PROJECT MANUAL

Jail Chiller Replacement

McHenry County
Woodstock, IL

This Project Manual contains Bidding Requirements, Contract Form, Conditions of the Contract and the Specifications for the Project. The contents of this Project Manual, the accompanying Drawings and any Addenda constitute the Bidding Documents for this Project.

GBA #P22-1352-00

GRUMMAN|BUTKUS
ENERGY EFFICIENCY CONSULTANTS
AND SUSTAINABLE DESIGN ENGINEERS

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SECTION 01 3103
STARTING OF SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Starting systems

B. Demonstration and instructions

C. Testing, adjusting and balancing

1.2 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Engineer and Owner seven days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.

D. Verify that tests, meter readings and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Verify utilities, connections and controls are complete and equipment is in operable condition.

G. Observe start-up and adjustments: Record time and date of start-up and results.

H. Observe equipment demonstrations to Owner: Record times and additional information required for Operation and Maintenance Manuals.

I. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturers' instructions.

J. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up and to supervise placing equipment or system in operation.

K. Submit a written report in accordance with Division 01 Section 01 400, “Quality Control Services,” that equipment or system has been properly installed and is functioning correctly.

1.3 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of Substantial Completion.

B. Demonstration and instructions shall be provided by a qualified manufacturers' representative who is knowledgeable about the Project.

C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners’ personnel in detail to explain all aspects of operation and maintenance.

D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance and shutdown of each item of equipment at agreed-upon times, at equipment location.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

F. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

1.4 INSPECTION AND ACCEPTANCE OF EQUIPMENT

A. Prior to inspection, verify that equipment is tested, operational and clean.

B. Assist Engineer with inspection. Prepare list of items to be completed and corrected.

1.5 TESTING, ADJUSTING AND BALANCING

A. The independent firm will perform services specified in Division 23 Section 23 0593, "Testing, Adjusting, and Balancing for HVAC," except for factory tests.

B. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with the requirements of the Contract Documents.

1.6 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 3300
SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures

B. Proposed products list

C. Contractor-prepared shop drawings

D. Preventive maintenance (PM) tasks/schedule

E. Product data

F. Samples

G. Manufacturers' instructions

H. Manufacturers' certificates

1.2 SUBMITTAL PROCEDURES

A. Refer also to provisions of the General Conditions.

B. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet, equipment tag, system designation number(s) and specification Section number, as appropriate.

C. Where possible, submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in a single submittal so long as this does not delay individual items whose review is time-critical.

D. If only part of required drawings in one group are submitted, action will be withheld on them until remaining drawings are submitted.

E. Catalog cuts showing more than one model of a product shall be clearly marked indicating which model is being proposed.

F. Capacity and performance data shall be given in same form, units and completeness presented in Contract Documents.

G. Identifying symbols and tags used on drawings shall be clearly cross-referenced on shop drawings.

H. Identify room names and numbers in which various products will be used.

I. Schedule submittals to expedite the Project and deliver to Engineer at business address. Electronic submittals are also acceptable.

J. Mark in units to match those specified.

K. Provide space for Contractor and Engineer review stamps.

L. Apply Contractor's stamp, signed or initialed, certifying that review, verification of Products required, field dimensions, adjacent construction Work and coordination of information is in accordance with the requirements of the Work and Contract Documents.

M. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

N. Revise and resubmit submittals as required, identifying all changes made since previous submittal.

O. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.3 CONSTRUCTION PROGRESS SCHEDULES

A. Submit estimated progress schedule in duplicate within 10 days after date of Owner-Contractor Agreement established in Notice to Proceed] for Engineer review.

B. Revise and resubmit as required.

C. Revise and resubmit work schedule affected by accepted alternates.

1.4 PROPOSED PRODUCTS LIST

Not Applicable

1.5 CONTRACTOR-PREPARED SHOP DRAWINGS

A. Submit in the form of electronic document AutoCAD or pdf format.

B. After review, reproduce and distribute copies in accordance with Paragraph on Procedures above and for Record Documents described in Division 01 Section 01 7700, “Project Closeout.”

C. Submit ¼” scale floor plans indicating proposed routing of new piping, electrical and duct systems, new and relocated equipment locations and connection points to existing services including sections through equipment and piping diagrams of all connections.

D. Identify equipment, pipe risers, duct risers, column lines, etc., with designations shown on Contract Documents.

1.6 PREVENTIVE MAINTENANCE (PM) TASKS/SCHEDULE

A. Within 10 days after date of Notice to Proceed, submit complete listing of PM tasks.

1.7 PRODUCT DATA

A. Submit the number of copies as established at the preconstruction conference.

B. Mark each copy to identify applicable products, models, systems, equipment tags and other data. Supplement manufacturers’ standard data to provide information unique to this Project.

C. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Division 01 Section 01 7700, “Project Closeout.”

1.8 SAMPLES

Not Applicable

1.9 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification Sections, submit manufacturers’ printed instructions for delivery, storage, assembly, installation, start-up, adjusting, testing, in quantities specified for Product Data.

B. Identify conflicts between manufacturers’ instructions and Contract Documents.

1.10 MANUFACTURER'S CERTIFICATES

A. When specified in individual specification Sections, submit manufacturer's certificate to Engineer for review in quantities specified for Product Data.

B. Indicate that material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product but must be acceptable to Engineer.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 4000
QUALITY CONTROL SERVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality assurance and control of installation

B. References

C. Manufacturers' field services and reports

1.2 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions and workmanship to produce Work of specified quality.

B. Comply fully with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes or specified requirements indicate higher standards or more precise workmanship.

E. Work to be performed by persons qualified to produce workmanship of specified quality.

F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.3 REFERENCES

A. Conform to reference standard by date of Owner-Contractor Agreement when there are no Bids date specified in product Sections.

B. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

C. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.4 MANUFACTURERS' FIELD SERVICES, FIELD TESTS AND REPORTS

A. When specified in individual specification Sections, Contractor shall require material or Product suppliers, Subcontractors, or manufacturers to provide qualified staff personnel to observe site conditions; testing; conditions of installation; quality of workmanship; start-up of equipment; testing, adjusting and balancing of equipment and materials; and troubleshooting as applicable – and to initiate instructions when necessary. Submit report per paragraph C below, this section.

B. Report observations and site decisions or instructions given to Owner, applicators or installers that are supplemental or contrary to manufacturers' written instructions.

C. Submit written report in duplicate within 10 days of observation, start-up, testing, etc. to Engineer for review.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 6000
MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products

B. Transportation and handling

C. Storage and protection

D. Product options

E. Substitutions

1.2 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

C. Provide interchangeable components of the same manufacturer for similar components.

1.3 TRANSPORTATION AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement or damage.

1.4 STORAGE AND PROTECTION

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate-controlled enclosures.

B. For exterior storage of fabricated products, place on sloped supports above ground.

C. Provide off-site storage and protection when site does not permit on-site storage or protection.

D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement or damage.

G. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications; no options or substitutions allowed.

C. Product Specified by Naming One Manufacturer as a Base and Naming Others as Acceptable: Obligations listed in paragraphs in 1.7.D. below apply when an "Acceptable Other" is used. Manufacturer named on the drawings and in equipment scheduling are to be considered as a Base; with respect to the particular product described, other manufacturers named in those documents are acceptable others.

D. When an "Acceptable Other" manufacturer is used in lieu of Specified, Contractor shall coordinate mechanical, plumbing and electrical requirements and will bear any additional costs required by other subcontractors as a result of the proposed product.

1.6 SUBSTITUTIONS

A. Refer to General Conditions.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that the Bidder:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
2. Will provide the same warranty for the Substitution as for the specified product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
4. Has investigated that the proposed product can be installed in the space available with access for servicing and maintenance.
5. Has coordinated mechanical, plumbing and electrical requirements and will bear any additional costs required by other subcontractors as a result of the proposed product.
6. Waives claims for additional costs or time extension which may subsequently become apparent.
7. Will reimburse Owner for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, or when acceptance will require revision to the Contract Documents.

F. Substitution Submittal Procedure:

1. Submit two copies of request for Substitution for consideration. Limit each request to one proposed Substitution.

2. Submit shop drawings, product data and certified test results attesting to the proposed product equivalence.
3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 7700
PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures

B. Final cleaning

C. Adjusting

D. Project record documents

E. Operation and maintenance data

F. Warranties

G. Spare parts and maintenance materials

1.2 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected and that Work is complete in accordance with Contract Documents and ready for inspection by Engineer.

B. Provide submittals to Engineer that are required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

D. Owner will occupy all portions of the building.

1.3 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean equipment and fixtures to a sanitary condition.

C. Replace strainers and replace filters of operating equipment affected by new installation.

D. Clean debris from roofs, gutters, downspouts, and drainage systems.

E. Clean site; sweep paved areas, rake clean landscaped surfaces affected by installation.

F. Remove waste and surplus materials, rubbish and any construction facilities and equipment from the site.

1.4 ADJUSTING

A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.5 PROJECT RECORD DOCUMENTS

A. Maintain on site, one set of the following record documents; record actual revisions to the Work:

1. Contract Drawings
2. Specifications
3. Addenda
4. Change Orders and other Modifications to the Contract

5. Reviewed shop drawings, product data, and samples

B. Store Record Documents separate from documents used for construction.

C. Record information concurrent with construction progress.

D. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:

1. Manufacturer's name and product model and number
2. Product substitutions or alternates utilized
3. Changes made by Addenda and Modifications

E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured depths of foundations in relation to finish [first] [main] floor datum
2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements
3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work
4. Field changes of dimension and detail
5. Details not on original Contract Drawings

F. Submit changes to Record Documents in AutoCAD format and pdf format.

G. Delete Engineer title block and seal from all documents.

H. Submit documents to Engineer with claim for final Application for Payment.

1.6 OPERATION AND MAINTENANCE DATA

A. Quality Assurance

1. Instructions and data are to be prepared by personnel experienced in maintenance and operation of described products.

B. Binders: Commercial quality, 3-D side ring binders with hardback, cleanable, plastic covers. When multiple binders are used, correlate data into related consistent groupings.

C. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" and title of project. Include subject matter of binder when multiple binders are required.

D. Internally subdivide the binder contents with permanent page dividers, logically organized as described below with tab titling clearly printed under reinforced laminated plastic tabs.

E. Contents: Prepare a printed Table of Contents for each volume, with each Product or System description identified.

F. Part 1: Directory listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors and major equipment suppliers.

G. Part 2: Operation and maintenance instructions, arranged by system and subdivided by component. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

1. Significant design criteria.

2. List of equipment.
3. Parts list for each component.
4. Operating instructions.
5. Maintenance instructions for equipment and systems.
6. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.

H. Part 3: Project documents and certificates, including the following:

1. Shop drawings and product data.
2. Air and water balance reports.
3. Certificates.
4. Photocopies of warranties.

I. Submit one copy of completed volumes in final form 15 days prior to final inspection. This copy will be returned after final inspection with Engineer comments. Revise content of documents as required prior to final submittal.

J. Submit final volumes revised within ten days after final inspection.

1.7 WARRANTIES

A. Execute and assemble documents from Subcontractors, suppliers and manufacturers.

B. Provide Table of Contents and assemble in 3-D side ring binder with durable cover.

C. Submit prior to final Application for Payment.

D. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.8 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.

B. Deliver to Project site and place in location as directed; obtain receipt from Owner prior to final payment.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 20 0500
BASIC CONSTRUCTION REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic mechanical requirements specifically applicable to Divisions 20 and 23.

1.2 SCOPE OF WORK

A. The following description is a general description of the HVAC this project. This work description is not all inclusive but is offered to give the Contractor a general idea of the scope of the project.

1. HVAC work includes but is not limited to the following:

a. Installation of one prepurchased air-cooled scroll chillers
b. New chilled water piping to new chiller
c. Temperature controls modifications for new equipment

1.3 DEFINITIONS

A. The following words or phrases have special meaning when used in the articles of this division and in any other requirements applicable to this division:

1. "Exposed to View" or "Exposed" — shall have reference to and mean that the pipes, ducts, etc., insulated or otherwise, in the completed structure are visible within any normally occupied space, room or area.
2. "In Concealed Spaces", "Concealed or "Not Exposed to View" — shall have reference to and mean that the pipes, duct, etc., insulated or otherwise are concealed and not exposed to view within furred spaces, above suspended ceilings, pipe chases, etc.
3. "Unfinished Spaces" or "Unfinished Rooms" — shall have reference to areas such as Machine Rooms, Equipment Rooms, or similar areas. Where the words "In Finished Areas" or "Finished Rooms" are used, it shall have reference to rooms or spaces, such as, Reading rooms, Offices, Public Corridors, etc.
4. "Finished Rooms or Spaces" shall refer to areas similar to offices, public corridors, and public toilet rooms.
5. "Provide" — shall be taken to mean "furnish and install" meaning to purchase and deliver to the job site and the installation thereof.
6. "Piping" — shall include, in addition to pipe all fittings, valves, hangers, and other supports, expansion compensators, anchors, and accessories related to such piping including associated insulation.
7. "Ductwork" — shall include, in addition to ducts, all fittings, transitions, dampers, hangers and other supports, fire dampers, access panels, associated insulation and accessories related to such ductwork.
8. "Contractor" in Specifications and Drawing refers to respective Contractor performing that portion of work.
9. "Invert Elevation" (I.E.) means elevation of inside bottom of pipe or duct.
10. "Mechanical Work" is work in Divisions 20, 21, 22, and 23.

NOTE: The words “Contractor shall” are implied and shall be so understood wherever the directions “furnish,” “install” or “provide” are used.

1.4 SPECIAL CONDITIONS

A. Minor items and accessories or devices reasonably inferable as necessary to the complete and proper operation of any system shall be provided by the Contractor for such system whether or not they are specifically called for by the Specifications or Drawings.

B. Where work specified in other sections of the specifications connects to equipment specified in Divisions 20 and 23 Sections, check the required connection to such equipment.

1.5 WORK BY OWNER

A. The following work shall be by the Owner:

Not applicable

1.6 OWNER-FURNISHED PRODUCTS

A. The following products shall be furnished by the Owner and installed by the Contractor:

1. Air-cooled scroll chillers

1.7 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Owner before proceeding.

1.8 CONTRACTOR USE OF PREMISES

A. Refer to Division 01 and General Conditions.

B. Limit use of site and premises to allow:

1. Owner occupancy.
2. Use of premises by Owner to conduct normal activities.
    a. Tie-ins to existing systems must be done in manner so as not to interfere with Owner’s operations. All shut downs of existing services require a three day notice minimum in writing.

C. Schedule the Work to accommodate this requirement.

D. Cooperate with Owner to minimize conflict and to facilitate Owner’s operations.

E. The Owner will be responsible for the identification and abatement of all hazardous materials and asbestos associated with the project. Although great care will be taken to eliminate any risks, the Contractor must be aware that hazardous materials may exist on site. Therefore, the Contractor shall immediately suspend work and notify the Owner if asbestos or other hazardous material is suspected in the work area of the project.

1.9 PROJECT SCHEDULE

A. Expected ship date for the chillers is late February, 2015.

B. Project shall be of substantial completion including startup and availability of the chillers for cooling no later than March 28th, 2015.

1.10 REFERENCE STANDARDS

A. Quality Assurance

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
2. Conform to reference standard by date of issue current on date of Contract Documents date for receiving bids date of Owner-Contractor Agreement when there are no Bid dates specified.
3. Obtain copies of standards when required by Contract Documents.
4. Maintain copy of applicable standard at job site during submittals, planning and progress of the specific work, until Substantial Completion.
5. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.
6. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

B. Reference Standards and Specification Abbreviations

1. Refer to Divisions 01, 20, 21, 22, and 23.

1.11 SUBMITTALS

A. Shop drawings and samples shall be submitted in compliance with the Conditions of the Contract and General Requirements.

B. Submittals shall contain outline dimensions, operating and maintenance clearances and sufficient engineering data to indicate compliance with the specifications. Each submittal shall be clearly labeled as indicated in the Conditions of the Contract and General Requirements.

C. Each piece of equipment shall be identified by the number shown in the schedules and by specification article number pertaining to the item. Shop drawings shall as a minimum be ¼" equals 1'-0" scale, and shall be newly prepared by the Contractor and not reproduced from the Architect's drawings. Layouts shall be made for all floor plans including all ductwork, piping, electrical distribution and other mechanical equipment. Layouts shall show clearances of piping, ducts, etc., above floor.

D. Contractor shall obtain Engineer's approval on all the work before any equipment is purchased, or any work installed. Contractor shall also secure approval of the Governmental Authorities having jurisdiction on all equipment and on the layout of the complete system.

E. The Engineer's review and approval of shop drawings is a gratuitous assistance and in no way does it relieve the Contractor from responsibility for errors or omissions which may exist on the shop drawings. Where such errors or omissions are discovered later, they must be made good by the Contractor, without any additional cost to the Owner, irrespective of any approval by the Engineer.

1. The Contractor shall incorporate with his shop drawings, a letter indicating all deviations from the plans and/or specifications. If in the opinion of the

Architect, the deviations are not equal, the Contractor will be required to furnish the item as specified and as indicated on the drawings.

2. Record documents shall be submitted in compliance with the requirements of the Specifications.

1.12 QUALITY CONTROL

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions and workmanship to product Work of specified quality.

B. Comply fully with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes or specified requirements indicate higher standards or more precise workmanship.

E. Work to be performed by persons qualified to produce workmanship of specified quality.

F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

G. Manufacturers' Field Services and Reports

1. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of installation, quality or workmanship, start-up of equipment, testing, adjusting and balancing of equipment and troubleshooting as applicable and to initiate instructions when necessary.
2. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
3. Submit report in duplicate within ten (10) days of observation to Architect for review.

1.13 CONTRACT CLOSEOUT

A. Final Cleaning

1. Refer to Division 01.
2. Execute final cleaning prior to final inspection.

B. Adjusting

1. Adjust operating products and equipment to ensure smooth and unhindered operation.

C. Project Record Documents

1. Refer to Division 01.
2. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
    a. Field changes of dimension and detail.
    b. Details not on original Contract Drawings.
3. Delete Architect's title block and seal from all documents.

4. Submit documents to Architect with claim for final application for payment.

1.14 SPARE PARTS AND MAINTENANCE DATA

A. Provide products, spare parts, maintenance and materials in quantities specified in individual specification sections.

B. Deliver to project site and place in location as directed; obtain receipt prior to final payment.

1.15 WARRANTIES

A. Provide notarized copies.

B. Execute and assemble documents from Subcontractors, suppliers and manufacturers.

C. Provide table of contents and assemble in 3-D side ring binder with durable cover.

D. Submit prior to final application for payment.

E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.16 REGULATORY REQUIREMENTS

A. Conform to 2006 International Mechanical Code with Amendments, State of Illinois Plumbing Code with Amendments and NFPA 13, latest editions.

B. Obtain permits and request inspections as directed by Owner.

C. Conform to all other governing agencies and authorities.

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT

A. Refer to Division 01.

B. Products

1. Products: Means new material, machinery, components, equipment, fixtures and systems forming Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of Work. Products may also include existing materials or components required for reuse.
2. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
3. Provide interchangeable components of same manufacturer for similar components.

C. Transportation and Handling

1. Transport and handle products in accordance with manufacturer's instructions.
2. Promptly inspect shipment to assure that products comply with requirements, quantities are correct and products are undamaged.

2.2 STORAGE AND PROTECTION

A. Refer to Division 01.

B. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate-controlled enclosures.

C. For exterior storage of fabricated products, place on sloped supports above ground.

D. Provide off-site storage and protection when site does not permit on-site storage or protection.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

F. Store loose granular materials on solid flat surfaces in a well-drained area. Provide mixing with foreign matter.

G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement or damage.

H. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

2.3 PRODUCT OPTIONS

A. Refer to Division 01.

B. Products Specified by Reference Standards or by Description only: Any product meeting those standards or description.

C. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications; no options or substitutions allowed.

1. Documents have been prepared utilizing a single manufacturer as the basis of design. Contractor shall be responsible for coordinating any varying requirements (e.g. space requirements, electrical requirement) when utilizing the other acceptable manufacturers.

PART 3 - EXECUTION

3.1 SCOPE

A. Work included under Divisions 20, 21, 22, and 23 shall include all labor, services, materials, and equipment and performance of all work required for installation of mechanical, plumbing, and fire suppression systems as shown on Drawings and as herein specified in following sections.

3.2 INTERPRETATION OF CONTRACT DOCUMENTS

A. Should there be discrepancy or a question of intent, refer matter to Engineer for decision before ordering any equipment or materials or before starting any related work.

B. Drawings and Specifications are to be taken together. Work specified and not shown or work shown and not specified shall be performed or furnished as though mentioned in both Specifications and Drawings. If there is discrepancy between Drawings and Specifications as to quantity or quality to be provided, the greater quantity or better quality shall be provided.

C. Minor items and accessories or devices reasonably inferable as necessary to complete and proper installation and operation of any system shall be provided by Contractor for such system whether or not specifically called for by Specifications or Drawings.

D. Engineer may change location of any equipment 5' and any piping, ductwork, conduit, etc. 10' in any direction without extra charge, provided such changes are made before installation.

E. Locations of items not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site and shall be subject to review and approval by Architect.

F. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum headroom and space conditions at all points.

1. Where headroom or space conditions appear inadequate, notify Architect or Owner's field representative before proceeding with installation.
2. Duct and pipe rerouting and duct size changes shall be made at no additional cost to the Owner.

G. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit installation of other work without delay.

H. Where there is evidence that parts of the Work specified in Divisions 20 and 23 will interfere with other work, assist in working out space conditions to make satisfactory adjustments, revise and submit coordinated shop drawings.

I. After review and without additional cost to the Owner, make minor modifications in the work as required by structural interferences, by interferences with work of other sections or for proper execution of the work.

J. Work installed before coordinating with other work so as to cause interference with other work shall be changed and corrected without additional cost to the Owner.

K. Drawings are diagrammatic in nature and are a graphic representation of requirements and shall be followed as closely as actual building construction will permit. All changes from the plans necessary to make the work conform to the building as constructed and to fit the work of other trades or to conform to rules of the Governmental Authorities having jurisdiction, NFPA, OSHA and the Owner's Insurance Underwriters, shall be made by the Contractor without extra cost to the Owner.

L. The layout of the piping, ductwork, equipment, etc., as shown on the drawings shall be checked and exact locations shall be determined by the dimensions of the equipment approved and the Contractor shall obtain approval for the revised layout before the apparatus is installed. The Contractor shall field measure or consult existing record Architectural and Structural Drawings if available for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc.

M. Omission in the Drawings and/or Specifications of any items necessary for the proper completion or operation of the work outlined in this specification shall not relieve the Contractor from furnishing same without additional cost to the Owner.

N. The Equipment Shop Drawings will be furnished to the Contractor before roughing-in. Contractor shall not install any piping or ductwork for said equipment until he has received approved shop drawings for same.

3.3 PROJECT/SITE CONDITIONS

A. Each Contractor shall visit the site prior to bid submission to determine all existing conditions that may affect his work and shall make appropriate allowances for such conditions in his bid. Failure to visit the site shall not be cause for a request for additional compensation later in the project during construction.

B. Install Work in locations shown on Drawings, unless prevented by Project conditions.

C. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Owner before proceeding.

3.4 ALTERATIONS IN PRESENT BUILDING AND SYSTEMS

A. Contractor shall take particular note of the revisions and alterations to the existing systems, facilities and equipment due to the new construction as indicated on the Drawings and/or in Specification. Contractor shall remove, reroute or alter all services, ductwork, etc., as required or as indicated on the drawings.

1. The Contractor shall maintain all services in the existing building. In case, where new service connections are to be made to existing services and service interruptions can in no way be avoided, the service interruptions shall be with the minimum of inconvenience to the Owner and the work shall be done at such time of any day, Saturday and Sunday included, and only as directed by the Owner or the Architect.

3.5 ERECTION & WORKMANSHIP

A. Contractor is to be responsible for all work fitting into place in satisfactory, neat and workmanlike manner in every particular, to approval of Engineer.

B. Unless explicitly stated to contrary, each Contractor shall furnish and install each item of equipment or material hereinafter specified, complete with all necessary fittings, supports, trim, piping, insulation, etc., as required for complete and operating installation.

C. Equipment and materials shall be installed according to manufacturer's instruction unless otherwise specifically directed by Contract Documents.

D. Contractor shall provide all necessary OSHA approved rigging, scaffolding, tools, tackle, labor, etc., necessary for the complete installation of the equipment.

E. Contractor shall adapt his work to job conditions and make such changes as required and permitted by the Architect such as moving his work to clear beams, joints, light fixtures, etc., adjusting risers, etc. avoiding interferences with windows and openings, etc. raising or lowering his work to permit the passing of ductwork or the work of other trades, etc., all as required or as job conditions dictate, without any additional costs to the Owner.

F. All appliances and equipment shall be installed and connected with best engineering practices and in accordance with the manufacturer's best instructions and recommendations.

G. Work done by Contractor at the site in the execution of this Project shall be performed only by skilled mechanics, recognized as such in their respective trades in the direct employ either of the Contractor proper or of affiliate firms which have a longstanding and continuing formal agreement with the Contractor for providing the rendered services on similar work of this type.

3.6 PROTECTION FROM INJURY

A. All pipes, fixtures, traps, equipment, and other parts of the Work shall be protected against injury by freezing or exposure to the weather during construction while stored or installed in place.

3.7 MECHANICAL AND ELECTRICAL WORK COORDINATION

A. Refer to Division 01.

B. Provide coordination for type of mechanical and electrical work required for this project for duration of work.

C. Submittals

1. Coordinate mechanical and electrical work of Divisions 20, 23, and 26 with work of each other and of other Divisions.
2. Coordinate progress schedules, including dates for submittals and for delivery of products.
3. Coordinate location and verify size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, fire sprinkler heads, fire hose cabinets, etc., in progress of the Work. Architectural Drawings shall take precedence over Mechanical and Electrical Drawings.
4. Participate in progress meetings. Report on progress of work to be adjusted under coordination requirements and any required changes in schedules. Transmit minutes of meetings and reports to concerned parties.

D. Coordination of Submittals

1. Review shop drawings, product data, and sample for compliance with Contract Documents and for coordination among work of all sections of Project Manual. Transmit to Architect.
2. Check field dimensions and clearances and relationship to available space and anchors.
3. Check compatibility with equipment and work of other sections, electrical characteristics and operational control requirements.
4. Check motor voltages and control characteristics.
5. Coordinate controls, interlocks, wiring of pneumatic switches and relays.
6. Coordinate wiring and control diagrams.
7. Review effect of any changes on work of other sections.
8. Verify and coordinate maintenance of Record Documents.

E. Coordination of Substitutions and Modifications

1. Review proposals and requests from subcontractors.
2. Verify compliance with Contract Documents and for compatibility with work and products of other sections.
3. Submit to Architect with recommendation for action.

F. Observation of Work

1. Observe work for compliance with Contract Documents.
2. Maintain list of observed deficiencies and defects; promptly submit to Architect.

G. Documentation

1. Observe and maintain a record of tests. Record:
    a. Specification section number, product, and name of subcontractor
    b. Name of testing agency and name of inspector
    c. Name of manufacturer's representative present
    d. Date, time, and duration of tests
    e. Type of test, and results
    f. Retesting required
2. Assemble background documentation for dispute and claim settlement by Architect.
3. Submit copies of documentation to Architect upon request.

H. Equipment Start-Up

1. Verify utilities, connections and controls are complete and equipment is in operable condition.
2. Observe start-up and adjustments; record time and date of start-up and results.
3. Observe equipment demonstrations to Owner; record times and additional information required for Operation and Maintenance Manuals.

I. Inspection and Acceptance of Equipment

1. Prior to inspection, verify that equipment is tested and operational, and clean.
2. Assist Architect with inspection. Prepare list of items to be completed and corrected.

3.8 CUTTING AND PATCHING

A. Refer to Division 01.

B. Submit written request in advance of cutting or alteration which affects:

1. Structural integrity of any element of Project
2. Integrity of weather-exposed or moisture-resistant element
3. Efficiency, maintenance, or safety of any operational element
4. Visual qualities of sight-exposed elements
5. Work of Owner or separate contractor

C. Include in request:

1. Effect on work of Owner or separate contractor
2. Written permission of affected separate contractor
3. All items requested in Division 01

D. Examination

1. Inspect existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.
2. After uncovering existing work, inspect conditions affecting performance of work.

3. Beginning of cutting or patching means acceptance of existing conditions.

E. Preparation

1. Provide temporary supports to ensure structural integrity of the Work. Provide devices and methods to protect other portions of Project from damage.
2. Provide protection from elements for areas which may be exposed by uncovering work.
3. Maintain excavations free of water.

F. Cutting and Patching

1. Execute cutting, fitting, and patching including excavation and fill to complete work.
2. Fit products together to integrate with other work.
3. Uncover work to install ill-timed work.
4. Remove and replace defective or non-conforming work.
5. Remove samples of installed work for testing when requested.
6. Provide openings in work for penetration of mechanical and electrical work.

G. Performance

1. Execute work by methods to avoid damage to other Work, and which will provide appropriate surfaces to receive patching and finishing.
2. Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
3. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
4. Restore work with new products in accordance with requirements of Contract Documents.
5. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
6. At penetrations of fire-rated walls, partitions, ceiling, or floor construction, completely seal voids with fire-rated fire resistant material to full thickness of the penetrated element.
7. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

3.9 ACCESS PANELS

A. Where control valves, shut-off valves, drip traps, heating coils, dampers, pull boxes or other specialties, which require service or adjustment, are installed above inaccessible type furred ceilings or within furred walls, Contractor whose equipment is involved shall furnish and install access panels as required.

B. Access panels shall be of sufficient size to make possible servicing, adjustment, removal and replacement of concealed equipment through opening provided. Panels shall be sized as shown on drawings, or if sizes are not shown, shall be minimum of 16” x 24” in walls and 24” x 24” in ceilings.

C. Contractor shall confer with other trades with respect to access panel locations, and shall wherever practical group valves, traps, dampers, etc. in such way as to be accessible from single panel and eliminate as many access panels as possible.

D. Submit shop drawings for review before ordering panels. Where fire rating is required, furnish label doors compatible with fire rating of assembly.

3.10 SOUND CONTROL

A. Mechanical penetrations into shall be maintained airtight to prevent sound transfer.

B. Conduits shall be grouted or sealed tightly in place.

C. Piping, ductwork, etc. shall pass through sleeves. Pack sleeves tight with glass fiber or oakum and caulked on both sides with non-hardening acoustical sealant.

3.11 FIRE RATED PENETRATIONS

A. Sleeves for pipes and ducts through fire rated and fire resistive floors and walls shall be constructed of materials classified by UL to provide fire stopping equal to time rating of construction being penetrated. Use asbestos free materials that comply with applicable codes and have been tested under positive pressure in accordance with UL 1479 or ASTM E 814.

B. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.

C. Seal holes or voids made be penetrations to ensure an effective smoke barrier.

D. Where floor openings without penetrating items are more than 4" in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.

E. Protect materials from damage on surfaces subject to traffic.

F. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

G. Keep areas of work accessible until inspection by applicable code authorities.

H. Perform under this section patching and repairing of fire stopping caused by cutting or penetration by other trades.

I. Clean up spills of liquid components.

J. Neatly cut and trim materials as required.

K. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.12 PROTECTION OF ELECTRICAL EQUIPMENT

A. Contractor shall furnish and install sheet metal drain pans beneath piping that is routed above electrical equipment and/or above the 3' access space in front of such equipment. Electrical equipment, for the purpose of addressing drain pan requirements, shall be defined as free-standing or wall-mounted switchgear, transformers, distribution boards or motor control centers. Piping includes, but is not limited to, plumbing, fire suppression, mains (not branch piping with sprinkler heads), hydronic heating or cooling, steam and condensate, and fuel systems.

1. Drain pans shall be 20 gauge galvanized sheet metal with a minimum 4" high turned up edge. Bottom of drain pan shall slope to a single drainage point at ⅛" per foot. A 1" diameter clear plastic tube shall allow collected fluid to drain to the nearest open site floor drain. Secure plastic tubing to building structure only.

2. Drain pan shall be hung from building structure with angle iron trapeze hangers (no hanger shall penetrate the drain pan). Consider drain pan to be full of water for hanger load calculations.
3. Drain pans shall include liquid detectors with alarms only if noted on the drawings.

B. Provide sprinkler heads beneath drain pan only as required by NFPA.

C. Contractor shall include provisions to adjust the local lighting layout, at no extra cost to Owner, in order to accommodate any detrimental effect the drain pan has on the illumination of the electrical equipment and access space.

3.13 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Architect and Owner seven days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence or other conditions which may cause damage.

D. Verify that tests, meter readings and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of responsible manufacturer's representative or Contractors' personnel in accordance with manufacturers' instructions.

G. When specified in individual specification sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up and to supervise placing equipment or system in operation.

H. Submit a written report in accordance with paragraph 1.12 previously specified that equipment or system has been properly installed and is functioning correctly.

3.14 TESTING, ADJUSTING AND BALANCING

A. Contractor shall appoint, employ and pay for services of independent firm to perform testing, adjusting and balancing.

B. Independent firm will perform services specified in Division 01 and Division 23 Section 23 0593, "Testing, Adjusting, and Balancing for HVAC."

C. Reports will be submitted by independent firm to Architect indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with requirements of Contract Documents.

3.15 REMODELING PROJECT PROCEDURES

A. Refer to Division 01.

B. Demolition

1. Contractor shall remove existing equipment and materials pertaining to his contract as specified or as required, whether shown on Drawings or not, to prepare for new work of all contracts.
2. Where necessary, reroute piping, ducts, conduits, wiring, etc. from within walls, floors, ceilings, etc. being removed. Contractor involved with

interrupted service shall be responsible for accomplishing required work whether shown on Drawings or not.

3. Cap all abandoned or terminated piping, conduit, etc. below floor, behind wall surface, above ceiling, etc. as required to be completely concealed after new work is complete.
4. In general, mechanical remodeling work is shown on Mechanical Drawings but carefully study all drawings for all contracts for "demolition" and "remodeling" work in existing building and field check to verify locations where such work is being done to determine exact extent of work required. No extra will be allowed for additional work required because of demolition or remodeling whether or not work is specifically noted, itemized or shown on Drawings.
5. Contractor shall cap or plug all pipes, valves, fittings, etc. left open after demolition if they are not to be reused.

3.16 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

B. Sufficient flushing water shall be introduced into the mains to produce a velocity of not less than 4' per second and this flow rate shall be continued until the discharge is clean and clear and does not show evidences of silt or foreign matter when a sample is visually inspected.

C. Inspect pressure piping in accordance with procedures of ASME B31.

3.17 PIPING TESTS

A. Test pressure piping in accordance with ASME B31.

B. General: Provide temporary equipment for testing, including pump and gauges. Test piping systems before insulation is installed wherever feasible and remove control devices before testing. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

1. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
2. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

C. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.

D. Drain test water from piping systems after testing and repair work has been completed.

END OF SECTION

SECTION 20 0501
MINOR MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Minor demolition specifically applicable to Divisions 20 and 23.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Refer to General Conditions and Division 01.

B. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements, equipment location, piping and ductwork sizes and arrangements as shown on Drawings.

B. Verify that abandoned piping, ductwork and equipment serve only abandoned facilities.

3.2 PREPARATION

A. Disconnect mechanical systems in walls, floors and ceilings scheduled for removal.

B. Coordinate utility service shut-downs with Utility Companies.

C. Provide temporary connections to maintain existing systems in service during construction.

D. Existing Mechanical Systems: Obtain permission from Owner at least 72 hours before partially or completely disabling any system.

3.3 DEMOLITION AND EXTENSION OF EXISTING SYSTEMS

A. Demolish and extend existing work under provisions of General Conditions, and Division 01.

B. In general, mechanical, plumbing, and electrical remodeling work is shown on Drawings but carefully study all drawings for all contracts for “demolition” and “remodeling” work in existing building and field check to verify locations where such work is being done to determine exact extent of work required. No extra will be allowed for additional work required because of demolition or remodeling whether or not work is specifically noted, itemized or shown on Drawings.

C. Remove existing equipment and materials pertaining to contract as specified or as required, whether shown on Drawings or not, to prepare for new work of all contracts.

D. Where necessary, reroute piping, ducts, etc. from within walls, floors, ceilings, etc. being removed. Contractor involved with interrupted service shall be responsible for accomplishing required work whether shown on Drawings or not.

E. Cap all abandoned or terminated piping, etc. below floor, behind wall surface, above ceiling, etc., as required to be completely concealed after new work is complete.

F. Cap or plug all pipes, valves, fittings, etc. left open after demolition if they are not to be reused.

G. Maintain access to existing mechanical installations which remain active. Modify installation or provide access panel as appropriate.

H. Extend existing installations using materials and methods compatible with existing mechanical installations, or as specified.

3.4 DISPOSITION OF REMOVED EQUIPMENT

A. Where existing materials or equipment are specified to be removed from service, respective Contractor shall take possession of same, coordinate with Owner where items are to be stored or remove unwanted items from site promptly, except as specified below or unless otherwise noted on Drawings.

B. All salvageable material and equipment, including but not necessarily limited to plumbing fixtures, heating units, air conditioning units, piping, valves, etc., shall be removed and maintained in as good condition as possible and turned over to Owner. However, if Owner decides any such materials are of no value to him, then they shall become property of Contractor who shall remove such discarded work from premises and dispose of same.

C. Existing equipment or systems, etc. which are specified to be replaced by new equipment, or system etc. shall not be removed from service until the new equipment, materials, systems, etc. have actually arrived at project site.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 01.

3.6 CLEANING AND REPAIR

A. Refer to General Conditions and Division 01.

B. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION

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SECTION 20 0519
METERS AND GAUGES FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Meters and gauges specifically applicable to Divisions 20 and 23, including:

1. Thermometers for piping
2. Pressure gauges for piping
3. Test plugs for piping

1.2 CODES AND STANDARDS (USE LATEST EDITION)

A. American Society of Mechanical Engineers (ASME)

1. ASME B40.100 – Pressure Gauges and Gauge Attachments
2. ASME B40.200 – Thermometers, Direct Reading and Remote Reading
3. ASME B40.3 – Bimetallic Actuated Thermometers

1.3 SUBMITTALS

A. Product Data: For each type of product indicated provide manufacturer's literature.

B. Shop Drawings: Schedule for instrumentation indicating manufacturer's number, scale range, and location for each.

C. Operations and Maintenance Data: Submit under provisions of Division 01. Accurately record location of all instrumentation.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS FOR PIPING

A. Acceptable Manufacturers

1. Ashcroft Inc.
2. H.O. Trerice Company
3. Miljoco Corporation
4. Weiss Instruments, Inc.

B. Direct reading liquid-in-glass thermometer complying with ASME B40.200

1. Case: Die-cast aluminum, 7" long
2. Tube: Blue colored spirit (organic) filled, lens front
3. Tube Background: Aluminum white with permanently etched scale calibration in degrees Fahrenheit
4. Window: Clear acrylic or glass; provide glass for steam and condensate applications
5. Connector: Adjustable angle joint with positive locking device
6. Stem: Brass of length to suit installation
7. Accuracy: ±1% scale division
8. Thermowells: Brass, pressure-tight, socket-type fitting made for insertion into piping and of type, diameter, and length required to hold thermometer clear of any pipe insulation.
9. Basis of Design: H.O. Trerice Company Model AX9-2

2.2 PRESSURE GAUGES FOR PIPING

A. Acceptable Manufacturers

1. Ashcroft Inc.
2. H.O. Trerice Co.
3. Miljoco Corporation
4. Weiss Instruments, Inc.

B. Dial type pressure gauge complying with ASME B40.100

1. Case: 4½" diameter black aluminum
2. Pressure Element Assembly: Bronze bourdon tube
3. Pressure Connection: Brass socket
4. Movement: Rotary stainless steel
5. Dial: Aluminum with permanently etched black scale calibrated in psi on white background
6. Window: Clear glass
7. Accuracy: ±0.5% percent of full scale
8. Basis of Design: H.O. Trerice Company Model 500XB

C. Pressure Gauge Accessories

1. Valves
   a. ¼ NPT brass needle valve for a maximum pressure of 2,000 psig
   b. Basis of Design: H.O. Trerice Company Series 735
2. Impulse Dampeners
   a. Brass with ¼ NPT connection
   b. Basis of Design: H.O. Trerice Company Series 870
3. Coil Syphons
   a. Seamless brass, schedule 40, ¼ NPT connections
   b. H.O. Trerice Company Series 885

2.3 TEST PLUGS FOR PIPING

A. Acceptable Manufacturers

1. Petersen Products Co.
2. Sisco Manufacturing Company, Inc.
3. H.O. Trerice Company
4. Watts Water Technologies

B. Test Plug (for insulated pipe)

1. ¼" by 3" long brass fitting for receiving ⅛" outside diameter pressure or temperature probe
   a. Core Inserts: Two self-sealing rubber valve cores with a color coded cap strap with gasket
      (1) Neoprene (maximum 200°F) at 500 psi
      (2) Nordel (maximum 275°F) at 500 psi
   b. Minimum Pressure and Temperature Rating: 1,000 psi at 140°F
   c. Basis of Design: Model 100XL (neoprene core) or Model 110XL (Nordel core) manufactured by Petersen Products Co.

C. Test Kit: Furnish one test kit containing one 0-100 psig range pressure gauge, two gauge adapters with 1/8" probes, one 25°F to 125°F low range thermometer, one 0°F to 220°F high range thermometer, and one internally padded and fitted carrying case. Model 1500XL manufactured by Petersen Products Co.

2.4 HYDRONIC INDICATION SYSTEM (COMPOUND PRESSURE GAUGE AND TRUMPET VALVE)

A. Acceptable Manufacturers

1. Flow Conditioning Corp.

B. Hydronic indication systems shall consist of hydronic indicator (compound gauge) and four-port trumpet valve model TV-4 by Flow Conditioning Corp.

1. Hydronic indicator shall have 1% accuracy. Steel case shall be 4-1/2", stem mounted with screwed ring and crystal. Indicator shall have re-calibrator, compound scale calibrated in psi and feet from full vacuum to selected pressure and quick set dial for pressure comparison. Maximum indicator pressure shall exceed pump working pressure by minimum 50 psi.
2. Trumpet valve shall have spring return push button manifold of rugged brass construction with ports for connection to system at indicated points and with test connection for gauge calibration.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Pressure Gauges

1. Provide pressure gauges in locations indicated on drawings with a scale range of those shown below such that the range is between 1½ and 2 times two times the operating pressure of the system.

a. 0-15 psi
b. 0-30 psi
c. 0-60 psi
d. 0-100 psi

B. Thermometers

C. Install liquid-in-glass thermometers in all chilled water, hot water, condenser water, steam and condensate piping applications in locations shown on drawings and with ranges as shown in the following table:

System	Range (degrees F)
Chilled water	0°F to 100°F with 1°F scale divisions

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install gauges and thermometers in locations where they are easily read from normal operating level.

C. Thermometers for Pipes

1. Install direct-mounting thermometers and adjust vertical and tilted positions.

2. Install thermometers in piping systems in thermowells with socket extending to center of pipe or a minimum of 2″ into fluid for piping less than 4″. Enlarge pipes smaller than 2½″ for installation of thermowells.

D. Pressure Gauges for Pipes

1. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.
2. Provide needle valve and impulse dampener for each pressure gauge installed in pipe carrying all fluids except steam.

E. Install test plugs in tees in piping where indicated.

F. Hydronic Indication System for Pumps

1. Install hydronic indication system on pumps as indicated on drawings.
2. Hydronic indication system shall be reliably and permanently attached to piping with heavy bracket at convenient height. Connect the system to the following ports:
    a. Upstream of strainer/suction diffuser
    b. Downstream of strainer/suction diffuser (pump inlet).
    c. Pump discharge
    d. Downstream of discharge isolation valve

END OF SECTION

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SECTION 20 0529
HANGERS AND SUPPORTS FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Hangers and supports specifically applicable to Divisions 20, 21, 22, and 23, including:

1. Multiple Pipe Supports
2. Roof Supports
3. Miscellaneous materials

1.2 CODES AND STANDARDS

A. American Society of Mechanical Engineers (ASME)

1. ASME B31.1 - Power Piping
2. ASME B31.5 - Refrigeration Piping
3. ASME B31.9 - Building Services Piping

B. American Society for Testing and Materials (ASTM)

1. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability *(Formerly ASTM A570)*
2. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A36 - Steel Plates, Shapes and Bars
4. ASTM A653 - Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process
5. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
6. ASTM C150 - Portland Cement
7. ASTM C404 - Uniformly Graded Natural Sand
8. ASTM E-814 - Fire Tests of Through-Penetration Fire Stops

C. American Welding Society (AWS)

1. Specifications for Qualification of Welding Procedures and Welders

D. American Water Works Association (AWWA)

E. Building Officials and Code Administrators International (BOCAI)

1. BOCA - National Building Code
2. BOCA - National Mechanical Code

F. International Conference of Building Officials (ICBO)

1. ICBO - Uniform Building Code

G. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices

H. National Fire Protection Association (NFPA)

1. NFPA 13 - Standard for the Installation of Sprinkler Systems
2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems
3. NFPA 101 - Code for Safety to Life from Fires in Buildings and Structures

I. Southern Building Code Congress International (SBCCI)

1. SBCCI - Standard Building Code

J. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA - HVAC Duct Construction Standards, Metal and Flexible

K. UL

1. UL 1479 - Fire Tests of Through Penetration Firestops and Building Joint Systems

L. Factory Mutual (FM)

1.3 QUALITY ASSURANCE

A. Supports for Mechanical and Plumbing Piping: Provide products in compliance with MSS Standards:

1. Provide pipe hangers and supports of which materials, design and manufacture comply with MSS SP-58.
2. Select and apply pipe hangers and supports, complying with MSS SP-69.
3. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
4. Terminology used in this section is defined in MSS SP-90.

B. Supports for Sprinkler Piping: Provide products which are UL listed and FM approved and in conformance with NFPA 13.

C. Supports for Standpipes: Provide products which are UL listed and FM approved and in conformance with NFPA 14.

D. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.4 SUBMITTALS

A. Product Data: Submit product data on all hanger and support devices, including shields and attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

B. Shop Drawings: Show fabrication and installation details and include Product Data for components:

1. Metal framing systems
2. Pipe stands

1.5 DELIVERY, STORAGE AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Acceptable Manufacturers

1. B-Line Systems, Inc.
2. Fee and Mason Manufacturing Company
3. Anvil International

B. Construction

1. General Service

a. Exterior insulated pipe: Carbon steel with hot-dip galvanized finish after fabrication

C. Piping system classification

1. Type C-1 Cold Systems (33°F - 59°F)

a. Chilled Water

D. Pipe supports shall be provided as indicated the table below.

Pipe Hanger and Support MSS Types									
Class		C-1				C-2			
Pipe Size		≤ 2″		> 2″		≤ 2″		> 2″	
Insulation[1]		Yes	No	Yes	No	Yes	No	Yes	No
Horizontal Pipe Attachments	Steel Clips	26 w/40	24 & 26	26 w/ 40	24 & 26	N/A	N/A	N/A	N/A
	Malleable Iron Rings	N/A	6, 11, & 12	N/A	6, 11, & 12	N/A	N/A	N/A	N/A
	Steel Bands	1 w/ 40	1	1 w/ 40	1	1 w/ 40	1	1 w/ 40	1
	Steel Clamps	3 & 4	3 & 4 w/ 40	3 & 4	3 & 4 w/ 40	N/A	3 & 4	N/A	3 & 4
	Cast Iron Hanging Rolls	N/A	N/A	41 & 43	41 & 43	N/A	N/A	41 & 43	41 & 43
	Cast Iron Supporting Rolls	N/A	N/A	44, 45, & 46 w/ 39	44, 45, & 46	N/A	N/A	44, 45, & 46 w/ 39	44, 45, & 46
	Steel Trapezes	59 w/ 40	N/A	59 w/ 40	N/A	N/A	N/A	N/A	N/A
	Steel Protection Saddles and Shields	40	N/A	40	N/A	40	N/A	40	N/A
	Steel or Cast Iron Stanchions	36, 37, & 38 w/ 40	36, 37, & 38	36, 37, & 38 w/ 40	36, 37, 38	36, 37, & 38 w/ 40	36, 37, 38	36, 37, & 38 w/ 40	36, 37, 38
	Steel Welded Attachments	(2)		(2)		(2)		(2)	

(1) *Hangers on insulated systems shall incorporate protection saddles or shields or shall be clamped or welded to the pipe and project through the insulation to provide external attachment.*

(2) *The design shall be in accordance with MSS SP-58.*

Pipe Hanger and Support MSS Types – Part 3						
Class			A-1	B	C-1	C-2
Vertical Pipe Attachments		Steel Riser Clamps (2 Bolt)	8	8	8	8
		Steel Riser Clamps (4 Bolt)(1)	42	42	42	42
Hanger Rod Fixtures	Steel or Malleable Iron	Turn Buckles	13 & 15	13 & 15	13 & 15	13 & 15
		Swing Eyes	16 & 17	16 & 17	16 & 17	16 & 17
		Clevises	14	14	14	14
Building Structure Attachments	Steel and/or Malleable Iron	Inserts(2)	18	18	18	18
		C-Clamps(3)	19 & 23	19 & 23	19 & 23	19 & 23
		Beam Clamps(4)	20, 21, 25, 27, 28, 29, & 30	20, 21, 25, 27, 28, 29, & 30	20, 21, 25, 27, 28, 29, & 30	20, 21, 25, 27, 28, 29, & 30
		Welded Attachments(1)	22, 57, & 58	22, 57, & 58	22, 57, & 58	22, 57, & 58
		Brackets	31, 32, 33, & 34	31, 32, 33, & 34	31, 32, 33, & 34	31, 32, 33, & 34

(1) *The design shall be in accordance with MSS SP-58.*
(2) *Refer to 2.7 – Upper Attachments for approved inserts.*
(3) *All C-Clamps shall be provided with a retaining strap held securely to the clamp with a hex nut of locking slot. C-Clamps shall not be used with bar joist structure.*
(4) *Clamps for direct attachment to bar joist structure shall be MSS Type 21 center beam clamp located at the plates along the bottom or top chord of the joist.*

2.2 MULTIPLE PIPE SUPPORT SYSTEMS

A. Acceptable Manufacturers

1. Cooper B-Line
2. Anvil International
3. Unistrut Corporation

B. Multiple Pipe Supports: Pipe supporting elements mounted to cold formed 12 gauge strip steel channel framing with thermoset acrylic finish. Provide specified pipe supporting elements to keep pipe in alignment and allow for expansion. Provide all channel nuts and accessories required to mount pipe supporting elements. Model P1000 by Unistrut.

C. Provide tubing clamps at each pipe support. Provide cushion inserts for uninsulated tubing.

D. Select hanger rods for two times the trapeze loads but not less than 3/8" diameter.

E. Secure hanger rod with square washers and locking nuts on top and bottom of strut.

2.3 ROOF SUPPORTS

A. Permanent pipe support

1. Acceptable Manufacturers:
    a. Pate PRS/MPRS
2. Factory fabricated 18 gauge galvanized sheet steel support curb with fully welded corner seams, and 18 gauge galvanized steel counterflashing with galvanized steel channel track attached.
3. Vertical and horizontal adjustable roller assembly of galvanized steel channel track, galvanized steel fittings, washers and nuts and a painted cast iron roller.
4. Support shall be designed to be compatible with roofing system and roofing pitch.
5. Fixed Height Roller
    a. UV resistant rubber base with fixed height electroplated cast iron MSS type 44 pipe roll. Cooper B-Line DBR.
6. Adjustable Height Channel
    a. Roof support: UV resistant rubber base with two ½" galvanized steel threaded rod risers and one 12 gauge galvanized steel horizontal channel support. Cooper B-Line DBE.
    b. Pipe support: Electroplated cast iron MSS type 44 pipe roll
7. Fixed Height Channel
    a. Roof support: UV resistant rubber base with fixed height 12 gauge galvanized steel horizontal channel support. Cooper B-Line DB6.
    b. Pipe support: Electroplated cast iron MSS type 44 pipe roll

2.4 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 PIPE HANGERS AND SUPPORTS

A. Hanger and Support Installation

1. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
2. Pipe Stand Installation:

a. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

3. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
4. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
5. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
6. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

B. Hanger and Support Spacing

1. Pipe shall be adequately supported by pipe hanger and supports specified in Part 3. Hangers for insulated pipes shall be sized to accommodate insulation thickness.
2. Horizontal steel piping shall be supported in accordance with MSS SP-69 Tables 3, 4, and 5, excerpts of which follow below:

Maximum Horizontal Pipe Hanger and Support Spacing Without MSS Type 40 Shields (feet)									
Nominal Pipe or Tube Size	Standard Weight Steel Pipe		Copper Tube		Fire Protection	Ductile Iron Pipe	Cast Iron Soil	Glass	Plastic
	Water Service	Vapor Service	Water Service	Vapor Service					
1/4	7	8	5	5	Follow requirements of the NFPA.	20 feet maximum spacing; minimum of one hanger per pipe section close to the joint behind the bell and at change of direction and branch connections. For pipe sizes six inches and under subjected to loadings other than weight of pipe and contents, the span shall be limited to the maximum spacing for water service steel pipe.	10 feet maximum spacing; minimum of one hanger per pipe section close to joint on the barrel and at change of direction and branch connections.	8 feet maximum spacing, follow manufacturer's recommendations.	Follow pipe manufacturer's recommendations for material and service condition.
3/8 – 1/2	7	8	5	6					
3/4	7	9	5	7					
1	7	9	6	8					
1-1/4	7	9	7	9					
1-1/2	9	12	8	10					
2	10	13	8	11					
2-1/2	11	14	9	13					
3	12	15	10	14					
4	14	17	12	16					
5	16	19	13	18					
6	17	21	14	20					
8	19	24	16	23					
10	22	26	18	25					
12	23	30	19	28					
14	25	32							
16	27	35							
18	28	37							
20	30	39							
24	32	42							
30	33	44							

Maximum Horizontal Pipe Hanger, Support, and Shield Spacing With MSS Type 40 Shields (ft)			
Standard Weight Steel Pipe			
Nominal Pipe Size	Shield Length (inches)	Shield Thickness (gage)	Hanger and Support Spacing (feet)
1/2 - 1-1/4	12	18	7
1-1/2	12	18	9
2 - 3	12	18	10
4	12	16	10
5 - 6	18	16	10
8 - 14	24	14	10
16 - 24	24	12	10
Copper Tubing			
Nominal Pipe Size	Shield Length (inches)	Shield Thickness (gage)	Hanger and Support Spacing (feet)
1/4 – 3/4	12	18	5
1	12	18	6
1-1/4	12	18	7
1-1/2 - 2	12	18	8
2-1/2	12	18	9
3	12	18	10
4	12	16	10
5 - 6	18	16	10
8	24	14	10

3.2 ROOF SUPPORTS

A. Verify that roofing system is complete and roof surfaces are smooth, flat, and ready to receive work of this section.

B. Clean surfaces of roof in areas to received supports.

C. Install in accordance with manufacturer's instructions.

D. Pipe and Duct Supports

1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping and ducts whether or not all required devices are shown.
2. The use of wood for supporting piping is not permitted.
3. Provide supports spaced so deflection of piping does not exceed L/240 of span.
4. Install framing at spacing indicated, but in no case at greater than 10 feet (3 m) on center.

3.3 METAL FABRICATIONS

A. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

B. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1½".

C. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

3.5 PAINTING

Not Applicable

END OF SECTION

P:\22 PROJECTS\P22-1352-00MCHENRY\04 DESIGN\07 SPECS\20 0529 HANGERS AND SUPPORTS FOR M-P-FP.DOCX

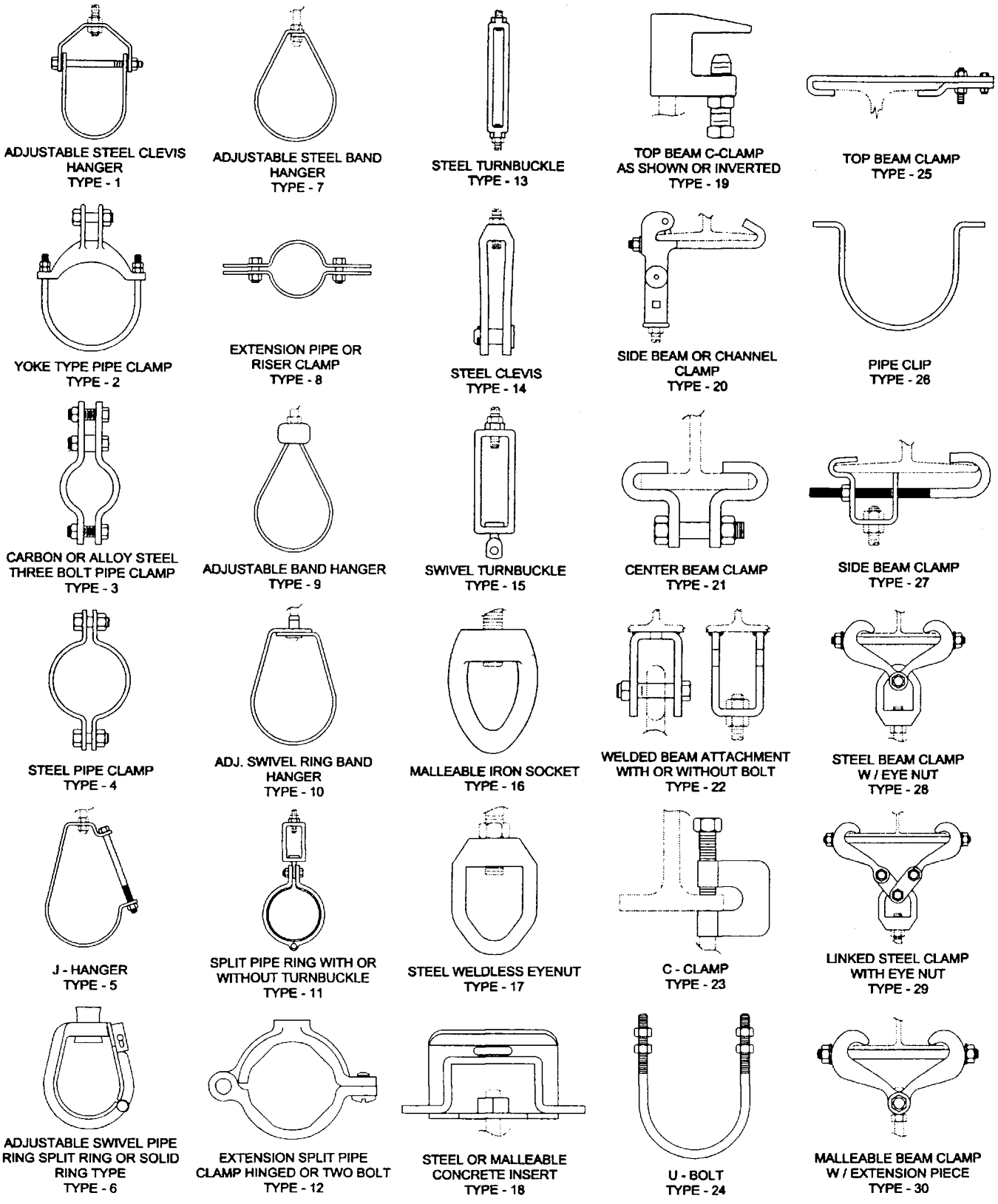

FIGURE 1. TYPE CHART

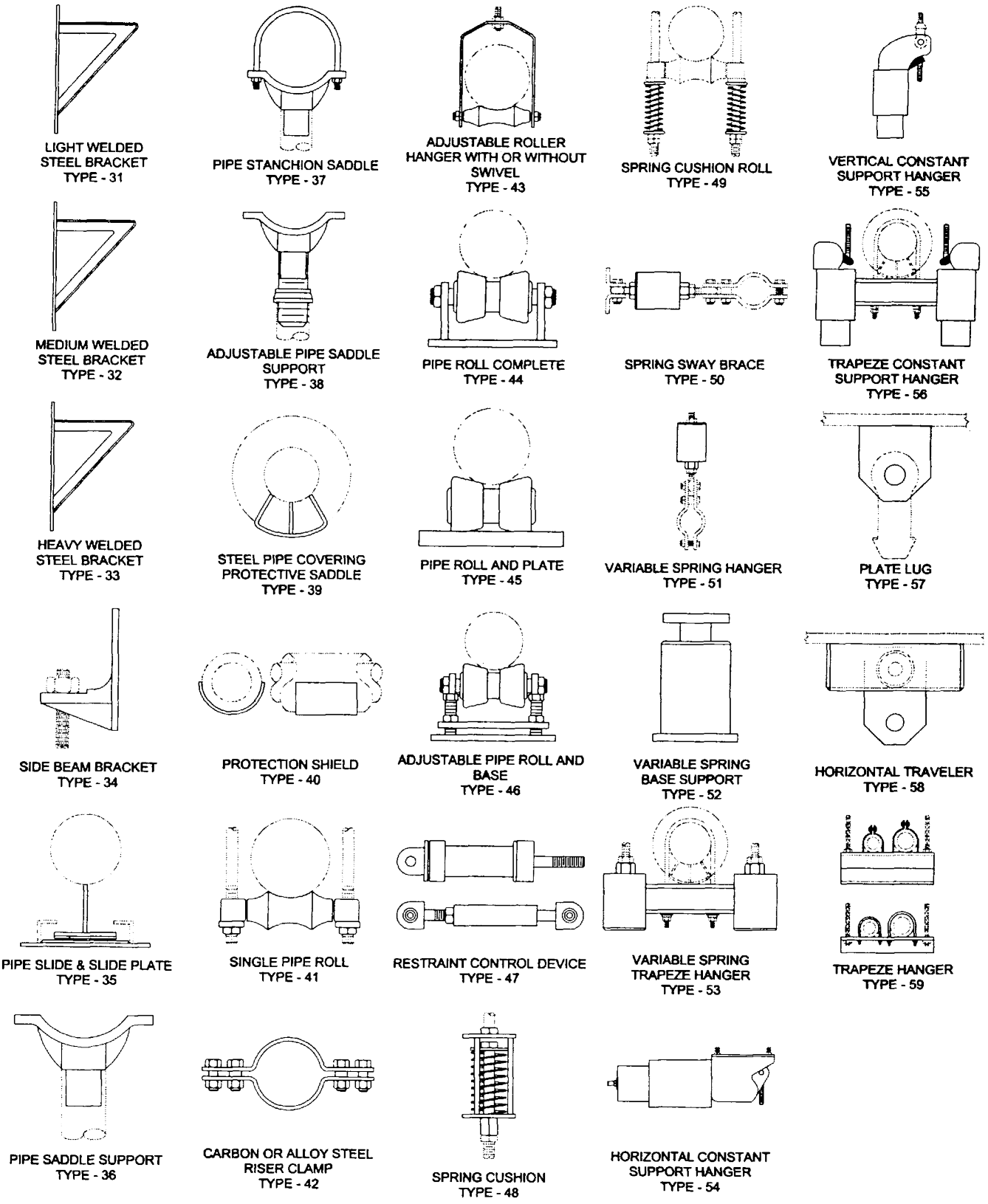

FIGURE 1. TYPE CHART

SECTION 20 0700
THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Thermal insulation products specifically applicable to Divisions 20 and 23, including:

1. Insulation
2. Protective coverings
3. Accessories
4. Repairs to all existing insulation cut or damaged by work performed under this Contract.

B. Products furnished but not installed under this section: None.

C. Products installed but not furnished under this section: None.

D. Services provided:

1. Design - None.
2. Training - None.
3. Obtain permits - None.

1.2 DEFINITIONS

A. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.

B. Ductwork Insulation: Thermal insulation applied to prevent heat transmission to or from a duct system.

C. Equipment Insulation: Thermal insulation applied to prevent heat transmission to or from a piece of equipment that is part of a plumbing, heating or cooling system.

D. Jacket: Protective covering over insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, polyvinyl chloride (PVC), aluminum or stainless steel.

E. Vapor Retarder Jacket: Insulation jacket material which impedes the transmission of water vapor.

F. Insert: Spacer placed between the equipment support system and the equipment to allow for the space required for insulation.

G. Insulation Shield: Buffer material placed between the equipment support system and the insulation to prevent the insulation material from crushing.

1.3 CODES AND STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate).

3. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
8. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation.
9. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
10. ASTM C553 - Mineral Fiber Blanket and Felt Insulation (Industrial Type).
11. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
12. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
13. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
14. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
15. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
16. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
17. Midwest Insulation Contractors Association (MICA) - Commercial and Industrial Insulation Standards.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE Standard 90.1-1989 Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings.

C. National Fire Protection Association (NFPA)

1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
2. NFPA-90A - Installation of Air Conditioning and Ventilation Systems.
3. NFPA-90B - Warm Air Heating and Air-Conditioning Systems.

D. National Insulation and Abatement Contractors Association (NIACA) - Guide to Insulation Product Specifications.

E. North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.

F. Underwriters Laboratory (UL)

1. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum five years documented experience.

C. Products: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84 or NFPA 255 or UL 723.

D. No insulation product shall support or promote mold or fungus growth.

1.5 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data: Provide a schedule, listing each type of insulation, thickness, density, type of protective covering, etc., and the work and service to which each type of insulation is to be applied. The schedule shall be submitted in quantities consistent with that required in the Conditions of the Contract. No insulation shall be purchased or installed until the schedule is reviewed by the Engineer.

C. Manufacturer's Installation Instructions: Indicate specific installation instructions per the manufacturers of the various products and indicate how the system (combination of products) will be assembled. Highlight critical environmental factors such as drying time, etc., as well as any variations between the manufacturer's installation instructions and the specified installation instructions along with a reason for the difference.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Deliver products to site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

C. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged or wet insulation; remove from project site. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to Owner.

D. Where existing insulation has been removed or disturbed, due to new connections and/or alterations, repair and replace existing insulation using materials that match existing, except where existing insulation includes asbestos material.

E. Existing insulation containing asbestos materials (or thought to contain asbestos materials) must be removed by Owner, either totally or in part, in strict accordance with OSHA Regulations utilizing OSHA approved Contractors. Repair and/or replacement of existing insulation containing asbestos shall be with new products as specified herein.

F. Maintain ambient conditions required by the manufacturer of each product.

1.7 SPARE PARTS

A. Six rolls of tape to be used for sealing penetrations in vapor retarder jackets.

1.8 WARRANTY

A. One year warranty on products and complete installation commencing at the time of Substantial Completion.

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Owens-Corning
3. Knauf
4. Armstrong
5. Certainteed Corp.
6. Rock Wool Manufacturing

B. Type GFP: *Glass fiber pipe* insulation; ANSI/ASTM C547, rigid molded, for use to 850F; thermal conductivity ('k' value) of 0.23 (Btu)/(hr ft^2 EF) at 75°F mean temperature, k=0.29 at 200°F, k=0.43 at 400°F; noncombustible factory-applied white kraft paper bonded to aluminum foil and reinforced with glass fibers (ASJ) (vapor permeability shall not exceed .02 perms) that has a self-sealing longitudinal lap which provides positive closure without the use of tools, staples, adhesives, ties or tape at ambient temperatures between 25°F and 110°F shall be provided as a vapor retarder.

C. Type GFFB: *Glass fiber flexible blanket* insulation; ASTM C553; for use to 250°F; 'k' value of .28 at 75°F mean temperature; commercial grade; ¾ lb/cu ft minimum density; noncombustible factory-applied foil-scrim kraft (FSK) jacket (vapor permeability shall not exceed .02 perms).

D. Type GFRB: *Glass fiber rigid board* insulation; ASTM C612; for use to 250°F; 'k' value of .28 at 75°F mean temperature Class 2; 3 lb/cu ft minimum density; noncombustible factory-applied foil-scrim kraft (FSK) jacket (vapor permeability shall not exceed .02 perms).

E. Type MFP: *Mineral fiber pipe* insulation; ASTM C-612-83/ASTM E-136, Federal HH-1-558B; rigid molded; 10 lb/cu ft minimum density, surface temperature not to exceed 105°F; foil scrim kraft jacket (FSK). OR all service jacket (ASJ).

F. Type MFFB: *Mineral fiber flexible blanket* insulation; ASTM C-553/ASTM E-136, Federal HH-1-558B; 6 lb/cu ft minimum density, R-value/inch of 4.2, surface temperature not to exceed 105°F; foil scrim kraft jacket (FSK). OR all service jacket (ASJ).

G. Type MFRB: *Mineral fiber rigid board* insulation; ASTM C-612-83/ASTM E-136, Federal HH-I-558B, 6 lb/cu ft minimum density, surface temperature not to exceed 105°F; foil scrim kraft jacket (FSK). OR all service jacket (ASJ).

H. Type FEP: *Flexible elastomeric plastic* insulation; ANSI/ASTM C534; 'k' value of 0.27 at 75°F mean temperature.

2.2 PIPE PROTECTIVE COVERINGS

A. Acceptable Manufacturers

1. Childers (metal)
2. Knauf (metal)
3. Schuller International, Inc. (PVC)
4. Proto (PVC)

B. Interior Applications

1. Vapor Retarder Jackets: Integral to glass fiber insulation as specified above.
2. PVC Jackets: One piece pre-molded high impact PVC fitting covers with fiberglass inserts and accessories, to include elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, jacketing, tacks and PVC tape.
3. Glass Fabric and Mastic: Two coats mastic required with 10 x 10 glass fabric.

C. Exterior Applications

1. Aluminum Jackets: ASTM B209; 0.016" thick; stucco embossed.
2. Stainless Steel Jackets: Type 304 stainless steel; 0.010" thick; smooth finish.
3. Glass Fabric and Mastic: Two coats mastic required with 10 x 10 glass fabric.

2.3 PIPE ACCESSORIES

A. Acceptable Manufacturers

1. Foster
2. Minnesota Mining
3. Chicago Mastic

B. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool; compatible with the insulation and protective coverings.

C. Finishing Cement: ASTM C449; compatible with the insulation/fitting covers/jackets.

D. Adhesives and Tapes: Compatible with insulation and protective coverings.

E. Metal Jacket Bands: ½" wide; 0.016" thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Install products only after piping, ductwork and equipment have been tested and approved.

B. Verify that surfaces are clean and dry with any and all foreign material removed.

C. Provide drop cloths or other means of protecting all equipment from drops, spattering, etc. which may be caused by the application of insulating products.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's and NAIMA instructions.

B. Whenever insulated pipes or ducts pass through sleeves or openings, the full specified thickness of the insulation shall pass through the sleeve or opening, except for sleeves located in fire rated partitions or floors. Space between pipe and sleeve located in fire rated partition or floor shall be sealed.

C. Contractor shall note that all adhesives shall be applied as specified, in continuous bands for complete coverage. The "spot" application of adhesives is not permitted.

D. Neatly finish insulation at supports, protrusions and interruptions.

E. Contractor shall coordinate with support and firestopping requirements as noted elsewhere in the Contract Documents.

3.3 APPLICATION (PIPING)

A. Schedule

INSULATION	OPERATING	
	TYPE	TEMP (°F)
Chilled Water	GFP	

B. Insulation thickness shall be as follows:

Fluid Design Operating Temperature Range, F	Nominal Pipe Diameter (in.)				
	< 1"	1" to < 1½"	1½" to < 4"	4" to < 8"	8" & up
Above 350°	4.5	5.0	5.0	5.0	5.0
251°-350°	3.0	4.0	4.5	4.5	4.5
201°-250°	2.5	2.5	2.5	3.0	3.0
100°-200°	1.5	1.5	2.0	2.0	2.0
40°-60°	1.5	1.5	1.5	1.5	1.5
Up to 39°	1.5	1.5	2.0	2.0	2.0

1. Use maximum fluid temperature for those systems where fluid temperature is above ambient temperature, minimum fluid temperature for those systems where fluid temperature is below ambient temperature.
2. EXCEPTION: Insulation thickness for roof drains and storm water shall be 1".

C. Indoor, Exposed Pipe

1. For pipe exposed in mechanical equipment rooms or in finished spaces, insulate pipe, fittings, joints, and valves the same as for concealed applications.
2. Locate insulation and cover seams in least visible locations on exposed piping systems.

D. Where multiple layers of pipe insulation are required, all longitudinal and circumferential joints shall be staggered.

E. Exterior Pipe

1. Insulate the same as for "Indoor, Concealed Pipe."
2. Cover pipe and fittings with aluminum jacket with seams located at 2 o'clock side of horizontal piping. Overlap jacket 90 degrees. Overlap jacket ends (do not butt together) along the length of the pipe (at least 3") and secure jacket with aluminum bands.

3.4 APPLICATION (EQUIPMENT)

A. Insulation shall be omitted at all equipment name plates and/or data plates.

B. Do not insulate factory insulated equipment.

C. Apply insulation as close as possible to equipment by grooving, scoring and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

D. Fill joints, cracks, seams and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

E. When equipment with insulation requires periodical opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

F. Insulate cold tanks and cold heat exchangers, with 1½" thick insulation (Type FEP).

1. Apply a coat of Foster No. 82-31 adhesive to all surfaces to be covered and all surfaces and edges of the insulation. Press edges into place and then press or roll rest of insulation into place. Finish by sealing all joints with appropriate insulating cement.
2. After insulation has been installed, apply two coats of white vinyl lacquer finish.
3. Plate heat exchangers: only insulate fixed end plates and exterior side of splash guards. Do not insulate interior side of splash guards.
4. Insulate the following:

a. Chemical Pot Feeders

3.5 ADJUSTING

Not Applicable

3.6 CLEANING

A. All empty cartons, containers, etc. which have contained insulating materials shall be removed from the site and premises by the Contractor as soon as possible after their contents have been removed.

END OF SECTION

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SECTION 23 0100
COMMON MECHANICAL WORK REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic requirements applicable to all Division 23 work.

1.2 RELATED SECTIONS

A. All specification sections in Division 20 are applicable to Division 23. It is the responsibility of the Division 23 Contractor to obtain all Division 20 specifications and conform to all applicable requirements. Division 20 Sections included are:

1. Section 20 0500: Basic Construction Requirements
2. Section 20 0501: Minor Mechanical Demolition
3. Section 20 0519: Meters And Gauges for Mechanical Systems
4. Section 20 0529: Hangers and Supports for Mechanical Systems
5. Section 20 0700: Thermal Insulation for Mechanical Systems

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 SCOPE

A. Work included under Divisions 20 and 23 shall include all labor, services, materials, and equipment and performance of all work required for installation of plumbing systems as shown on Drawings and as specified.

END OF SECTION

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:

1. Hydronic Piping Systems:
    a. Variable-flow systems
2. HVAC equipment quantitative-performance settings
3. Verifying that automatic control devices are functioning properly
4. Reporting results of activities and procedures specified in this Section

1.2 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing Firm: The entity responsible for performing and reporting TAB procedures.

1.3 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB, or TABB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven (7) days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
    a. Submittal distribution requirements
    b. The Contract Documents examination report
    c. TAB plan
    d. Work schedule and Project-site access requirements
    e. Coordination and cooperation of trades and subcontractors
    f. Coordination of documentation and communication flow

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC, NEBB or TABB/SMACNA.

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification," or the TABB Instrument List.

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. Provide one of the following performance guarantees:

1. AABC National Project Performance Guarantee
2. NEBB Certificate of Conformance Certification
3. TABB Quality Assurance Program Guarantee

B. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS

2.1 ACCEPTABLE FIRMS

A. Aero Testing & Balancing Systems, Inc., Chicago, IL

B. Independent Testing and Balancing, Warrenville, IL

C. International Test and Balance, Inc., Des Plaines, IL

D. Superior Test and Balance, Inc., Algonquin, IL

E. Or other qualified independent contractor as approved by Engineer prior to bid.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.

2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in General Conditions and Division 01 Section 01 7700, "Project Closeout" and Division 20 Section 20 0500, "Basic Requirements for Mechanical, Plumbing, and Fire Protection.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems – Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine strainers for clean screens and proper perforations.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine equipment for installation and for properly operating safety interlocks and controls.

N. Examine automatic temperature system components to verify the following:

1. Valves, and other controlled devices are operated by the intended controller.
2. Valves are in the position indicated by the controller.

3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.
7. Controller set points are set at indicated values.
8. Interlocked systems are operating.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," or SMACNA's "HVAC Systems – Testing, Adjusting, and Balancing" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.5 PROCEDURES FOR MOTORS

A. Motors, ½ HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.6 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.

2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
6. Capacity: Calculate in tons of cooling.
7. If air-cooled chillers, verify condenser fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.7 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.8 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or ungrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.9 TOLERANCES

A. Adjust hydronic systems to ± 5% of design parameters.

3.10 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves
2. Manufacturers' test data
3. Field test reports prepared by system and equipment installers
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page
2. Name and address of TAB firm
3. Project name
4. Project location
5. Architect's name and address
6. Engineer's name and address
7. Contractor's name and address
8. Report date
9. Signature of TAB firm who certifies the report
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance
    b. Notable characteristics of systems
    c. Description of system operation sequence if it varies from the Contract Documents

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.

E. Packaged Chiller Reports:

1. Unit Data:

    a. Unit identification
    b. Make and model number
    c. Manufacturer's serial number
    d. Capacity in tons
    e. Refrigerant type and capacity in lbs
    f. Starter type and size
    g. Starter thermal protection size
    h. Compressor make and model number
    i. Compressor manufacturer's serial number

2. Air-Cooled Condenser Test Data (Indicated and Actual Values):

    a. Refrigerant pressure in psig
    b. Refrigerant temperature in °F
    c. Entering- and leaving-air temperature in °F
    d. Number of compressors

3. Evaporator Test Reports (Indicated and Actual Values):

    a. Refrigerant pressure in psig
    b. Refrigerant temperature in °F
    c. Entering-water temperature in °F
    d. Leaving-water temperature in °F
    e. Entering-water pressure in feet of head or psig
    f. Water pressure differential in feet of head or psig
    g. Water flow rate in gpm

4. Compressor Test Data (Indicated and Actual Values):

    a. Suction pressure in psig
    b. Suction temperature in °F
    c. Discharge pressure in psig
    d. Discharge temperature in °F
    e. Oil pressure in psig
    f. Oil temperature in °F
    g. Voltage at each connection
    h. Amperage for each phase
    i. Kilowatt input
    j. Crankcase heater kilowatt
    k. Chilled-water control set point in °F
    l. Condenser-water control set point in °F
    m. Refrigerant low-pressure-cutoff set point in psig
    n. Refrigerant high-pressure-cutoff set point in psig

5. Refrigerant Test Data (Indicated and Actual Values):

a. Oil level
b. Refrigerant level
c. Relief valve setting in psig
d. Unloader set points in psig
e. Percentage of cylinders unloaded
f. Bearing temperatures in °F
g. Vane position
h. Low-temperature-cutoff set point in °F

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification
b. Location
c. Service
d. Make and size
e. Model and serial numbers
f. Water flow rate in gpm
g. Water pressure differential in feet of head or psig
h. Required net positive suction head in feet of head or psig
i. Pump rpm
j. Impeller diameter in inches
k. Motor make and frame size
l. Motor horsepower and rpm
m. Voltage at each connection
n. Amperage for each phase
o. Full-load amperage and service factor
p. Seal type

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig
b. Pump shutoff discharge, suction and total pressures in feet of head or psig
c. Actual impeller size in inches
d. Full-open flow rate in gpm
e. Full-open pressure in feet of head or psig
f. Final discharge pressure in feet of head or psig
g. Final suction pressure in feet of head or psig
h. Final total pressure in feet of head or psig
i. Final water flow rate in gpm
j. Voltage at each connection
k. Amperage for each phase

3.12 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

2. Randomly check the following for each system:
    a. Verify that balancing devices are marked with final balance position.
    b. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.13 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

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SECTION 23 0900
BASIC TEMPERATURE CONTROL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Scope
B. Quality Assurance
C. Specifications
D. Project/Site Conditions
E. Work by Subcontractors
F. Coordinated Work
G. Project Phasing
H. Hazardous Materials
I. Design Submittals
J. Start-up and Testing
K. Guarantee
L. Substantial Completion Submittals
M. Closeout Submittals
N. Record Documents
O. Operating and Maintenance (O&M) Manuals
P. Training
Q. Preventive Maintenance Contract

1.2 SCOPE

A. The purpose of this project is to update, replace and expand the existing energy management and control systems [pneumatic temperature control systems].

B. The work includes the complete installation of an electronic building automation, energy management and temperature control system as identified below:

1. Control for the following systems:

a. Base Bid 1

(1) Modify existing chiller controls for new chiller
(2) Tie-in of new automatic chiller isolation valve
(3) Related software.

C. Contractor must take special precautions at all times to prevent any damage to Owner's equipment or premises. This Contractor shall be liable for any damage.

1.3 QUALITY ASSURANCE

A. The system shall be designed, installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have in-place a support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing

contractors are not acceptable. Contractor must be an authorized representative of the controller manufacturer and shall be fully backed by same.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be the manufacturer's latest standard design that complies with the specification requirements.

C. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, "Governing Radio Frequency Electromagnetic Interference" and be so labeled.

D. This system shall have a documented history of compatibility by design for a minimum of 10 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing controllers and field panels and extend new controllers and field panels on a previously installed network.

E. The Contractor shall employ specialists in the field of Building Automation Systems including: Programming, Engineering, Field Supervision and Installation. Specialists shall have a minimum of 5 years of experience with Building Automation Systems.

F. The Contractor shall be responsible for all work fitting into place in a satisfactory, neat, workmanlike manner acceptable to the Owner and Engineer.

1.4 SPECIFICATIONS

A. The Contract Documents are to be considered scope in coverage only and do not necessarily show the exact location and details of the work to be installed. It shall be the responsibility of the Contractor to furnish and install the work in conformity with the requirements of these Specifications, the applicable codes, regulations and standards, the best trade practices and to meet with the approval of Owner. If any departures from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted immediately to Engineer for approval.

B. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, this specification shall govern.

C. If the drawings and specifications are in conflict with each other, the more stringent shall apply.

1.5 PROJECT/SITE CONDITIONS

A. Before submitting Proposal, the Contractor shall visit and carefully examine the individual sites so as to familiarize himself with existing conditions, the amount of work required, the working hours and special auxiliary restrictions of the project requirements including storage and delivery of materials.

B. The Contractor shall verify all conditions on the job which may affect the installation of the work, and shall familiarize himself with applicable local and state regulations. Any discrepancies or interferences shall be reported immediately to Engineer. Additions to the contract price will not be allowed when they are due to the failure of the Contractor to carefully inspect existing condition.

C. The submission of a Proposal will be construed as evidence that such examination has been made. Later claims for labor, equipment or material required for difficulties encountered, which could have been foreseen had such examination and evaluation have been, will not be recognized.

1.6 WORK BY SUBCONTRACTORS

A. The temperature controls contractor for the site is Alpha Controls. Contact Jason Vogelbaugh at 217 299.1379 or JasonV@AlphaACS.com

B. All Subcontractors to the Contractor shall be approved by Owner.

C. The Contractor shall be totally responsible for his work and all work by his Subcontractors.

1.7 COORDINATED WORK

A. This Contractor shall cooperate with other contractors performing work on this project, or other projects at the site, as necessary to achieve a complete, neatly fitting installation for each condition. To that end, each Contractor shall consult the drawings and specifications, for all trades to determine nature and extent of other work.

1.8 PROJECT PHASING

Not Applicable

1.9 HAZARDOUS MATERIALS

A. If hazardous materials including, but not limited to, asbestos, pollutants, or PCB are in any way suspected, inform Owner immediately and suspend work on that portion of the project.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 DESIGN SUBMITTALS

A. Submit all design submittals per Division 01.

1. Submit electronic copies of all drawings and product data every time a submission is made until final approval.
2. Separate submittals may be made: hardware and software.

B. Engineer shall review and comment on copies submitted.

C. If design does not conform to the design intent, Contractor shall resubmit to Engineer.

D. Submittals and drawings shall be sufficient to:

1. Show that the intent of the specification has been met.
2. Provide a document for use by Owner showing all equipment incorporated into the system including both new and existing.
3. Provide a document for use by Owner showing all equipment pneumatic and wiring connections of the system for both new and existing equipment.

E. Items to be included in hardware drawings at minimum are:

1. Include a complete bill of material of equipment used indicating quantity, manufacturer and model number and other relevant technical data.
2. Include manufacturer's description and technical data, such as performance curves, product specification sheets and installation/maintenance instructions for the items listed in Division 23 Section 23 0901, "Temperature Control Hardware."
3. Provide each electrically operated device with completely coded interconnection wiring diagrams. Show all termination and wiring numbers.
4. Provide schematic wiring diagrams for each control panel. Show all terminations and wiring numbers.
5. Provide schematic wiring diagrams for all field sensors and controllers.
6. Provide each pneumatic operated device with complete piping diagram.
7. All schematic diagrams shall show both new and existing equipment for a complete control system schematic.
8. Provide system schematic diagrams for chiller plant and all other miscellaneous points. Schematics to indicate every monitored/controlled point associated with that system.
9. Provide system riser diagrams showing all controllers, workstations, network wiring, etc.

F. Items to be included in software drawings at minimum are:

1. DDC and ASC Controllers
    a. Provide one manufacturer's program manual to Engineer. Manual shall contain complete description of all factory programs furnished and applications programming language.
    b. At Engineer's request, provide programming flow diagrams of the applications software.
    c. Include a complete description of the operation of the temperature control/monitoring system, including sequences of operation.
        (1) Such descriptions are to be in Contractor's own words and not identically repeated from the Drawings.
        (2) Where sequences indicate, imply or suggest the use of "look-up" tables based on testing to be performed during the project, Contractor shall include such tables using "best-guess" values as place-holders. Contractor shall use actual measured values as they become available.
    d. Provide identification of those portions of the control sequences which are defined and activated by the Operator Workstation.
    e. Provide the control loop algorithms/calculations proposed.
    f. Provide a controller point list, including both inputs and outputs (I/O), indicating I/O point number, the controlled device associated with the I/O point and the location of the I/O device.
    g. Provide schedules, lists or other documentation of all operation parameters.

h. The Contractor shall provide eight (8) hours of labor at Engineer's office for the principal program writer to meet with Engineer to interpret/review line by line programming.

G. Quantities of items submitted will not be reviewed by Engineer and are the responsibility of the Contractor.

H. When manufacturer's cut sheets 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. Clearly note exact models, options and accessories being provided. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.

I. Drawings and product data not bearing the approval stamp of the Contractor, showing Contractor has reviewed and approved, or containing deviations from the contract documents, will be returned to the Contractor for resubmittal for compliance with above requirements.

J. Equipment furnished and installed which is not reviewed by Engineer and not conforming to the design concept of the project will have to be removed and replaced with acceptable equipment all at the cost of the Contractor.

K. Corrections or changes indicated on drawings and product data shall not be considered as extra work order.

L. Engineer's checking and reviewing of drawings is a gratuitous assistance and in no way relieves the Contractor from responsibility for errors or omissions which may exist on the drawings. Whenever such error or omissions are discovered, they must be made good by the Contractor, without any additional cost to Owner, irrespective of any review by Engineer.

M. Provide to Engineer any additional information or data which they deem necessary to determine compliance with these specifications or which they deem valuable in documenting the equipment to be installed.

3.2 START-UP AND TESTING

A. Where new digital controls are being installed they shall be installed to the greatest extent possible before switch over from the existing temperature control system.

1. Prior to switch over, the controllers shall be completely installed, checked and tested.
2. Controller software and hardware shall be verified prior to switch over.

B. Prior to testing and verifying proper system operation, Contractor shall furnish Engineer, for acceptance, electronic copies of the start-up/testing procedure proposed. Engineer must approve the check-out procedure prior to start-up/testing.

C. The start-up/testing procedure shall be submitted in writing one (1) calendar month prior to the projected start of start-up/testing.

D. Check out procedure must include provisions for technicians to specifically check off procedures or tests performed.

E. At minimum, the following shall be included in the checkout procedure:

1. The Contractor shall test and verify proper operation for each control loop.

2. Each control loop check will verify that the controller, manual override, fail-safe control and electric interlocks are operating as intended to accomplish the control strategy.

    a. Provide to Engineer trend logs of a minimum of thirty minutes in length, sampling no less frequently than every one minute, registering analog values of controlled variables showing that control loops respond adequately during system start-up as well as steady state conditions. Logs must show the loop response to a step input of at least 5F change in setpoint or 10% relative humidity change in setpoint.

3. Contractor shall test and verify that correct terminations/designations of I/O are in place for each input and output.
4. Contractor shall test and verify that sensors are properly calibrated, operational, and are within the performance parameters established in this specification.

    a. Contractor shall have onsite instrumentation to calibrate/verify all analog input sensing. Instruments shall themselves be properly calibrated and be of greater accuracy than the sensors installed.

5. Contractor shall test and verify onsite that operator interface menus and help screens are properly displayed, and that point names and designations are correct.
6. Contractor shall test and verify communications between controllers.

F. Start-up of an individual digital controller shall be planned such that the entire switch-over and checkout of a system can occur in less than one day. Incomplete or unverified controller systems shall not be left in operation overnight without permission of Owner.

1. Contractor will not be allowed to switch over additional systems until the present controller being worked on is 100% complete.

G. After the procedure is approved and after portions of the system are complete (phasing of system installation/commissioning to be approved by Owner) and ready to be placed into regular service, Contractor shall inform Owner of this fact in writing.

H. Contractor shall agree on start-up dates with Owner.

I. On each start-up date for completed portions of the system, Contractor shall have on-site qualified vendor field technicians to place the system in operation, making such tests, adjustments and changes as may be found necessary to insure successful operation of the installed equipment and systems.

J. Contractor shall notify Owner 24 hours in advance when equipment needs to be shutdown during start-up/testing.

K. All tests shall be documented by the Contractor and certified, verifying that the tests have been performed and that all deficiencies have been corrected.

1. Contractor shall demonstrate on site to Engineer that each input and output operates as specified, control loops are tuned, alarms report as specified, failsafe modes are as specified, and other verification as requested by

Engineer and/or Owner to demonstrate that the system has been checked by the Contractor.

2. All testing must be performed and all deficiencies corrected to Engineer's and Owner's satisfaction.

L. At the end of start-up/testing, if equipment and systems are operating in a manner satisfactory to Engineer and Owner, Owner will sign a certificate affirming that the systems operation has been tested and accepted in accordance with the terms of his specification. The date of Owner's final acceptance of the entire system (not phased portions) will be the start of the guarantee period.

3.3 GUARANTEE

A. Workmanship and material for work specified shall be guaranteed free from defects for a period of twelve (12) months after final completion and acceptance by Owner of the entire system, not portions of the system. Note that warrantees for individual controllers placed in service will not commence until the entire system is complete and accepted by Owner. Any equipment herein described that is shown to be defective during the guarantee period shall be adjusted, repaired, or replaced at no charge to Owner.

B. After the final inspection and demonstration, a punchlist of incomplete or unsatisfactory items will be developed by Engineer.

C. The Contractor shall respond to the punchlist with a date by which all items will be completed/corrected.

D. Upon completion of all punchlist items, the Contractor shall inform Engineer in writing of this fact. This date will serve as the tentative guarantee start date.

E. Upon verification that all punchlist items are complete by the Engineer, the tentative guarantee start date will become the actual guarantee start date.

F. Items which unreasonably delay the start of the guarantee and are beyond the Contractor's control such as change orders late in the project will not be considered in establishing the guarantee start date.

G. During the guarantee period, software updates/controller improvements (i.e., microprocessor chip changes) shall be provided to Owner at no charge. Coordinate with Owner prior to the installation of such changes.

Note: The intent of G. is to insure that Owner receives any product updates which are directed toward correcting a product problem which may or may not be apparent. It is not intended to automatically extend to Owner new product features or enhancements which did not exist at the time of Contract Award.

H. At Owner's request, the Contractor shall visit the building to clarify for the operating personnel any questions as to the proper operation and maintenance of the system during the first year after final acceptance of system.

3.4 CLOSEOUT SUBMITTALS

A. Contractor shall provide closeout submittals required by the Contract Documents including, but not limited to, the following prior to requesting Final Acceptance of the Work:

1. Record Documents as described in Paragraph 3.5 herein;

2. Operating and Maintenance Manuals for items so required by the various Specification Sections and other items as so requested by Owner and as described in Paragraph 3.6 herein;
3. Warranties, guarantees, and bonds as outlined in Paragraph 3.3 of this section;
4. Keys and keying schedule;
5. Tools, spare parts, maintenance stock of materials, etc.;
6. Evidence of compliance with requirements of governmental agencies having jurisdiction including, but not necessarily limited to:
    a. Certificates of Inspection;
7. Certificates of Insurance for products and completed operations;
8. List of subcontractors, service organizations, and principal vendors, including names, addresses, and telephone numbers where they can be reached for emergency service at all times including nights, weekends, and holidays;
9. Verification that all training has been reviewed with Owner personnel as described in Paragraph 3.7 herein;
10. Certified copy of final punchlist of itemized work to be completed or corrected (including equipment requiring final connection), stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by Owner;
11. Revised evidence of final, continuing insurance coverage complying with the insurance requirements;
12. Final Application for Payment in accordance with the provisions of the Contract Documents;

B. Contractor and all Subcontractors and major material suppliers who have furnished material or labor for the Work under contract with the Contractor or Subcontractor shall submit final lien waivers. The lien waivers shall be for the full amount of the Contract involved.

3.5 RECORD DOCUMENTS

A. General

1. When conflict occurs between various technical specification sections and this Section 23 0900, “Basic Temperature Control Requirements,” the more stringent requirements shall govern.
2. Each Contractor shall maintain at the site for Owner one record copy of all drawings, specifications, addenda, approved shop drawings, change orders, and other modifications, in good order and marked to record all changes applicable to the work made during construction. All changes made during construction shall be recorded by the Contractor. Contractors shall be responsible for accuracy of all changes made.
3. The daily record of changes shall be the responsibility of Contractor’s field superintendent. No arbitrary mark-ups will be permitted.
4. Failure to keep accurate records of equipment installed will require the Contractor to site verify the installation as required, all at Contractor’s expense.

B. Recording

1. Legibly mark and record at each Product section of the Project Manual a description of actual Products installed, including the following:
    a. Manufacturer's name and product model and number.
    b. Product substitutions or alternates utilized.
    c. Changes made by Addenda and Modifications.
2. Record Drawings: Legibly mark to record actual construction:
    a. Location of devices (sensors, actuators, controllers, etc.) internal utilities (including conduit routing), and appurtenances, concealed in construction or not readily observable from floor level, referenced to visible and accessible features of structure.
    b. Changes of dimension and detail.
    c. Details not on original Contract Drawings.
    d. Modifications/additions to original electrical and pneumatic interface schematics.

C. Submittal
1. During the first week of each month, Contractor shall present, at the project site, the job copy showing variations and changes to date to Owner for review.
2. At completion of Project, submit copies on disk of Project Record Documents to Owner. Project Documents shall contain Project Documents indicating all changes made during construction. Accompany submittal with transmittal letter, in duplicate containing:
    a. Date
    b. Project title and address
    c. Contractor's name and address
    d. Title and number of each record document
    e. Certification that each document as submitted is complete and accurate.
    f. Signature of Contractor or his authorized representative.

3.6 OPERATING AND MAINTENANCE (O & M) MANUALS

A. Contractor shall also provide required quantity of O&M manuals for Owner Training as specified in Division 01.

B. The format and information contained in the new O & M manuals will be as follows:
1. Format
    a. Binders: Commercial quality, 8½" x 11" three-ring binders with hardback, cleanable, plastic covers; one inch maximum ring size. Use multiple binders as required.
    b. Front cover and binding: Identify each binder with typed title.
    c. Tab Dividers: Provide tabbed fly leaf for each separate product, system or subject with typed description.
    d. Table of Contents: Provide table of contents for each volume.
    e. Project Record Drawings: Reduce AutoCAD drawings to 11" x 17" format, provide with reinforced punched binder tab. Bind in with

text; fold drawings to size of text pages. (Larger drawing will be allowed if 11" x 17" format is unreadable.)

2. Volume 1 Hardware
   a. Section 1:
      (1) Include all submittals and drawings updated to as built conditions.
      (2) Include manufacturer's operation and installation instructions for items such as modems, printers, CRTs, computers, keyboards, etc.
   b. Section 2:
      (1) Field hardware, product literature.
   c. Section 3:
      (1) Controller product catalogs, controller panels, electronic cards, components, etc.
3. Volume 2 Custom Software
   a. Section 1 - Software. Provide print outs of all software programming files, including but not limited to all point logs, alarm logs, points with attributes, engineering unit file, programs, message file, etc. Provide software submittals including flow charts and description of operation updated to as built conditions.
   b. Section 2 - Control. Provide software submittals including flow charts and description of operation updated to as built conditions.
   c. Section 3 - Users Summary Catalog. Provide important information which operators would be expected to use on a day by day basis. Work with Owner in defining exact material to be included in this manual.

C. Provide electronic copies of all job software on disks which can be directly loaded by Owner.

D. All drawings, applications software and other job documentation will become the property of Owner.

E. Distribution of O&M manuals will be by Owner.

3.7 TRAINING

A. Contractor shall provide one (1) training session during the Contract period. Training shall be coordinated with the Owner such that personnel from all three working shifts are available.

B. One month prior to training, the Contractor shall provide an outline of all topics to be covered in all sessions for approval by Owner.

C. The instructor(s) shall be competent and have full knowledge of the system installed and shall provide training specifically oriented to Owner's installed system.

D. The instructor(s) shall utilize the operating and maintenance manual provided for the system as a reference manual during the training session. Each person attending the training session shall be provided with an O&M manual. At minimum, these sessions shall include the following:

1. Description of the overall control system configuration and physical layout, indicating location of all sensors and controlled devices.
2. Description of all programs and program features (software).
3. Description of the control strategies being utilized at the installation.
4. Description of all key hardware components utilized in the system.
5. Demonstration of how to communicate with (command and monitor) the DDC and ASC Controller(s).
6. Demonstration of the programming instructions required to use the system.
7. Demonstration of how to retrieve alarms and logs.
8. Demonstration of diagnostic trouble-shooting techniques for the system.
9. Description of any changes made to existing electric and pneumatic controls which remain.
10. Provide quick reference card for operator ease of operation.

3.8 DDC PREVENTIVE MAINTENANCE AND REPAIR

A. All new components shall be incorporated into existing maintenance contract. Bid shall include maintenance costs for new components until end of current maintenance contract.

B. Systems and components covered by this contract shall include:

1. All new digital and electric controls associated with the systems in each corresponding Bid.

C. Proposals shall be on the Contractor's standard form and schedules including:

1. Maintenance schedules or check-off lists for each of the various types of equipment to be supplied. Schedules will give both the servicing tasks and task frequency.

D. Online and On-Site Troubleshooting and Diagnostics

1. Maintain existing services.

E. Software Services

1. Maintain existing services.

F. Preventative Maintenance

1. Maintain existing services.

G. Corrective Maintenance, Repair and Component Replacement

1. Include cost of all labor and material.

H. Operator Training

1. Make recommendations for additional training of system operators. Indicate type of training suggested: written texts, video tape, off-site classroom, on-site classroom, etc.

I. Response Window and Response Time

1. Maintain existing services.

J. Service Documentation and Quality Assurance

1. Provide documentation of all service calls, including time, date and brief description of activity. Each PM work order will include inspection date,

individual to report to, equipment identification, equipment location, work to be performed, and any special instructions.

END OF SECTION

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SECTION 23 0901
TEMPERATURE CONTROL HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General Conditions of the Construction Contract and Supplementary Conditions and Division 01 of the specifications apply to the work in this section.

B. This section is hereby made part of all other sections of Division 23 as fully as if repeated in each.

1.2 SECTION INCLUDES

A. Direct Digital Control Controllers

B. Application Specific Controllers

C. DDC System Field Hardware

D. Miscellaneous Hardware

1.3 SCOPE

A. This Section establishes a minimum quality of hardware and installation and establishes standard equipment or equipment configurations.

B. The digital control/building automation system shall utilize systems as herein specified and manufactured by the existing temperature controls, Alpha Controls.

C. Work installed by the Contractor shall be done in a neat and workmanlike manner, as determined by Owner and in keeping with acceptable standards for this type of work.

D. Unless indicated in this specification, all materials used shall be new. Where items have been indicated to be reused, it is the Contractor's responsibility to insure that the reused items are operating properly and are in good condition. Contractor must make Owner aware of defective items designated for reuse. Owner will be responsible for repairs.

E. Submit data, at minimum, on the following:

1. Direct Digital Control Controllers
2. Application Specific Controllers
3. Network Communications
4. Direct Digital Control and Application Specific Controller Accessories
    a. Modem
    b. Battery
    c. I/O Point Termination Modules
    d. Output Status
    e. Means of Manual Control
    f. Communication Boards
    g. Enclosures
    h. Flow Sensors and Transducers
    i. Autozero Modules

j. Electronic Damper Actuators

5. Field Interface Panels
6. DDC Field Hardware
    a. Sensors, including supporting documentation
    b. Transmitters
    c. Utility Interfaces
    d. Switches
    e. Relays
    f. Solenoid Air Valves
    g. Transducers
    h. Freezestats
    i. Power Supplies
7. Miscellaneous Hardware
    a. Electrical Surge Suppressor
    b. Electric HOA Switches

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROLLERS

A. All controllers shall be as indicated in paragraphs above.

2.2 NETWORKING COMMUNICATIONS

A. The new components shall utilize existing network architecture.

2.3 DDC CONTROLLERS

A. DDC Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, hardware-based real time clock, power supplies and input/output (I/O) point termination modules.

B. Each DDC Controller shall support a minimum of two (2) Local Area Networks.

C. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system
4. Supervisory control of all ASC Controllers
5. Historical/trend data for points specified
6. Maintenance support applications
7. Custom processes
8. Operator I/O
9. Dial-up communications
10. Manual override monitoring

D. DDC Controllers shall provide a minimum of two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC

Controllers shall allow temporary use of devices without interrupting the normal operation of permanently connected modems, printers or terminals.

E. Expansion of the DDC Controller I/O capacity through the use of expansion panels, expansion modules, I/O boards, etc., shall be allowed provided:

1. Capabilities of the expansion system are identical to the base DDC Controller.
2. Communicates with the base DDC Controller over a unique internal bus, separate for the peer-to-peer building level network and the local area network.
3. Relies on the micro-processor within the DDC Controller for all processing requirements.
4. Base DDC Controller does not become overloaded.
5. Where the expansion panel is physically located out of sight of the DDC Controller, provide a communication port for a portable operator terminal at every such expansion panel, unless otherwise noted on the Drawings. Such port shall be an extension of the same port as on the base DDC Controller and shall have the same capabilities.
6. Uses the same I/O termination modules as used for the base DDC Controller.

F. Each DDC Controller shall be capable of sharing point information with other DDC Controllers connected on the same network, such that control sequences executed at one DDC Controller may receive input signals from sensors connected to other DDC Controllers within the network. If the network communication link fails or the original DDC Controller malfunctions, the control loop shall continue to function using the last value received from the failed DDC Controller.

G. Except as noted on the Drawings as “global points,” or “remotely connected points,” all points for a system shall be physically connected to the same DDC Controller as where its system software resides.

H. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587, latest edition.

2.4 APPLICATION SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network, either DDC or ASC controllers.

B. Where specifically identified to be used on the Drawings, all ASC Controllers used within the same category shall be the same product.

C. Shall be a micro-processor based, multi-tasking, real-time digital control processor.

D. Shall include all point inputs and outputs necessary to perform the specified control sequences.

E. Shall support its own real-time operating system. Provide a hardware-based real time clock with battery backup to allow for stand-alone operation in the event communication with its supervising DDC controller is lost and to insure protection during power outages.

F. All programs shall be field-customized to meet the control sequences specified.

G. Programming of all ASC Controllers shall utilize the same language and programming interface.

H. Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

2.5 DDC CONTROLLERS AND APPLICATION SPECIFIC CONTROLLERS - GENERAL

A. Controllers shall be the latest versions available utilizing most recently updated software and hardware offered by the manufacturer

B. Each controller shall support firmware upgrades without the need to replace hardware.

C. Each controller shall act as a stand-alone unit; it shall not be dependent on another controller.

1. Each controller shall function as the system coordinator for the equipment management functions, control peripheral devices and perform all necessary calculations.
2. Each controller shall be independently programmed, with all operating and applications software residing within the unit.
3. All real-time control functions shall be resident in the DDC and ASC Controllers to facilitate greater fault tolerance and reliability.

D. Each controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components and connected sensors. The controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

E. All controllers shall be UL-listed.

F. Provide all processors, power supplies, communications controllers, etc., so that the implementation of a point only requires the addition of the appropriate point sensor, point I/O termination module, wiring or pneumatic tubing, and software programming.

G. Every field point must be associated with a unique I/O point address. No multiplexing schemes are allowed.

H. Controllers shall be furnished in an all steel enclosure with baked enamel finish, NEMA type 1, UL-approved enclosure with a hinged access door and keyed latch. The enclosure shall be sized for sufficient mounting space of additional point termination modules to meet the required spared points and points designated on the Drawings as "future." The lock shall be keyed consistent with the all other Controllers and all field interface panels. Provide protected utility outlet. Controllers meeting these criteria may be directly-mounted. All other Controllers shall be mounted within such an enclosure.

Exception: A non-metallic enclosure furnished by the controller manufacturer may be provided when it can be demonstrated to the Owner that it:

1. Provides adequate protection for the mounting location.

2. All controller devices, such as point termination modules, power supplies, controller modules, communications modules, etc., are enclosed within the controller.
3. All wiring, tubing and their terminations are enclosed within the controller or an external cable trough.

   Exception: Controllers mounted above the ceiling do not require keyed locks.

   Exception: Terminal Equipment ASC Controllers do not require utility outlet.

I. Where two (2) or more units of the same class of equipment are required, these shall be the same products of a single manufacturer. However, the component parts of the system need not be the products of a single manufacturer.

J. Provide battery backed-up RAM memory and real time/calendar clock. The battery should have minimum five year shelf life so that replacement is infrequent. In the event of power failure, the operating system, application database, stored data and real time/calendar clock should be maintained intact for a minimum of 72 hours.

K. Power Failure and Restart

1. In the event of the loss of AC power to the controller, there shall be an orderly shutdown to prevent the loss of database or operating system software.
   a. Control sequences shall go to the normal system shutdown conditions.
   b. Non-volatile memory shall be incorporated for all critical controller configuration data. Battery back-up shall be provided to support the real-time clock and any critical data which may be in volatile memory, for a minimum of 72 hours.
2. Upon restoration of normal power, after a minimum off time delay, the controller shall automatically resume full operation without manual intervention. Input values and set points received from other controllers shall have default values setup in the event communication is lost between controllers.
3. Should the controller memory be lost for any reason, the Operator Workstation shall automatically reload the program and databases. Such reloading shall be transparent and without any intervention by the system operators.
   a. The system operators shall also have the capability of reloading the controller via the peer-to-peer building level network, via the local area network, via the local RS-232C port, or via telephone line dial-in.

L. Each controller shall be installed such that at least 20% spare capacity of each unique input and output is provided. In other words, if a controller requires 10 analog inputs (8 defined points plus 2 future points), capacity for 12 must be provided; two will remain as spare points.

1. This rule applies for all Base Bids, Alternates Bids and designated future points.

2. Input/output point termination modules to satisfy spare point requirements do not need to be provided. However, adequate space for them does need to be provided.

M. Terminations

1. Wiring to and from the controller shall be to terminal strips with screw type terminals. The use of wire nuts or crimped connections within the controller shall be minimized and will only be allowed if the device has fixed length leads pre-attached by the manufacturer. Wire nuts are applicable only to line voltage circuits. Crimped connectors are applicable to non-analog low voltage circuits.
2. All wiring within the controller shall be run in plastic wiring duct to give a neat and workmanlike appearance.
3. Every device and field termination shall be labeled using words, letters or numbers with permanent, mechanically fabricated or printed, laminated tags exactly corresponding to as-built drawings.

N. Input/Output Electrical Protection

1. All inputs and outputs (analog and binary) shall be protected, at minimum, to withstand 120VAC continuously without damage to the controller. Protection shall conform to IEEE Standard 587, latest edition, and shall be provided at field point terminations and at controller terminations.
2. Provide electrical surge protection on power and communications wiring to and from the controller.
3. This electrical protection includes any input or output supplied, whether or not it is utilized in meeting this specification.

O. Output Status

1. All outputs shall have a visual indication of their status without the need for an operator I/O device. Binary outputs shall use a light emitting diode (LED). Electrical analog outputs shall use a voltmeter, ammeter or LED bars. Pneumatic analog output indication shall be with pressure gauges or LED bars.
2. Applies to DDC Controllers, Application Specific Controllers and Field Interface Panels.

P. Manual Control

1. All outputs shall have a manual means for the operator to force specific outputs independent of the controller. Forced outputs which require the controller to be operating will not be accepted as a manual control method.

   Exception: Electric power to the I/O point termination modules may be required for manual operation.

2. Controller shall monitor the status of all override switches and inform the operator that automatic control has been inhibited. Controllers shall also collect override activity information for reports.
3. Where status monitoring is not an integral part of the I/O point termination module, provide separate binary input point to provide such monitoring.
4. Provide indication on the system graphic when the switch is in the “Hand” or “Off” position.

5. All binary outputs shall have a manual Hand/Off/Auto selector switch.
6. All analog outputs shall have a manual Hand/Auto selector switch and a manual gradual switch for manual control when the selector switch is in the "Hand" position.
7. All manual controls shall be integral with the controller.

2.6 DDC SYSTEM FIELD HARDWARE

A. Field Interface Panel

1. All field interface devices, where practical shall be mounted in field interface panels. All other field interface devices shall be mounted at the point of field interface in a separate enclosure suitable for the location. When the manufacturer provides an enclosure/packaging of the device or sensor suitable for the location that protects the device from dust and moisture, conceals integral wiring and moving parts, this enclosure shall be acceptable.
2. Mounted within the field interface panel shall be power supplies for sensors, interfacing relays and contactors, pneumatic to electric and electric to pneumatic transducers, manual override switches, etc.
3. Provide an enclosure meeting the same requirements as DDC Controllers and Application Specific Controllers.
4. No power line carrier type interfacing equipment will be allowed in the field interface panel.
5. Terminations
    a. Wiring to and from the field interface panel shall be to terminal strips with screw type terminals. Analog or communications wiring may use the field interface panel as a raceway without terminating. The use of wire nuts or crimped connections within the field interface panel shall be minimized and will only be allowed if the device has fixed length leads pre-attached by the manufacturer. Wire nuts are applicable only to line voltage circuits. Crimped connectors are applicable to non-analog low voltage circuits.
    b. All wiring within the field interface panel shall be run in plastic wiring duct to give a neat and workmanlike appearance.
    c. Every field interface device and every field termination shall be labeled using words, letters or numbers with permanent, mechanically fabricated or printed, laminated tags exactly corresponding to as-built drawings.

B. Analog Input Devices

1. Contractor shall provide equipment for analog inputs as indicated in the point lists and shown on the Drawings. This shall include the sensor and transmitter.
2. Sensors and transmitter provided shall be of the type that is universally accepted in the industry, can easily be second-sourced and could be utilized with the majority of digital controller manufacturer's equipment.
3. All sensors and transmitters utilized in a similar application shall be of the same manufacturer.

4. Sensing ranges and accuracies given are for the normal values anticipated. The actual sensor range will be dictated by the maximum and minimum sensed values anticipated and standard sensor ranges.
5. All sensors shall be calibrated at the midpoint of the expected sensed values.
6. Sensor/transmitter shall be appropriately packaged for the location, as follows:
    a. Thermal well housing for water applications.
7. Sensor/transmitter shall be appropriately selected to withstand ambient conditions, such as:
    a. Moisture or condensation, where it is a factor.
    b. Vibration from ductwork, equipment, etc.
    c. Reasonably expected transient conditions such as temperatures, pressures, humidity, etc., outside the normal sensing range.
8. Sensor/transmitter shall be appropriately selected to most closely match the expected sensing range.
9. Sensor/transmitter shall be appropriately selected for an accurate, responsive, and noise free signal.
10. The system shall maintain the specified end-to-end accuracy, indicated below for the noted range, throughout the guarantee period from sensor to controller read-out.
    a. Sensing accuracy shall be determined by the square root of the sum of the errors squared. All sensing errors introduced, including but not limited to, sensor accuracy as manufactured, repeatability, self heating, linearity, thermal drift, lead length, analog to digital conversion, annual sensor drift, etc., shall be taken into account.
    b. Contractor must submit all accuracy information required to prove that sensing accuracy provided will not exceed that specified.
        (1) Supporting documentation that solely indicates a percentage, without indicating what it is a percentage of (i.e., span, reading, etc.) will not be acceptable.
11. Sensor power supplies shall be located in Controller Panels or Field Interface Panels.
12. Temperature Sensor Assemblies
    a. Temperature sensing shall be with RTDs with matched transmitters. Thermistors, nickel and silver elements, thermocouples or pneumatic transmitters shall not be allowed.
    b. The assembly shall consist of a 1,000 ohm platinum RTD and a solid-state, 2-wire, 4-20mA transmitter. The transmitter shall be compatible with the temperature element and the DDC panel. The assembly shall be factory calibrated over the entire operating span.
    c. End-to-end accuracies shall be as follows:

Application	Accuracy	Range
Chilled water	± 0.20°F	40°F - 70°F

    d. Manufacturers: Hy-Cal, Minco or approved equal.
    e. Liquid Insertion

(1) The assembly shall be contained in a housing suitable for pipe mounting.
(2) Provide sensor/transmitter as specified above.
(3) Existing thermal wells may be reused, at Contractor's option, only if used for existing automation system point to be replaced by this system. Use of thermal wells for thermometers or empty pressure gauge taps is not acceptable. Otherwise, provide new wells.

13. Current Measurement (Amps)

a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal which will be converted to a 4-20 mA DDC compatible signal for use by the system.

b. Current Transformer. Provide a split core current transformer to monitor motor amps.

(1) Operating frequency - 10 - 80 Hz
(2) UL recognized
(3) Five amp secondary
(4) Select current ratio as appropriate for application.

c. Current Transducer. Provide a matching current to voltage or current to mA transducer and power supply. Current transducer shall include:

(1) 6X input over amp rating for AC inrushes of up to 120 amps.
(2) Manufactured to UL 1244.
(3) Accuracy: ± 0.5% of full scale, Ripple ± 1%.

d. When used for pump or fan status, differentiate signal between off, on with no load, and on with load (high and low speeds).

e. Manufacturers: Veris Industries or approved equal.

14. VFD Speed Feedback

a. Provide signal indicating actual variable frequency drive speed.
b. Provide all interface devices as required.

15. Highest Zone Thermostat Pressure

a. Obtain pneumatic control signal from existing pneumatic signal selector.
b. Verify calibration and setpoint for each existing thermostat connected to the signal selector.

C. Analog Output Devices

1. Contractor shall provide equipment for analog outputs as indicated in the point list and shown on the Drawings. This shall include digital to analog conversion and wiring or pneumatic tubing to the controlled device. When necessary, the analog output signal must be fed back and used in the control algorithm.

2. All controlled devices which are to be modulated are to receive analog signals of one of the following forms: 4-20 MA, 0-5 VDC or 0-10 VDC.
3. Analog output signal for variable frequency drives shall be 0-10 VDC.
4. Coordinate with chiller manufacturer for proper signal to control chiller capacity.

D. Binary Input Devices

1. Contractor shall provide equipment for binary inputs as indicated in the point lists and shown on the Drawings.
2. All binary shall be electrically isolated from the digital controller either by optical isolation or relays. Provide filtering to eliminate false signals resulting from input "bouncing."
3. All binary inputs shall be provided by double or single pole-double throw dry contacts wired Normally Open (NO) or Normally Closed (NC) as required. All binary inputs will be wired to alarm on "out of normal" conditions.
4. Status Relay. Relays shall be located in the field interface panel or in the monitored equipment's control panel. These relays shall be of the sealed, multiple pole type with socket mount. These relays shall have silver cadmium contacts with a minimum life of one million operations. Contact rating shall be 5 amps at 110 volts resistive. Provide Potter Brumfield, Allen Bradley or approved equal.
5. Current Status Switch
    a. Self-powered current sensing consisting of a current transformer, solid state current sensing circuit, adjustable trip point, solid state switch, dry contact SPDT relay and separate LEDs indicating the power and sensor trip status.
    b. Unit shall be capable of detecting belt loss, belt failure, motor failure and other mechanical failures.
    c. Unit will be accurate to within ± 1% of range.
    d. Unit shall be suitable for variable frequency drive applications.
    e. A conductor of the load shall pass through the window of the device. Device shall be able to accept up to twice its trip point range.
    f. Shall be used for all fan and pump status points, unless otherwise noted on the Drawings.
    g. Manufacturers: Veris Industries or approved equal.
6. VFD Fault Status
    a. Provide status indication of the variable frequency drive being in a fault condition.
    b. Obtain contact closure from variable frequency drive.
7. VFD Manual/Bypass Status
    a. Provide status indication of the variable frequency drive placed into manual control mode or in bypass mode.
    b. Obtain contact closure from variable frequency drive.

E. Binary Outputs

1. Contractor shall provide equipment for binary outputs as indicated in the point list.

2. For all binary outputs to inductive loads such as relay, solenoid, or motor coils, transient voltage suppression shall be placed across the binary output relay contacts.
3. Binary outputs shall be wired/piped normally open or normally closed for proper operation and failsafe operation.
4. Control relays shall be located in the field interface panel. These relays shall be of the sealed, multiple pole type with socket mount. These relays shall have silver cadmium contacts with a minimum life of one million operations. Contact rating shall be 5 amps at 110 volts resistive. Provide Potter Brumfield, Allen Bradley or approved equal.

   NOTE: No inductive or switching loads shall be mounted in the same enclosure as digital controllers.

2.7 MISCELLANEOUS HARDWARE

A. Valve/Damper End Switch

1. Shall be oil tight, roller type, SPDT snap acting switch.
2. Contact rating: 5 amps at 110 volts resistive.
3. Mechanism to provide ample over travel to prevent stress on damper and control equipment.
4. Manufacturers: Furnas Electric or approved equal.

B. Electric H.O.A. Switches

1. Provide control panel and MCC mounted electric Hand/Off/Auto switches as required.
2. Contact rating: 5 amps at 110 volts resistive.
3. Manufacturers: Square D 9001-D4G3S, Allen Bradley or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Items to be so labeled include, but are not limited to:

1. Dampers and operators.
2. Valves and operators.
3. Controllers and field interface panels.

   Note: Labeling of modules and devices within controllers and panels (such as point modules, E/P switches, etc.) is <u>not</u> included.

4. Sensors, transmitters and transducers including DDC, pneumatic and electric.
5. Operator interface workstation. Label each separate piece of equipment.
6. Portable operator interface devices.

3.2 DDC AND APPLICATION SPECIFIC CONTROLLERS

A. General

1. The control system will be turned over to Owner in complete operating order. All new hardware will be checked, calibrated, and adjusted for immediate use. All software required will be turned over to Owner ready for use, including all operating parameters, set points, and schedules.

2. Each controller will operate as a stand-alone unit such that it does not require any other unit or any operator interface to be on-line to perform its specified functions.
3. Provide control inputs and outputs as indicated on the point lists.
4. For each input point, provide the required field hardware necessary to provide the listed input point to interface to its respective control panel.
5. For each output point, provide all control devices required to provide proper control of the point.

B. Controllers are to be powered by individual 120/1/60 power circuits.

1. Obtain power from same type of source (normal or emergency) as the system(s) being controlled the nearest emergency power circuit. Where controller serves multiple systems on both normal and emergency power, power shall be obtained from an emergency power circuit.
2. A separate third wire (independent grounding wire) shall be furnished as part of the control panel power circuit.
3. Provide a fused disconnect at each controller panel. Non-control loads are not to be on this circuit.
4. Each panel shall be protected by an electrical power surge protector.

   NOTE: No inductive or switching loads shall be mounted in the same enclosure as the Controller. This is to eliminate any chance for electrical interference with the Controller.

   NOTE: No line voltage power may be directly connected to the input/output terminal strip.

5. Terminal Equipment ASC Controllers may share a common circuit.

C. Before mounting each panel, the Contractor shall examine the mounting location for exposure to water leakage. Panels shall not be located directly below or next to any piping valve or accessory which might leak or require servicing. Mounting location shall provide full accessibility to the panel.

D. Panel shall be mounted to a permanent wall or it shall be mounted on a free standing, unistrut type support system.

E. The panel shall be labeled using one inch plastic engraved tags. Every termination to the panel shall be labeled with mechanically fabricated or mechanically printed letters, numbers, etc., which exactly correspond to as-built drawings.

F. Provide typewritten point list at each new controller.

G. Electrical Interference

1. The Contractor will follow the equipment manufacturer's recommendations and incorporate shielding to insure that the electronic control system <u>does not</u> experience any supply voltage transients or electromagnetic interference.
2. Should the system fail to operate satisfactorily due to any electrical interference, the Contractor will take corrective action at no charge to Owner. This will remain in effect until the end of the warranty period.
3. The Contractor shall install all equipment in a manner such that it is not adversely affected by electromagnetic noise. If so, the Contractor shall make any necessary corrections.

4. The Contractor shall install all equipment in a manner such that it does not produce electromagnetic noise which affects other equipment located at this facility. If so, Contractor shall make any necessary corrections.

3.3 DDC SYSTEM FIELD HARDWARE

A. Field Interface Panel

1. The panel shall be firmly attached to a permanent wall or it shall be free standing from unistrut type supports. It shall be mounted directly adjacent to the controller panel.
2. Provide individual 120V power circuits to each panel. A separate third wire (independent grounding wire) shall be furnished as part of the field interface panel power circuit. Power source shall be the same as the controller.
3. Provide a fused disconnect at each panel. Non-control loads are not to be on this circuit.

B. Sensors

1. All water temperature sensors shall be installed in wells.

3.4 MISCELLANEOUS HARDWARE

A. Miscellaneous hardware shall be installed as per manufacturer's recommendations.

B. Thermostat and switch set points shall be set by the contractor to an appropriate level for the application.

END OF SECTION

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SECTION 23 0902
TEMPERATURE CONTROL SOFTWARE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. DDC and ASC Controller Software Description

B. Operator Workstation Software Description

C. DDC System Point List

D. Alarm, Trend Log, Totalization Lists

E. Color Graphics

F. Control Sequences of Operation

G. Control System Failures

1.2 SCOPE

A. All necessary software to form a complete operating system as described in this specification shall be provided.

1.3 SUBMITTALS

A. Comply with pertinent provisions of the Project Manual.

B. Submit data on the following:

1. DDC and ASC Controller Software Capabilities
2. DDC System Point List
3. Job Specific Software Data Bases
4. Control Software Programs and Flow Charts
5. Control Sequences of Operation

PART 2 - PRODUCTS

2.1 CONTROL SOFTWARE DESCRIPTION

A. General

1. The software programs specified in this section shall be provided as an integral part of the DDC and ASC controllers and shall not be dependent upon any higher level computer for execution.
2. The Contractor shall work with Owner to enter all operating information for software provided, such as point name descriptions, passwords, etc., such that at job finalization, all this information is entered. The Contractor shall be responsible for this information being completely entered and documented before job finalization.
3. Provide software required to meet the control strategies and performance described in this Section.
    a. Owner reserves the right to make changes in the software control strategies and sequences at the time of approval of the software submittals without change in cost to Owner.

4. Software shall be turned over to Owner, complete and ready for operation. Operator entered parameters shall be entered as shown. When not indicated, submit a written request for values to Owner.
5. Note that all setpoints and time delays shall be operator adjustable. Coding Setpoint values into the programming is not allowed.
6. The Operator shall have the ability to custom program any control program software online.
    a. The custom programming package shall provide online process text editing. This capability shall allow creation, addition, deletion, or modification of a program.
    b. The custom programming package will verify operator inputs to insure there are no language errors. All errors found shall be identified to the operators.
    c. Software shall be segmented such that editing of one program does not affect other programs.
7. The Operator shall have the ability to online interrogate or modify setpoints and parameters of any controller.
    a. The Operator shall be able to identify field points by a short name and shall not require look-up charts to call up a specific point.
    b. All displayed field points, parameters or setpoints shall be shown, properly scaled with correct engineering units.
    c. All analog values shall show scale such as degrees F, percent RH, etc. All binary points shall indicate status such as on/off, open/closed, etc.
8. The software provided shall be programmed to create a system in which the network architecture is invisible to the operator. The operator shall be able to monitor point statuses, etc., without the need for referencing hardware point locations in controllers.

B. Pre-tested Control Algorithms. The DDC and ASC Controllers shall have the ability to perform the following pre-tested control algorithms as required:
1. Two Position Control
2. Proportional (P) Control
3. Proportional plus Integral (P+I) Control
4. Proportional, Integral, plus Derivative (P+I+D) Control
5. Automatic Control Loop Tuning

C. Control Algorithm Tuning. The Contractor shall tune control algorithm to actual conditions such that all control sequences are stable, yet control gain is maximized.
1. Two Position and Proportional Control
    a. Control loops for space temperature shall not over or under shoot by more than 2°F on start-up conditions.
    b. Control loops for humidity shall not over or under shoot by more than 10% relative humidity on start-up conditions.
    c. Control loops for duct temperature shall not over or under shoot by more than 5°F on start-up conditions.

2. P+I and P+I+D Control and Automatic Control Loop Tuning

   a. Control loops shall be tuned to achieve both short-term response and long-term stability.

   b. Short-Term Response:

      (1) Controlled variable shall achieve 80% of a step-change in setpoint within the time shown below. The acceptable number of cycles of over- and under-shoot (error) are as shown below.

      (2) Controlled variable shall achieve 100% of a step-change in setpoint and stabilize within the time shown below. The acceptable number of cycles of over- and under-shoot (error) are as shown below.

      (3) All control loops shall be tested and tuned to achieve the above requirements when subjected to a step-change up and a step-change down from setpoint.

      (4) All allowable times and cycles shown reference the step-change in setpoint.

Controlled Variable	Change in Setpoint	80% of Step-Change in Setpoint			100% of Step-Change in Setpoint		
		Time (min)	Error	Cycles of Error	Time (min)	Error	Cycles of Error
Chilled Water Temperature (small and short systems)	2°F	3	--	--	8	0.5°F	3
Chilled Water Temperature (large or long systems)	2°F	5	--	--	10	0.5°F	3
Water Differential Pressure	5 psig	2	--	--	5	1 psig	3
Water Pressure	to be determined in the field						
Water Flow	to be determined in the field						

      (5) When control loop responses cannot be met due to limitations of controlled equipment, provide documentation substantiating such limitations.

      Example: Discharge air temperature cannot meet cooling setpoint within the above response times even though the cooling coil valve is fully open. Insufficient online chiller capacity, pumping, coil capacity, etc.

   c. Long-Term Response:

      (1) Once the controlled variable has attained setpoint, it shall maintain setpoint within the following:

         (a) Chilled water temperature ±0.10°F

3. All control loops shall be capable of driving their respective actuator full stroke in less than one (1) minute.

D. Equipment Cycling Protection. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

E. Heavy Equipment Delays. The Controller shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

F. Power Fail Motor Restart. Upon the resumption of normal power, the Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

G. Energy Management Applications. Controller shall have the ability to perform all of the following energy management routines, whether utilized or not.

1. All Controllers

    a. Time of Day Scheduling
    b. Calendar Based Scheduling
    c. Holiday Scheduling
    d. Temporary Schedule Overrides
    e. Night Setback Control
    f. Heating/Cooling Interlock

2. All Controllers except Terminal Equipment ASC Controllers

    a. Optimal Start and Stop (coordinated with Time of Day Scheduling)
    b. Peak Demand Limiting
    c. Water Temperature Reset
    d. Chiller Sequencing

3. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment where described on the Drawings.

H. Custom Process Programming Capability. Controllers shall be able to execute custom, job specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs, Variables and Outputs:

    It shall be possible to use any of the following in a custom process:

    a. Any system-measured point data or status (inputs)
    b. Any calculated data (variables)
    c. Any results from other processes (outputs)
    d. User-defined Constants (variables)
    e. Arithmetic functions (+, -, *, /, square root, exp, etc.)
    f. Boolean logic operators (and, or, exclusive or, etc.)
    g. On-delay/Off-delay/One-shot timers (outputs)

2. Process Triggers

    Custom processes may be triggered based on any combination of the following:

a. Time interval
b. Time of day
c. Date
d. Other processes
e. Time programming
f. Events (e.g., point alarms)

3. Dynamic Data Access

   A process shall be able to incorporate process input, variable and output data from any and all other Controllers on the network.

   In addition, a process shall be able to issue commands to points in any and all other Controllers on the network.

4. Advisory/Message Generation

   Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

5. Custom Process Documentation

   The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphical flowcharts and English language descriptors.

I. Alarm Management. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the Controller's ability to report alarms be affected by either operator activity at an Operator Workstation, local I/O device, or communications with other Controllers on the network.

1. Point Change Report Descriptions: All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms.
   a. A minimum of three priority levels shall be provided.
   b. Each Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up.
   c. Point priority levels shall be combined with user definable destination categories (i.e., Operator Workstation, printer, Controller, pager, etc.) to provide full flexibility in defining the handling of system alarms.
   d. Users shall have the ability to manually inhibit alarm reporting for each point.

e. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of Operator Workstations used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store an alarm message to more fully describe the alarm condition or direct operator response.
5. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full.
6. Local Alarms: The Controller shall provide alarms for all analog input values that are outside of user definable ranges, for all binary output points that do not prove status based on a paired binary input status point, and for all programmed binary alarm status points.
    a. The user shall be able, from the Operator Workstation, to configure the alarm limit ranges, limit deadbands and to enable/disable the alarm.
    b. The user shall be able to configure any Controller alarm as a conditional alarm that will only occur when a selected binary point is on or off. This shall be used to prevent nuisance alarms during non-operating and/or Controller start-up modes.
    c. Analog input alarms shall be operator configured to alarm based on:
        (1) An operator adjustable alarm deadband which shall generate a warning or alarm whenever the value is above/below the current active setpoint plus/minus the alarm deadband.
        (2) High and low alarm limit setpoints and return to normal values or deadbands.

J. Historical Data and Trend Analysis. A variety of historical data collection utilities shall be provided to manually and automatically sample, store, and display system data in all of the following ways.

1. Continuous Point Histories: DDC Controllers shall store Point History Files for all analog and binary inputs and outputs and calculated variables ("virtual" points) for their own points and for all ASC Controller points attached to the DDC Controller.
    a. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day.
    b. Point History Files for binary input, binary output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

2. Control Loop Performance Trends: DDC Controllers shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one second increments for verification of control loop performance.
3. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of one minute to two hours, in one minute intervals, shall be provided. Each DDC Controller shall have a dedicated buffer for trend data.
4. Data Storage and Archiving: Trend data shall be stored at the DDC Controller and uploaded to hard disk storage at the Operator Workstation when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in third party personal computer applications.
5. Historical data and trend data shall be provided in formatted reports. User shall be able to define multiple groupings of trend data, each with a unique name. Points may be assigned to multiple groups, each with different collection parameters.
6. Provide commands to view and print reports utilizing the user's defined unique name given to each.

K. Run Time Totalization. DDC Controllers shall automatically accumulate and store run time hours for binary input and output points when specified in the Execution portion of this specification.

1. The user shall have the ability to define a warning limit for Run Time Totalization. Unique, user-specified messages shall be generated when the limit is reached.

L. Analog/Pulse Totalization. DDC Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points when specified in the Execution portion of this specification.

1. Totalization shall provide calculation and storage of accumulations of data such as kWH, gallons, kBtu, ton-hours, etc.
2. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

M. Event Totalization. DDC Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event Totalization shall be performed on a daily, weekly, or monthly basis as programmed when specified in the Execution portion of this specification.

1. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

N. Communications. Provide all software programs to support communications between Controllers, local operator interface(s) and Operator Workstation. Provide software programs for automatic dial-in from a remote terminal to the control system and automatic dial-out from the control system to a remote terminal.

O. Daylight Savings Time. Provide program which will automatically update each Controller's system clock for daylight savings time and revert Controller's system clock to standard time.

P. Hardware/Software Trouble. The Controllers will self-test and monitor their hardware and software for system trouble. Upon detection of any trouble condition an alarm will be initiated at the Controller and at the Operator Interface Workstation. Failure of any unit on the system shall not affect the proper operation of the remaining system components.

Q. Field Point Trouble. The Controllers will analyze field inputs and outputs to monitor for field trouble. Upon detection of any trouble condition it will register an alarm. All alarms will be immediately forwarded to the Operator Workstation. All alarms shall be stored in memory at the DDC Controller.

1. Each analog input point shall be assigned maximum and minimum operating (or expected) values. When the sensed variable exceeds the assigned operating range or is open or shorted, an alarm shall be generated.

2.2 OPERATOR WORKSTATION SOFTWARE DESCRIPTION

A. General

1. Contractor shall provide all programming of the Operator Workstation related to the installation for controlling, monitoring and alarming the points associated with project. Also, programming shall be provided to store data, retrieve data, generate reports, communicate with all Controllers in the system to accomplish control, monitoring and alarming at the Operator Workstation, downloading of control programs of all connected input/output points to Controllers and to retrieve (upload) control programs from Controllers.
2. The Contractor shall provide start-up and testing of the programming. All specified programming shall perform to the satisfaction of Owner.
3. All programming provided by the Contractor shall be stored with existing system programming and backed up accordingly.
4. Owner shall aid Contractor with information as required for programming and as specified in this section.

B. Point Definitions

1. Each point in the system accessed by the monitoring/alarm Operator Workstation being either a hardware or software point, shall have a short logical name of six to twelve characters and shall have a long descriptive name of 25 to 50 characters.
2. Point definition information programmed by the Contractor shall include but not be limited to:

a. Logical name
b. Descriptive name
c. DDC panel address where it resides
d. Engineering units
e. Sensing range
f. Alarm limits
g. Normal state/off normal state

h. Control calibration values
i. Point function type

3. Point logical names shall be automatically grouped when defining point names.
4. Owner will assist Contractor in developing point definitions where required.

C. Summaries

1. Programming to format summaries shall be provided by the Contractor for implementing user defined logs. The following are summaries that shall be created.

a. All points
b. Points by defined groups
c. Alarms
d. Alarm limits
e. Time schedules
f. Alarm messages
g. Setpoints

D. Groups

1. Programming shall be created to provide the following point groups:

a. Chiller Plant
b. Miscellaneous controlled/monitored/alarmed devices

2. Include outside air temperature and humidity in chiller system point group.

E. Logs – Trend and Alarm

1. Programming to format logs shall be provided by the Contractor for implementing user defined logs. The following are logs that shall be created:

a. Analog trend
b. Binary trend
c. Alarms

2. Each trend log shall have user defined parameters to include:

a. Scheduled start/stop times
b. Sample time interval
c. Number of samples
d. Name of sampled point
e. Type of samples required
f. Engineering unit of samples

3. At minimum, the last sixty (60) values for all input and output points per Controller. Start time of trends shall be operator programmable.

a. Initially set up trend logs to record the inputs as defined in this section.
b. Initially time intervals shall be set at two (2) minutes, but shall be user changeable from (1) minute to one (1) hour.

4. The Operator will have the ability for each log to be automatically printed on time schedule or stored in memory, such that the print command can be manually executed.

5. Trend logs shall be capable of being exported to Microsoft Excel, which resides on the Operator Workstation.

F. Data Records

1. Programming to create, store and edit user defined data records shall be provided by the Contractor for implementing the following data records.
   a. Summaries
   b. Logs
   c. Reports
   d. Alarm lists
   e. Alarm messages
   f. System operation information
   g. Operator information

G. Alarms

1. Programming to define specified points as alarm points shall be provided by the Contractor for implementing alarm receiving, reporting and printing.
2. All alarm messages shall be created and programmed by the Contractor for implementing in the event of alarm reporting.
3. Alarm reporting priorities shall be programmed by the Contractor as defined by Owner.
4. All incoming Controller alarms into Operator Workstation shall be programmed for alarm printer, screen and hard disk destinations.
5. Programming shall be created to provide alarms as defined in this section. Provide multiple alarms for multiple systems.

H. Color Graphics

1. Programming to create and store color graphic diagrams shall be provided by the Contractor as specified at the Operator Workstation.
2. All point values included in the color graphic diagrams shall be dynamic when the finished graphic is viewed, monitored, printed and reprogrammed.
3. Color graphic diagrams shall be stored in hard disk memory.
4. The Contractor shall create, program and store the color graphic diagrams.
5. Chiller Plant System Schematic – Modify existing single line piping including chillers, pumps, control valves, sensors and switches, etc.
6. Binary status and alarm devices included in the color graphic diagrams shall change color when indicating an on or off, high or low, or normal or alarm condition.
7. All point names of devices shown on the color graphic diagrams shall be shown next to their respective device.

PART 3 - EXECUTION

3.1 DDC SYSTEM POINT LISTS

A. For each building system being monitored or controlled, provide input/out points as shown on the Drawings. Refer to Division 23 Section 23 0901, “Temperature Control Hardware,” for required spare capacity.

3.2 ALARM LIST

A. Set up alarm programming for the system point conditions and events. Provide individual alarms for multiple systems, if appropriate.

3.3 TREND LOG LIST

A. Set up trend logs to record appropriate values for the following systems. Provide individual trends for multiple systems.

1. Chiller Plant
2. Miscellaneous controlled/monitored/alarmed devices

3.4 TOTALIZATION LIST

A. Runtime Totalization

1. Pumps
2. Chillers

B. Analog Totalization. Provide hourly, daily and monthly totalization calculations.

1. Refrigeration energy (based on current transformers)
2. Electrical energy consumption

C. Event Totalization

1. Pumps
2. Chillers

3.5 COLOR GRAPHICS

A. Provide the following project specific color graphic screens:

1. Chiller Plant System Schematic
2. Logs
    a. Alarm
    b. Trend
    c. Totalization

3.6 CONTROL SEQUENCES

A. Provide all hardware and software as required.

B. All existing safeties shall be maintained.

C. Provide dead band in all sequenced controls to avoid simultaneous heating and cooling.

D. Provide start/stop of all systems with appropriate safeties.

E. Provide initial time schedules and setpoints of all equipment. Obtain schedules from Owner. All schedules and setpoints shall be operator adjustable and not coded within the software.

F. Refer to Drawings for additional control sequence requirements.

G. Provide programming for the following energy management software:

1. Peak demand limiting
2. Chiller plant optimization
3. Optimal start/stop
4. Hydronic water temperature reset

3.7 CONTROL SYSTEM FAILURES

A. Digital control system failure is defined as loss of controller program, lock-up of controller program, loss of controller power or loss of field interface device power.

1. In the event of digital control system failure, specified chillers, primary chilled water pumps shall be wired to fail ON. Utilize normally closed digital output relay contacts for each chiller/pump that is to fail ON.
2. In the event of digital control system failure, supply fans shall remain in last commanded state (ON or OFF); all modulating dampers and valves shall remain in last commanded state.

END OF SECTION

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SECTION 23 0903
TEMPERATURE CONTROL CONDUIT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit

B. Connectors

C. Junction Boxes

1.2 SCOPE

A. This section includes conduit requirements for use with wire, cable and pneumatic polyethylene tubing.

1.3 SUBMITTALS

Not Applicable

PART 2 - PRODUCTS

2.1 CONDUIT

A. All wiring shall be installed in a complete conduit raceway system of a minimum trade size of ½". Conduit shall be installed continuous from terminal to terminal and shall be mechanically and electrically connected. The entire system shall be grounded.

1. Exception: With permission of Owner, metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors. Receive authorization from Owner before using surface raceway.
2. Exception: The conduit system shall be complete except that up to 12" of exposed Class 2, 3, or communications wiring may be used from the conduit system to an actuator. Wiring extending beyond the conduit system shall be protected by a plastic bushing at the end of the conduit.

B. Conduit shall be rigid steel or IMC. EMT is not allowed.

C. Conduits installed in dry locations requiring flexible connections for adjustment or vibration isolation shall be provided with a 14" maximum length of flexible galvanized steel (Greenfield) conduit. Flexible conduit installed in wet locations and exterior locations shall be liquid-tight type.

2.2 CONNECTORS

A. Couplings and connectors for use with rigid aluminum shall be the threaded type. Terminations shall be with double locknut and insulated bushings. Fittings installed outdoors shall be water tight.

B. Couplings and connectors for electrical metallic tubing (EMT) shall be gland compression.

2.3 JUNCTION BOXES AND PULL BOXES

A. Provide junction boxes and pull boxes of the proper size and shape.

B. Junction and pull boxes shall be supported independently of the conduit system.

C. Junction and pull boxes shall be of galvanized steel construction.

D. Paint each junction box cover per specification Division 26 Section 26 0505, "Basic Electrical Materials and Methods." Mark cover using permanent marker to indicate that wiring enclosed is associated with the controls system.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION

A. Conduit shall not be smaller than the sizes indicated or specified, and where no size is indicated, the Contractor shall size the conduit in accordance with the requirements of the local/state Electrical Code for the number, size and type of wires indicated and specified for application, except that no conduit shall be less than ½" trade size.

B. Where conduit enters panel boxes, pull boxes, outlet boxes or wireways, it shall be secured in place by galvanized locknut on the outside and galvanized locknut and bushing on the inside. Bushing shall be insulated throat type with ground lug. Care shall be taken to see that all conduit runs from a permanent and continuous ground return back to the panel ground connection point. All bushings shall be bonded to the junction box, outlet box, cabinet, etc. Where required, bonding jumpers shall be installed between conduit and boxes.

C. Conduits for branch circuits shall be installed continuous between connections to outlets, boxes and cabinets and shall have a minimum possible number of bends or fittings. Bends shall be made with an approved hickey or conduit-bending machine and shall be smooth and even without flattening or flaking.

D. Exposed conduit runs shall be run neatly and shall be parallel to the walls of the building.

E. The actual installation of conduit shall be made in the field to clear all piping, ductwork, equipment fixtures, ceiling inserts, access doors, etc. Bends, turns, and pull boxes, as required, shall be provided in accordance with field conditions.

F. Conduit ends shall be reamed and shall be thoroughly cleaned before installation. Conduit openings and boxes shall be plugged or covered as required to keep conduit clean during construction. All conduit shall be swabbed clear of obstructions before the pulling of wires.

G. Conduit runs shall be securely fastened in place with approved straps, and hangers and supports from inserts set in the construction above. Vertical conduit shall be securely clamped to steel members and unistruts, and attached to the structure.

H. Conduit shall not pierce or interfere with waterproofing, vapor barriers, damp-proofing, etc.

I. Raceways run through foundation walls, basement slabs, or through any walls for floors that have vapor barriers, waterproofing, or any type of damp-proofing, shall be sealed by use of special wall and floor entrance seals designed for the purpose.

Drawings of the proposed seals and clamping arrangements shall be submitted for approval.

J. Conduits passing from the building exterior to interior or passing between conditioned and non-conditioned spaces shall be sealed to prevent condensation in the conduit.

K. Conduits crossing building expansion joints shall be provided with expansion fittings and flexible grounded bonds bypassing the fittings to insure ground continuity.

L. All conduit shall be supported with fasteners designed for the application and must be attached to the building structure and shall not be supported from other conduit, pipes, ductwork, ceiling suspension members or equipment. Existing pipe hangers for multiple conduits with spare capacity may be used.

1. Exception: When conduit is required to terminate at a sensor or control point on ductwork, the conduit may be fastened to the ductwork. This is the only condition in which conduit is allowed to be fastened to ductwork.
2. Note: Perforated metal strap and tie wire are prohibited.

M. Existing conduit which is in place and has additional wire carrying capacity due to existing wiring being removed or due to original spare capacity may be used for new wiring if the conduit installation meets this Temperature Control conduit specification.

N. All openings for conduit passing through masonry walls or floor shall be core drilled by this Contractor. Core holes shall be sealed as follows:

1. For the conduits penetrating floor or fire walls, the Contractor shall provide fire stopping equivalent to the construction penetrated.
2. Where conduit passes through floor or exterior walls, caulk at both sides to insure waterproofing around conduit.
3. Where conduit penetrates walls separating quiet areas such as offices from noisy areas such as equipment rooms, the opening around the conduit shall be filled with fiberglass insulation and sealed.

3.2 JUNCTION BOX INSTALLATION

A. All outlets shall be installed in accessible locations and none shall be installed above ducts, behind furring or in other similar locations. Any outlet designated as providing power for particular piece of equipment shall be accessible for disconnection with said unit in place.

END OF SECTION

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SECTION 23 0904
TEMPERATURE CONTROL WIRING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wire

B. Cable

1.2 SCOPE

A. Power wiring, Class 1, 2, or 3 wiring, and communications wiring required for satisfactory installation and operation of all equipment specified under temperature control shall be furnished and installed by this contractor.

B. Wiring shall be installed in accordance to wiring specification found in this section.

C. All wiring shall be UL listed and installed in accordance with applicable electrical codes and shall comply with equipment manufacturer's recommendations.

Note: When specified materials or installation methods exceed applicable electrical codes and equipment manufacturer's recommendations, this specification shall govern.

1.3 SUBMITTALS

A. Submit data and samples of the following:

1. Analog Cable
2. Other low voltage signal cable

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. All wires shall be copper and shall meet the minimum wire size and insulation class listed.

Wire Class	Minimum Wire Size	Minimum Insulation Class
Power	12 Gauge	600 Volt
Class 1	14 Gauge Stranded	600 Volt
Class 2	18 Gauge Stranded	300 Volt
Class 3	18 Gauge Stranded	300 Volt
Communications	Per Manufacturer	Per Manufacturer

B. 120V power circuit wiring shall be #12 AWG. Home runs longer than 100 feet shall be #10 AWG.

C. 24V control power circuit wiring and all wiring to flow switches and relays shall be #14 AWG. Runs greater than 200 feet in length shall be #12 AWG.

D. Use twisted shielded pair, insulated and jacketed cable, #18 AWG minimum, for wiring to sensors (temperature, humidity, etc.). All sensor wiring shall have a 100% grounded shield.

E. Network communications wiring shall be in accordance with manufacturer's specifications.

F. Use THHN wires for power circuit wiring and all control wiring in dry locations; use THWN wires for wet locations.

G. Conductors shall be continuous from outlet to outlet and no splices or connections shall be made, except within outlet boxes, junction boxes or cabinets.

H. Permanent wiring shall not be pulled into conduits or raceways until permission is granted by Owner.

I. Where the space above a ceiling is a supply or return air plenum, the wiring therein shall be plenum rated.

PART 3 - EXECUTION

3.1 WIRING

A. All sensor wiring shall use crimped or soldered connections; wire nuts are not allowed.

B. Sensor wiring shall be continuous containing no splices between the digital controller and the field sensor.

C. Identify all control/signal wires with labeling tape using either words, letters or numbers that can be exactly cross-referenced with as-built drawings.

3.2 INSTALLATION

A. Wires shall be kept a minimum of 3" from hot water piping, steam piping, condensate piping or any other hot surfaces.

B. The Contractor shall provide a separate insulated green ground wire inside each power branch circuit conduit. Connect one end of the ground wire to the ground bus or ground terminal in the panel board. Connect the other end of the ground wire to the grounding lug in equipment being served. Provide and install a grounding lug in equipment being served if no grounding lug exists.

C. Identify all temperature control raceways with labels stating "Control System Wiring." Typed (not handwritten) labels shall be affixed to the covers of all junction boxes and pull boxes.

3.3 RACEWAY SYSTEM

A. Power and Class 1 wiring may be run in the same conduit. Class 2 and 3 wiring and communications wiring may be run in the same conduit. Power and Class 1 may not be run together with Class 2, Class 3, or communications wiring.

B. No sensor wiring shall be run in the same conduit with power or Class 1 wiring.

C. Where different wiring classes terminate within the same enclosures, maintain clearances and install barriers per National Electric Code.

D. Pneumatic tubing may not be run in wiring conduit.

END OF SECTION

SECTION 23 0906
TEMPERATURE CONTROL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Miscellaneous Existing Controls

B. Demolition of Controls

1.2 SCOPE

A. Demolition of DDC and pneumatic control panels, devices and associated wiring, tubing and conduit for mechanical systems specified in this section.

1.3 SUBMITTALS

Not Applicable

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 MISCELLANEOUS EXISTING CONTROLS

A. Existing control equipment that is to remain is to be calibrated/adjusted for proper operation.

B. Any equipment found to be defective and requiring replacement shall be brought to the attention of Owner. Owner will be responsible for repairs to same.

C. Existing control equipment that is to remain shall be relocated to a new enclosure.

3.2 DEMOLITION

A. Demolition of the existing control systems shall be limited to those systems in which the temperature controls are to be replaced by this Project.

B. Demolition shall include removal of all existing components indicated to be replaced. This includes but is not limited to:

1. Chiller control panel components
2. Electric devices, wiring and conduit

Note: Abandoned tubing and wiring, including conduit, shall be removed completely except where tubing or conduit are installed in inaccessible locations, such as within walls or floors. All tubing ends shall be capped. Above drop ceilings is considered to be inaccessible except that wiring and pneumatic tubing within or outside conduit is to be pulled out. Conduit is to remain in place.

C. Owner will inform the Contractor of any equipment to be removed that will remain the property of Owner. All other equipment removed shall be disposed of by the Contractor.

D. The Contractor shall insure that removed controls do not compromise the operation of the existing controls which remain.

E. The Contractor shall be required to make minor modifications to the existing control system such that when a portion of a control system is removed, the remaining system is left in a neat and orderly condition similar to the original installation.

1. Contractor shall maintain all fire and smoke control system interlocks on units where such exists.

F. Patch and seal any holes left in ductwork, walls, etc. after the existing controls have been removed.

END OF SECTION

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ASECTION 23 2113
HYDRONIC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Hydronic pipe and fitting materials, joining methods, valves, and specialties in this section include:

1. Chilled water piping

B. Services provided:

1. Pipe pressure testing

1.2 DEFINITIONS

A. CWP: Cold working pressure

B. EPDM: Ethylene propylene copolymer rubber

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber

D. NRS: Non-rising stem

E. OS&Y: Outside screw and yoke

F. PTFE: Polytetrafluoroethylene

G. RS: Rising stem

H. SWP: Steam working pressure

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American Welding Society (AWS)

1. AWS A5.8: Specification for Filler Metals for Brazing and Braze Welding
2. AWS D1.1/D1.1M: Structural Welding Code - Steel
3. AWS D10.12/D10.12M: Guide for Welding Mild Steel Pipe

B. American Society of Mechanical Engineers (ASME)

1. ASME B1.20.1: Pipe Threads, General Purpose, Inch
2. ASME B16.1: Cast Iron Pipe Flanges and Flanged Fittings
3. ASME B16.3: Malleable Iron Threaded Fittings
4. ASME B16.4: Cast Iron Threaded Fittings
5. ASME B16.5: Pipe Flanges and Flanged Fittings, NPS1/2 to NPS24
6. ASME B16.10: Face-to-Face and End-to-End Dimensions of Valves
7. ASME B16.15: Cast Bronze Threaded Fittings.
8. ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
9. ASME B16.21: Nonmetallic Flat Gaskets for Pipes Flanges
10. ASME B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
11. ASME B16.23: Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
12. ASME B16.24: Bronze Flanges and Flanged Fittings.
13. ASME B16.29: Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
14. ASME B16.34: Valves – Flanged, Threaded and Welding End
15. ASME B16.39: Malleable Iron Threaded Pipe Unions

16. ASME B18.2.1: Square and Hex Bolts and Screws - Inch Series
17. ASME B31 Series: Code for Pressure Piping
18. ASME B31.1: Power Piping
19. ASME B31.9: Building Services Piping
20. ASME Boiler and Pressure Vessel Code: Section IV, "Heating Boilers"; Section VIII, "Pressure Vessels," Division 1; Section IX, "Welding and Brazing Qualifications"

C. American Society for Testing Materials (ASTM)

1. ASTM A 47/A 47M: Specification for Ferritic Malleable Iron Castings
2. ASTM A48/A 48M: Specification for Gray Iron Castings
3. ASTM A 53/A 53M: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
4. ASTM A 106: Specification for Seamless Carbon Steel Pipe for High-Temperature Service
5. ASTM A 126: Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
6. ASTM A 234/A 234M: Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Services
7. ASTM A 307: Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
8. ASTM A 395/A 395M: Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
9. ASTM A 536: Specification for Ductile Iron Castings
10. ASTM A 733: Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
11. ASTM B 32: Specification for Solder Metal
12. ASTM B 61: Specification for Steam or Valve Bronze Castings
13. ASTM B 62: Specification for Composition Bronze of Ounce Metal Castings
14. ASTM B 75: Specification for Seamless Copper Tube
15. ASTM B 88: Specification for Seamless Copper Water Tube
16. ASTM B 306: Standard Specification for Copper Drainage Tube (DWV)
17. ASTM B 584: Specification for Copper Alloy Sand Castings for General Applications
18. ASTM B 813: Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
19. ASTM B 828: Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
20. ASTM D 1785: Specification for PolyVinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
21. ASTM D 2466: Specification for PolyVinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
22. ASTM D 2467: Specification for PolyVinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
23. ASTM D 2564: Specification for Solvent Cements for PolyVinyl Chloride (PVC) Plastic Piping Systems
24. ASTM D 2672: Specification for Joints for IPS PVC Pipe Using Solvent Cement

25. ASTM D 2846/D 2846M: Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
26. ASTM D 2855: Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
27. ASTM F 402: Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermostatic Pipe and Fittings
28. ASTM F 438: Specification for Socket-Type Chlorinated PolyVinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40
29. ASTM F 439: Specification for Socket-Type Chlorinated PolyVinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80
30. ASTM F 441/F 441M: Specification for Chlorinated PolyVinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80
31. ASTM F 493: Specification for Solvent Cements for Chlorinated PolyVinyl Chloride (CPVC) Plastic Pipe and Fittings
32. ASTM F 656: Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

D. American Water Works Association (AWWA)

1. AWWA C606: Grooved and Shouldered Joints

E. Brazing Handbook.

F. Manufacturers Standardization Society (MSS)

1. MSS SP-45: Bypass and Drain Connections
2. MSS SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture
3. MSS SP-67: Butterfly Valves
4. MSS SP-68: High Pressure Butterfly Valves with Offset Design
5. MSS SP-70: Cast Iron Gate Valves, Flanged and Threaded Ends
6. MSS SP-71: Gray Iron Swing Check Valves, Flanged and Threaded Ends
7. MSS SP-72: Ball Valves with Flanged of Butt-Welding Ends for General Service
8. MSS SP-78: Cast Iron Plug Valves, Flanged and Threaded Ends
9. MSS SP-80: Bronze Gate, Globe, Angle and Check Valves
10. MSS SP-85: Gray Iron Globe and Angle Valves, Flanged and Threaded Ends
11. MSS SP-107: Transition Union Fittings for Joining Metal and Plastic Products
12. MSS SP-108: Resilient-Seated Cast Iron-Eccentric Plug Valves
13. MSS SP-110: Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
14. MSS SP-122: Plastic Industrial Ball Valves
15. MSS SP-125: Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves

1.4 QUALITY ASSURANCE

A. Pipe: Each length of pipe shall be legibly identified at mill by paint, stenciling, or raised symbols identifying manufacturer and class type or schedule of pipe. Copper pipe shall be identified at 3 foot intervals.

B. Fittings: To be identified by the manufacturer by permanently attached tags, imprints, or other approved means, indicating the class of wall thickness and material.

C. Valves: Manufacturer's name and pressure rating marked on valve body.

D. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

E. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

F. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9 and applicable state labor regulations.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

G. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

H. Qualifications for Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

I. All grooved piping products shall be supplied by a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. Grooving procedures shall be in accordance with the manufacturer's current listed standards conforming to ANSI/AWWA C606.

1.5 SUBMITTALS

A. Product Data: Submit for each type of the products as listed below. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model, and dimensions.

1. Pipe materials and fittings
2. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated balancing valves and automatic flow control valves.
3. Air control devices
4. Hydronic specialties

B. Shop Drawings: For all new piping systems submit layout drawings at ¼" – 1'-0" scale in both hard-copy and AutoCAD compatible format. Shop drawings shall include, but not be limited to:

1. Piping layout indicating sizes and locations
2. Elevations of piping
3. Slopes of horizontal piping
4. Wall and floor penetrations
5. Pressure rating for each service
6. Penetrations through fire-rated and other partitions, floors, etc.
7. Equipment installation and connections based on the equipment being used on the Project
8. Hangers and supports including multiple pipe hangers
9. Location of alignment guides, expansion joints, and anchors, including attachment to building structure
10. Shop drawings shall show other building and building system components for coordination purposes. Input from other installers shall be obtained.

Any proposed changes to piping layout required for coordination purposed shall be indicated. Coordination items shown shall include but no be limited to:

a. Any pipe (e.g. sprinkler, plumbing pipes, roof drains, etc.) in vicinity of hydronic piping
b. Electrical equipment, duct banks, and conduit
c. Structural members, including structural members to which piping supports and anchors will be attached

C. Pipe Testing Submittals and Reports

1. Submit documentation of pipe pressure testing and submit test result reports within two weeks of testing.
2. Contractor shall be responsible for any corrective action required due to a failed pipe pressure test.

D. Manufacturer's Installation Instruction: Submit manufacturer's installation instructions for all manufactured products and assemblies required for this project.

E. Welding certificates

F. Operation and Maintenance Data: Include installation instruction, assembly views, lubrication instructions, and replacement parts list. For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

G. Final Record Drawings

1. During the construction process, the Contractor shall maintain a set of drawings showing the exact routing and location of piping systems being installed. The drawing shall be updated neatly by hand on a daily basis and account for routing modifications made in the field. Contractor shall use these drawing as a basis for generating the project as-built drawings.

H. As-Built Drawings

1. Upon completion of project, Contractor shall furnish as-built drawings showing in scale the exact routing and locations of all newly installed piping systems. Submit in both hard-copy and electronic AutoCAD format.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect new pipe interiors from moisture, construction debris and dust, and other foreign materials with the use of plastic end caps/plugs on each end of pipe. Maintain end-caps/plugs in place until piping is installed.

B. Store materials indoors, protected from the weather. Where exterior storage is necessary, elevate piping above grade and enclose with waterproof wrapping or cover.

C. Deliver and store valves in shipping containers with labeling in place.

D. Replace any piping or devices which are damaged during shipping or storage.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. One year warranty on products and complete installation commencing at the time of Substantial Completion

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Grade B, Type E or S, Schedule 40, black steel with plain ends. Pipe 12" and over shall be standard weight, 0.375" wall thickness.

1. Fittings and Joints
    a. 2" and smaller: ANSI/ASTM B16.3 Class 150 malleable iron or ANSI/ASTM B16.4 Class 125 cast iron fittings. Threaded joints.
    b. 2-1/2" and larger: ASTM A234, wrought steel welding type fittings. ANSI/AWS D1.1 welded joints.
2. Flanges and Flanged Fittings
    a. ANSI/ASME B16.1, Class 125 raised face cast iron flanges
    b. ANSI/ASME B16.5, Class 150 forged steel, raised face, welding neck flanges
    c. Flanges to match those on valves and equipment
    d. Slip-on steel flanges not allowed.

2.2 FLANGES, UNIONS AND COUPLINGS

A. Steel Pipe

1. Unions 2" and Smaller: ANSI/ASME B16.39 malleable iron unions for threaded pipe, ground joint, screwed bronze or brass to iron. Pressure class and joint type of union shall be equal to that specified for fittings of respective piping service.
2. Flanges 2 ½" and Larger: ANSI/ASME B16.5, forged steel, raised face, welding neck flanges. Pressure class and joint type of flange shall be equal to that specified for fittings of respective piping service.
3. Slip-on flanges are <u>not</u> allowed.

B. Flanges to match those on valves and equipment.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated

D. Pipe-Flange Gasket Materials

1. Suitable for chemical and thermal conditions of piping system contents.
2. ASME B16.21, nonmetallic, flat, asbestos free, 1/8" maximum thickness unless thickness or specific material is indicated.
    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges

2.3 DIELECTRIC FITTINGS

A. Dielectric Nipples 4" and Smaller

1. Acceptable Manufacturers: Flow Design Inc., Perfection Corporation, Victaulic.
2. Electroplated steel nipple with inert and non-corrosive thermoplastic lining; threaded or grooved ends, 300-psig minimum working pressure at 225°F meeting the requirements of ASTM F-492. Clearflow dielectric waterway fittings as manufactured by Perfection Corporation.

2.4 GLOBE VALVES

A. Acceptable Manufacturers

1. Crane
2. Hammond
3. Milwaukee
4. Nibco

B. Up to 2": Class 150, 300 psig CWP rated, manufactured in accordance with MSS-SP-80. ASTM B62 bronze body, union bonnet, bronze trim, rising bronze stem, malleable iron handwheel, asbestos free packing, renewable composition PTFE of TFE disc, screwed ends. Model 590T manufactured by Milwaukee.

C. 2 ½" and greater: Class 125, 200 psig CWP rated manufactured in accordance with MSS-SP-85. ASTM A126 iron body, bolted bonnet, bronze trim, rising stem, cast iron handwheel, asbestos free packing OS&Y, solid disc, flanged end. Model F-2981-M manufactured by Milwaukee.

2.5 BALL VALVES

A. Acceptable Manufacturers

1. Apollo
2. Crane
3. Hammond
4. Milwaukee
5. Nibco
6. Watts Regulator

B. Up to 2 ½": 600 psi CWP rated, manufactured in accordance with MSS-SP-110. Two-piece bronze body, stainless steel full port vented ball, PTFE or TFE seats, lever handle and threaded ends. Model T-585-70-66 manufactured by Nibco.

C. Ball valves mounted in insulated pipes shall have 2" extended stems of non-thermal conductive material to clear pipe covering, and a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing insulation.

2.6 BUTTERFLY VALVES – RESILIENT SEATED

A. Acceptable Manufacturers

1. Bray
2. DeZurik
3. Keystone/Tyco
4. Milwaukee
5. Nibco

B. Standard Pressure Butterfly Valves:

1. 2 ½" to 6": 175 psi close off pressure at temperatures up to 225°F, manufactured in accordance with MSS-SP-67, suitable for bi-directional dead-end service at rated pressure without use of downstream flange. Cast iron or ductile iron body with lug ends, aluminum bronze or Nylon 11 coated ductile iron disc, blowout proof stainless steel stem, peroxide cured EPDM seat bonded or vulcanized to the body, for service to 250°F, extended neck for insulating, 10 position lever handle for valves up to 6" in size. Series 31 manufactured by Bray.
2. Valves 8" and larger shall be furnished with handwheel and gear drive.
3. Valves 14-20": Same as above, except 150 psi rated at temperatures up to 225°F.

C. Provide chain operators for valves 8" and over installed 8'-0" or more above floor in mechanical rooms.

2.7 STRAINERS

A. Acceptable Manufacturers

1. Armstrong International
2. Keckley
3. Metraflex
4. Spirax Sarco
5. Titan Flow Control
6. Victaulic

B. Size 2½" to 16": Class 125, rated for 175 psi @ 150F, ASTM A126 cast iron body, Y pattern type with 20 mesh perforated Type 304 stainless steel screen, bolted cover for screen access and blow-off plug, flanged ends. Model YS58-CI manufactured by Titan Flow Control.

2.8 AIR VENTS

A. Acceptable Manufacturers

1. Amtrol
2. Armstrong
3. Bell and Gossett
4. Taco

B. Manual Type: Bronze body, threaded inlet connection, with ⅛" brass needle valve at top of chamber. Class 125, 150 psig CWP rated, maximum operating temperature 225°F.

C. Automatic Float Type: Bronze or cast iron body, stainless steel float, stainless steel valve and valve seat. Class 125, 150 psig CWP rated, maximum operating temperature 225°F. Model 107A manufactured by Bell and Gossett.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes. Install piping at a uniform grade of 0.2 percent upward in direction of flow when not other slope is indicated on the drawings.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Install groups of pipes at common elevations, parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

K. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

1. The use of saddle or “cut-in” connections is NOT allowed.
2. The use of T-Drill connections is NOT allowed.

L. The use of bullhead tee connections, where two opposite flows join to a common perpendicular outlet, is NOT allowed.

M. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

N. Install pipe wells for temperature controls sensors and instrumentation. Coordinate with temperature controls contractor.

O. Pipe Joint Construction

1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's “Copper Tube Handbook,” using lead-free solder alloy complying with ASTM B 32.

4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
6. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
7. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
8. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    c. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
    d. PVC Non-Pressure Piping: Join according to ASTM D 2855.

P. Coordination of mechanical work installation and access requirements:
1. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Owner and General Contractor.
2. Where pipes are to be installed in partitions, furred out spaces and chases, obtain information as to their exact location and size and install work so as to be entirely concealed in allotted space.
3. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for work and also furnish information and shop drawings necessary to permit installation of other work without delay.
4. Where there is evidence that parts of Mechanical Work will interfere with other work, assist in working out space conditions and/or structure, and make necessary adjustments to accommodate work.
5. Mechanical Work installed before coordinating with other work so as to cause interference with other work to be changed to correct such condition without additional cost to Owner.
6. Install Mechanical work to permit removal (without damage to other parts) of coils, heat exchangers, pumps, fan shafts and wheels, belt guards, sheaves and drives and other parts requiring periodic replacement or maintenance.

7. Arrange pipes, ducts and equipment to permit ready access to valves, cocks, traps, starters, motors, dampers, control components and to clear the openings of swinging and overhead doors and of access panels.
8. Provide access panels in equipment, ducts and like items for inspection of interiors and proper maintenance.

Q. Appliances and equipment to be installed and connected with best engineering practices and in accordance with manufacturer's instructions and recommendations. Piping, valves, connections and other like items recommended by manufacturer or as required for proper operation to be provided without additional cost to Owner.

R. In no case will any pipe, conduit or duct be installed where it is supported on or suspended from another pipe, conduit or duct.

S. Follow manufacturers' directions in installation and operation of all equipment and materials.

T. Indirect waste lines, cooling coil drain pan lines, overflow pipes, relief valve discharge pipes, etc. shall have ends beveled at 45° angle to minimize splashing.

U. After completion or piping installation, clean, flush, and treat systems. Coordinate with chemical treatment requirements; refer to Division 23 Section 23 2500, "Pipe Cleaning, Flushing, and Chemical Treatment."

V. Valves

1. Examine valve interior for cleanliness. Clean or replace as required.
2. Remove special packing materials from valves.
3. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by valve operation.
4. Install valves with stems upright or horizontal, not inverted.
5. Install valves in position to allow full movement and operation.
6. Install chainwheels on operators for butterfly and other shut-off valves sizes 8" and over, installed 8'-0" or more above floor in mechanical rooms.
7. Install swing check valves in horizontal position with hinge pin level.

3.2 APPLICATIONS

A. Select system components with pressure rating equal to or greater than system operating pressure.

B. Install unions in piping 2" and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

C. Install flanges in piping 2½" and larger, at final connections of equipment and elsewhere as indicated.

D. Install drains, consisting of a tee fitting, ¾" ball valve, and short threaded nipple with cap, at main shut-off valves, low points of piping, bases of vertical risers, at equipment and elsewhere as required for system drainage.

E. Provide manual air vents where shown on drawings and all high point of water systems, at heat transfer coils and elsewhere as required for air venting. Where large air quantities can accumulate in piping systems, provide enlarged air collection chambers.

F. Provide non-conducting dielectric fittings wherever joining dissimilar metals.

G. Piping to equipment shall be installed full size as indicated on the plans. If equipment connections differ from piping shown on the drawings, provide reducers/increasers at all valves, devices, and equipment as required.

3.3 WELDING

A. All welding shall be performed by experienced welders in a neat and workmanlike manner. Welding done on piping, pressure vessels and structural steel under this section shall be performed only by persons who are currently qualified in accordance with ANSI Standard Code for Pressure Piping, Section I, Power Piping, Bulletin ANSI B31.1.0-1980; applicable portions of ASME Boiler and Pressure Vessel Code, Section I, Power Boilers, and Section IX, Welding Qualifications. Submit for approval and record certified copies of Procedure Specification for Welding, Welding Procedure Qualification Tests and Welder Performance Qualification Tests. Welding specifications and qualification tests shall be recorded on Forms Q-1 as recommended in Appendix II of Section IX of the ASME Boiler and Pressure Vessel Code. Records shall be certified by Contractor and shall be accessible to authorized inspector.

B. Bevel piping on both ends before welding as required and defined in Code.

C. Use following weld spacing on all butt-welds:

Nominal Pipe Wall Thickness	Space
¼" or less	⅛"
Over ¼" or less than ¾"	3/16"
¾" and over	3/16"

D. Use backing rings on welds in all piping 10" and larger.

E. Where welding branches or connections are taken from a branch or main and the branch or connection pipe size is the same diameter as the main, a welding tee must be installed in the main for the branch or connection. Saddle or cut-in connections are NOT allowed.

F. Where branches or connections are made to a welded main and the branch or connection is a minimum of two pipe sizes less than the diameter of the main, and the branch is 2 ½" and larger, install a Bonney-Forge weldolet at the branch connection to the main. Where the branch or connection is 2" and smaller, install a Bonney-Forge threadolet at the branch connection to the main. Screwed couplings, half couplings or screwed nipples welded to mains for screwed branches will not be permitted.

G. The method of attaching weldolet or threadolet units to the piping shall be in strict accordance with the ANSI Code for Pressure Piping, B31.1.

H. Before start of any welding, remove all corrosion and other foreign material from surface to be welded.

I. Welding shall be performed by either manual shielded metallic arc process or automatic submerged arc process. Use direct current exclusively.

J. Electrodes to be used with manual shielded metallic arc method shall conform to ASTM A-233, Classification E-6010.

K. Size of electrodes, voltages, current, thickness, and number of passes or beads shall be in accordance with provisions of previous paragraph.

L. After deposition, clean each layer of weld metal to remove all slab and scale by wire brushing or grinding, then chip where necessary to prepare for proper deposition of next layer.

M. Weld reinforcement shall be not less than 1/16" or more than ⅛" above normal surface of joined sections. Reinforcement shall be crowned at center and shall taper on each side to surface being joined. Exposed surface of weld shall present workmanlike appearance and shall be free of depressions below surface of joined members.

N. No welding of any kind shall be done when temperature of base metal is lower than 0°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Temperature of metal shall be "warm to hand" – or approximately 60°F.

O. All welders engaged in work performed under this Section shall have been qualified in accordance with test requirements of Section IX of the ASME Boiler and Pressure Vessel Code. Each operator shall identify his production welds by marking his regularly assigned identification number or mark within 1" of weld. Contractor shall submit complete list of individual numbers of identifying marks and operator's name, and a copy of each operator's certificate.

3.4 TESTING

A. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of tests herein specified. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. Field test all piping before start-up of systems. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.

C. Perform all tests other than herein specified which may be required by legal authorities or by agencies to whose requirements this work is to conform.

D. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to Owner.

E. No work shall be insulated, painted, backfilled or concealed until authorized by Owner's representative and/or the Engineer representative.

F. Inform Engineer and Owner's representative 48 hours prior to when work is ready for test.

G. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.

H. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

I. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times “SE” value in Appendix A in ASME B31.9, “Building Services Piping.”
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing. Submit to Owner and Engineer.

J. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, and cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

K. Test pressures shall be increased if necessary to comply with applicable codes.

END OF SECTION

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SECTION 23 2500
PIPE CLEANING, FLUSHING AND CHEMICAL TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cleaning of piping systems

B. Treatment for closed systems

1.2 SUBMITTALS

A. Submit product data indicating chemical treatment materials, chemicals and equipment. These items shall match Owner's existing standards.

B. Submit manufacturer's installation instructions.

C. Submit manufacturer's field reports.

D. Submit reports indicating start-up of treated systems have been completed and are operating properly.

E. Submit reports indicating analysis of system water after cleaning and after treatment.

1.3 OPERATION AND MAINTENANCE DATA

A. Include data on chemical feed pumps, agitators and other equipment including spare parts lists, procedures and treatment programs.

B. Include step by step instructions on test procedures including target concentrations.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three year's experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and for discharge to public sewage systems.

1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion.

B. Provide on-site inspections of equipment during scheduled shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.

1.7 MAINTENANCE MATERIALS

A. Provide sufficient chemicals for treatment and testing during warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gehrke Technology Group – Wauconda, IL

2.2 MATERIALS

A. All materials proposed must be compatible with existing treatment systems and chemicals.

B. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
2. Algaecide.

C. Closed System Treatment (Water):

1. Sequestering agent to reduce deposits and adjust pH.
2. Corrosion inhibitors.
3. Conductivity enhancers.

2.3 EQUIPMENT

Not Applicable

PART 3 - EXECUTION

3.1 PREPARATION

A. Systems shall be operational, filled, started and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in OPEN position during cleaning.

3.2 CLEANING SEQUENCE

A. Add cleaner to closed systems at concentration as recommended by manufacturer.

B. Chilled Water Systems: Circulate for 48 hours, then drain systems as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed.

C. Remove, clean and replace strainer screens.

D. Inspect, remove sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and with Owner's present practice.

3.4 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Provide ¾" water coupon rack around circulating pumps with space for four

3.5 FIELD INSPECTION AND REPORT

A. Provide report, in accordance with Division 01 Section 01 4000, “Quality Requirements,” prepared by manufacturer’s representative, stating that systems installed and services provided under this Section are in accordance with manufacturer’s recommendations and are properly operating.

END OF SECTION

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SECTION 23 6423
AIR-COOLED LIQUID CHILLERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Products provided in this section include:

1. Air-cooled chillers between 150 and 500 nominal tons
2. Charge of refrigerant and oil
3. Building automation system (BAS) interface
4. Vibration isolators (alternate)
5. Sound attenuation package(s) (alternate)

B. Services provided in this section include:

1. Factory functional testing
2. Manufacturer's field services
3. BAS integration
4. Maintenance agreement

1.2 REFERENCES

A. The references listed below refer to the latest version approved and in effect.

1. Air Conditioning, Heating, and Refrigeration Institute (AHRI)
   a. AHRI 370: Sound Performance Rating of Large Air-Cooled Outdoor Refrigerating and Air-Conditioning Equipment
   b. AHRI 550/590: Water Chilling Packages Using the Vapor Compression Cycle
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
   a. ASHRAE 15: Safety Code for Mechanical Refrigeration
   b. ASHRAE 34: Designation and Safety Classifications of Refrigerants
   c. ASHRAE 90.1: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
3. American Society of Mechanical Engineers (ASME)
   a. ASME SEC 8: Boiler and Pressure Vessel Code
4. American Society for Testing and Materials (ASTM)
   a. ASTM B-117: Standard Practice for Operating Salt Spray (Fog) Apparatus
   b. ASTM D-1654: Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
5. International Organization for Standardization (ISO)
   a. ISO 9001/2: Standard for Manufacturing Quality
6. National Electric Code (NEC)
7. National Electrical Manufacturers Association (NEMA)
   a. NEMA 250: Enclosures for Electrical Equipment

b. NEMA AB-1: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
c. NEMA ICS 2: Industrial Control and Systems: Controllers, Contactors, and Overload Relays
d. NEMA ICS 6: Industrial Control and Systems: Enclosures
e. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches
f. NEMA MG 1: Motors and Generators

8. Occupational Safety and Health Act (OSHA)
9. Underwriters Laboratories Inc. (UL®)
   a. UL 508: Industrial Control Equipment
   b. UL 1995: Heating and Cooling Equipment

1.3 QUALITY ASSURANCE

A. Conform to all national, state, and local codes.

B. Conform to Intertek Testing services for the construction of chillers and provide ETL/cETL Listed compliance label.

C. Comply with UL and UL Canada and include a compliance label by a qualified testing agency.

D. Chiller components shall be constructed, tested, and stamped in accordance with applicable ASME codes.

E. Conform to ASHRAE 15: Safety Code for Mechanical Refrigeration.

F. Conform to NFPA 70: National Electrical Code.

G. Chiller shall be manufactured in a facility registered to ISO 9001 or ISO 9002.

H. Chiller performance shall be rated and certified in accordance with AHRI 550/590.

I. Chiller sound data shall be rated and certified in accordance with AHRI 370.

J. Chiller painted components shall be capable of withstanding 1,000-hour salt spray test in accordance with ASTM B-117.

K. Chiller shall be functionally tested at the factory with water flowing through the chiller.

L. Chiller startup services shall be performed by factory trained personnel.

1.4 SUBMITTALS

A. Not Used.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's installation instructions for storage, rigging, unloading, and transporting units.

B. Provide protective covering over entire chiller and piping connections. Protective covering shall remain until chiller is installed.

C. Unit controls shall be capable of withstanding 110°F storage temperature in the control compartment.

1.6 SPARE PARTS

A. Provide recommended spare parts list as part of submittal package.

1.7 WARRANTY

A. Provide warranty under provisions of General Conditions.

B. Provide one (1) year parts and labor warranty on chiller package including materials, labor, and refrigerant from date of startup or 18 months from shipping, whichever occurs first.

C. **Extended Warranty:** Provide 2nd-5th extended parts and labor warranty including materials, labor, and refrigerant.

1.8 MAINTENANCE SERVICE

A. Furnish service and maintenance of complete assembly for one (1) year from equipment startup.

B. The maintenance agreement shall cover all preventive maintenance and service during regular work hours including but not limited to:

1. Cooling Season Preparation and Inspection
    a. Check refrigerant and oil levels.
    b. Check oil sump, oil heaters and temperatures.
    c. Check and test all operating and safety controls.
    d. Check the starter/VFD operation including cooling loop.
    e. Start the chilled water pump.
    f. Start the chiller and calibrate controls.
    g. Leak check the unit and identify leak sources for repair.
    h. Log operating conditions after system and unit stabilized.
    i. Review operating procedures and Owner's log with operator.
    j. Check auxiliary equipment operation.
2. Four Inspections During the Cooling Season (April, June, August, October)
    a. Inspect chiller and adjust safety controls.
    b. Inspect condenser coils and clean as needed per manufacturer's instructions.
    c. Check operation of controls.
    d. Check oil and refrigerant levels.
    e. Check operation of lube system.
    f. Check the oil return system.
    g. Check operation of motor and starter.
    h. Record operating conditions.
    i. Check log and review chiller and system operation with operator.
    j. Conduct routine maintenance as recommended and required.
    k. Log and report repairs and parts that are required.
3. Annual Equipment Shutdown Inspection and Preventative Maintenance
    a. Check the compressor-motor assembly for the following items and perform tasks as indicated:
        (1) Record voltages.
        (2) Meg test and record motor winding resistance.
        (3) Lubricate motor.
        (4) Check seals.
    b. Check the compressor oil system for the following items:

(1) Conduct analysis on oil and oil filter at an independent laboratory.
(2) Check oil pump, seal, and motor.
(3) Cleaning the dirt leg.
(4) Check heater and thermostat.
(5) Check all other oil system components including cooler, strainer, and solenoid valve where applicable.

c. Check variable frequency drive (if applicable) and perform the following tasks:

(1) Run diagnostic check.
(2) Clean contacts or recommend replacement.
(3) Check linkage.
(4) Meg test the motor.
(5) Check all terminals and tighten connections.
(6) Check overloads, dash pot oil, and calibrate.
(7) Inspect and clean heat rejection device, as required.
(8) Dry run starter (or before start-up); check status.
(9) Replace VFD system coolant

d. Review the control panel for the following items:

(1) Run diagnostic check of micro control panel.
(2) Check safety shutdown operation.
(3) Check all terminals and tighten connections.
(4) Check display data accuracy and setpoints.

e. Check the condenser for the following items:

(1) Clean condenser coils per manufacturer’s instructions.

f. Check the cooler for the following items:

(1) Check the water flow.
(2) Check flow switch operation.
(3) Check refrigerant level.

g. Check the system for the following items:

(1) Conduct a leak check and identify leak sources for repairs.
(2) Record condition of sight glasses.
(3) Check the refrigerant cycle to verify the proper operating balance.
(4) Check chilled water heat transfer.

h. General items included:

(1) Repair insulation removed for inspection and maintenance procedures.
(2) Clean equipment and surrounding area upon completion of work.
(3) Consult with the operator.
(4) Report deficiencies and repairs required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carrier 30XV – Prepurchased by Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on existing steel foundation.

C. Install units on vibration isolators provided by manufacturer.

D. Connect to electrical service. Refer to Division 26.

E. Connect to chilled water piping. Refer to Division 23 Section 23 2113, "Hydronic Piping and Specialties."

F. Lubricate fans and motors as recommended by the manufacturer.

G. Inspect unit condenser coils for damage and repair as necessary.

H. Check all controls after start-up.

3.2 MANUFACTURER'S FIELD SERVICES

A. Provide startup services by factory trained manufacturer's representative in accordance with Conditions of Contract. Services shall include but not be limited to:

1. Inspection of chiller installation to confirm it meets manufacturer's requirements including overall condition of the chiller, shipping brace removal, operational and maintenance clearances, piping connections, electrical connections, vibration isolator installation, controls integration, and field installed accessories.
2. Provide startup of chiller per manufacturer's operation manual.
3. Provide calculation of estimated energy efficiency ratio (EER) based on operating conditions available to verify chiller performance.
4. In conjunction with the Controls Contractor, provide a minimum of four (4) hours of commissioning of the chiller integration to the building automation system (BAS).
5. Verify that control wiring is per manufacturer's requirements.
6. Verify that chiller is communicating with the BAS.
7. Verify that all required points have been successfully mapped to the BAS and are calibrated correctly.
8. Troubleshoot any communication issues.

B. On completion of installation of vibration isolators, the local vibration isolator manufacturer's representative shall inspect the chiller installation and indicate installation errors or other faults in the system that affect the isolating system performance.

3.3 DEMONSTRATION

A. Provide a minimum of four (4) hours per chiller of systems demonstration and training by factory-trained manufacturer's representative in accordance with Conditions of Contract. Coordinate with Owner so that all shifts are included in training.

3.4 FIELD INSPECTION AND REPORT

A. Provide report prepared by manufacturer's representatives for chiller and vibration isolators, stating that systems installed, and services provided under this Section are in accordance with manufacturer's recommendations and are properly operating.

END OF SECTION

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