Form C dry contacts in each control relay in accordance with the elevator supplier's direction (NO or NC interlocks).
4. Extend 2-#12's from the shunt trip control relay module to the elevator shunt trip breaker.
5. Extend 2-#14's from the fireman's hat indicator control relay module to the elevator controller for activation of the fireman's alert signal within the elevator cab.
6. Extend 2-#12's from the elevator shunt trip control voltage sensing to a monitoring module.

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.

3.13 System Testing

A. Upon completion and before acceptance, system performance shall be demonstrated in the presence of the Architect 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.

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 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 72. During this checkout period, adjust audible device output levels as needed.

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. 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.

3.15 Base bid includes five (5) additional combination audible/visual alarm signals 75 / 115 cd, two (2) additional ceiling mounted smoke detectors and two (2) 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.

END OF SECTION

DIVISION 31

EARTHWORK

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, plants and grass to remain.
2. Removing existing trees.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing utilities.
7. Temporary erosion and sedimentation control measures.

1.2 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.3 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 01 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS – Not Applicable

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction and as indicated.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
2. Do not permit vehicles, equipment, or foot traffic within fenced area.
3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.
2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

3.4 UTILITIES

A. Arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Obtain written approval from Owner before disconnecting.
2. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than five days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
4. Use only hand methods for grubbing within tree protection zone.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated. Compact fill as indicated.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, grass, sod and other waste materials and dispose of off site.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.
3. Dispose of excess topsoil as specified for waste material disposal.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt paving.
   2. Pavement-marking paint.

1.2 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

   1. Job-Mix Designs: For each job mix proposed for the Work.

B. Material Certificates: For each paving material, from manufacturer.

C. Material Test Reports: For each paving material.

D. Job Mix Formulas:
   1. Submit job mix formula for all asphalt paving work.
   2. The JMF must state that the mix meets the requirements of INDOTSS Section 402 as specified.
   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
      d. Voids filled with asphalt
      e. Percent of air voids
      f. Density

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Indiana Department of Transportation Standard Specifications (INDOTSS), current addition, for asphalt paving work.

B. Testing and Inspection:
   1. All testing and instpection shall be performed by an independent Geotechnical Engineering Consultant (Geotech Engineer).
   2. The Geotech Engineer is responsible for all testing, sampling and inspection.
   3. The Contractor is responsible for all coordination and scheduling with the Geotech Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

   1. Prime Coat: Minimum surface temperature of 60 deg F.
   2. Tack Coat: Minimum surface temperature of 60 deg F.
   3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
   4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
   5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials or 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: INDOTSS Section 904.03, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: INDOTSS Section 904.02, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. General: INDOTSS Section 402

B. Binder: Performance Graded Asphalt Binder, INDOTSS 902.01 (a)

C. Prime coat: Asphalt Emulsion, AE-PMP, INDOTSS 902.01 (b)

D. Tack Coat: Asphalt Emulsion, AE-PMT, INDOTSS 902.01 (b)

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.

C. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, colors complying with FS TT-P-1952.

1. Color: White parking stalls, Blue ADA Symbols

D. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2. Provide at locations indicated on site plans.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

2. Percent of aggregates passing sieves:

Sieve Size	**Surface**	**Intermediate**
19.0mm (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
No. 50	5-26	2-18
No. 100	2-17	0-11
No. 200	0-5	0-4
Percent of Bitumen	5.7-7.2	4.1-5.2
Percent of Air Voids	4.0	4.0

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch of height indicated above pavement surface.

3.9 SURFACE TREATMENTS

A. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 WHEEL STOPS

A. Install wheel stops in bed of adhesive as recommended by manufacturer.

B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.12 PREFORMED TRAFFIC-CALMING DEVICES

A. Install preformed speed [**bumps**] [**humps**] [**cushions**] in bed of adhesive as recommended by manufacturer for heavy traffic.

B. Securely attach preformed speed [**bumps**] [**humps**] [**cushions**] to pavement with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Traffic-Calming Devices: Finished height of asphalt speed [**bumps**] [**humps**] [**cushions**] [**and**] [**tables**] above pavement will be measured for compliance with tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.14 DISPOSAL

A. Unless otherwise indicated, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 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. Bicycle racks.
3. Trash receptacles.
4. Decorative bollards
5. Book Drop

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. Furnishings based on Forms + Surfaces Products. Equal products may be submitted for review 10 days prior to Bid.
   1. Benches:
      a. Cordia – 72” Benches
         1) Provide hardwood slats for benches.
         2) Aluminum, Powdercoat Frame
         3) Provide number of benches indicated.

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. Cordia 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. Refer to Drawings for quantity and locations.

2.3 TRASH RECEPTACLES

A. Trash receptacles
   1. Cordia – Forms and Surfaces
   2. Welded aluminum frame with powder coat finish.
   3. FSC Wood Slats
   4. Free-standing with levelers
   5. Provide stainless steel security chains for lids.
   6. 35 inches high, 22 inches square.
   7. Provide polyethylene, replaceable liners. Provide two extra liners per trash receptacle.

2.4 BOLLARDS

A. Fixed decorative iron bollards.
   1. Ductile iron.
   2. Powder coated finish as selected from manufacturer’s full range.

3. Anchorage: Removable, provide concrete cast in place anchor and hardware for installation.
4. 31.75” high x 10” diameter

B. Basis of Design: Reliance Foundry – R-7591 Decorative Bollard

2.5 BOOK DROP AND CART

A. Book Drop
1. 12 gauge aircraft grade aluminum.
2. Stainless steel hinges
3. Insulation kit
4. Magnetic close, depository opening
5. Keyed cam locks
6. Cart access door, 3 point latching.
7. Finish as selected from manufacturer’s full line of available colors and finishes.
8. Dimensions: 30” w x 43” deep x 53 5/8” high

B. Basis of Design: Kinglsley 50 C-Series

C. Book Cart
1. 16 gauge aircraft grade aluminum.
2. 4” diameter swivel casters
3. Cart cover
4. Bottom pad
5. Capacity: 400 lbs, 380 books, 950 media jewel cases
6. Finish as selected from manufacturer’s full line of available colors and finishes.
7. Dimensions: 25 ½” wide x 27” deep x 38 ¼” high

D. Basis of Design: Kinglsley – DuraLight - 50 High capacity cart

2.6 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.

2.7 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.

2.8 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.

2.9 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 indicated on Drawings.

END OF SECTION 323300

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.

1.2 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 SUBMITTALS

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

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For soil amendments and fertilizer from manufacturer.

E. Material Test Reports: For imported topsoil.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Experience: Five years' experience in turf installation.
2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
3. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
4. Pesticide Applicator: State licensed, commercial.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.6 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: April-May
2. Fall Planting: August-September

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.7 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 60 days from date of planting completion.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
1. Sun and Partial Shade: Proportioned by weight as follows:
a. 90 percent Hybrid Bluegrass blend – a minimum of 3 varieties evenly blended.

2. Shade: Proportioned by weight as follows:
   a. 20 percent Hybrid Bluegrass
   b. 40 percent Creeping Red Fescue
   c. 20 percent Hard Fescue
   d. 20 percent Chewings Fescue

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
3. Provide lime in form of ground dolomitic limestone or calcitic limestone.

B. Aluminum Sulfate: Commercial grade, unadulterated.

C. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

D. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2.5 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of [**4 inches**] [**6 inches**]. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening.
2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil to a minimum depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.

    a. Apply fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft..

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch, peat mulch or planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.7 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow to a height of 1-1/2 to 2 inches.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.9 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200