

Project Manual for

CHILLER REPLACEMENT URBANA CITY BUILDING

400 South Vine Street
Urbana, Illinois 61801

BID#: 1516-12



City of Urbana, Illinois
Public Works Department
706 S. Glover Avenue
Urbana, Illinois 61802
(217) 384-2342

BID DOCUMENTS, DATE: May 29, 2016



Henneman Engineering Inc.

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NOTICE OF INVITATION TO BID

BID # 1516-12

Bids will be received at the Office of the Director of Public Works, City of Urbana, Illinois, for:

Chiller Replacement – Urbana City Building 400 South Vine Street, Urbana Illinois

Bid Documents may be obtained from the Office of the Director of Public Works, 706 South Glover Avenue, Urbana, Illinois 61802. Bid Documents can be downloaded from the City of Urbana website located at www.urbanailinois.us. Bidders shall notify the Engineer, Henneman Engineering, Inc. (217)359-1514, attention Mark Burnett mburnett@henneman.com when obtaining plans, to ensure that they are copied on any Addenda issued.

Bids will be received through 2:00 P. M., Thursday, June 16, 2016, at the Public Works Center, 706 South Glover Avenue, Urbana, Illinois, and at said time the bids shall be opened and read publicly.

No Pre-Bid Meeting will be scheduled for this project. Bidders wishing to visit the project site, or with technical questions about the project, shall contact Henneman Engineering, attention Mark Burnett at (217)359-1514 or by email at mburnett@henneman.com. Any questions regarding the Bid process may be directed to Mr. Vince Gustafson, Public Facilities Supervisor for the City of Urbana, at (217) 384-2342 or by email at vhgustafson@urbanailinois.us.

Substitutions must be submitted by 2:00 PM., Wednesday, June 8, 2016 to the Architect/Engineer, Henneman Engineering Inc., for review. No substitutions will be accepted after this date. All substitutions must meet requirements established in Contract Specifications in its entirety.

The City reserves the right to reject any or all bids, and to waive irregularities or technicalities.

* * *

William R. Gray, P. E., Director
PUBLIC WORKS DEPARTMENT
City of Urbana, Illinois 61802

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STANDARD CONTRACT PROVISIONS

[CONTRACTUAL]

- 1) All items contained in the "Standard Contract Provisions" are applicable to this call for bids.
- 2) The City of Urbana (hereinafter referred to as "Owner") may require from the Bidder prior to the award of the contract a detailed statement regarding the business and technical organization and plant of the Bidder that is available for the work that is contemplated. Information pertaining to financial resources, experience of personnel, and previously completed projects may also be required.

The competency and responsibility of bidders will be considered in making awards.

- 3) The Bidder shall visit and become familiar with the site of the work before submitting their bid and thoroughly understand the conditions under which the work will be done.

No plea of ignorance of site conditions will be accepted as an excuse for any failure of omission on the part of the Contractor to fulfill in every detail all the requirements of the work.

- 4) With their proposal, each Bidder shall furnish a bid deposit in the form of a certified check, a cashier's check on any bank doing business in Urbana, Illinois, or acceptable bid bond made payable to the City of Urbana in the amount of ten percent (10%) of the bid as a guarantee that the Successful Bidder will accept the contract when offered. Personal checks or corporate checks are not acceptable.

If within fifteen (15) days after the notice of award of contract, unless a written extension is granted by the Public Facilities Supervisor, the Contractor to whom the contract is awarded refuses or neglects to execute such contract or proceed with the work, or failure to furnish a satisfactory performance bond, he shall forfeit the amount of his deposit as liquidated damages. A plea of mistake in such an accepted bid shall not be available to the Bidder for the recovery of their deposit, or as a defense to any action based upon such accepted bid.

The bid deposit of all, except the three lowest bidders, will be returned within fifteen (15) days after opening of bids, or upon Owner's determination that the Bidder's proposal will not be considered further, whichever is earlier. The bid deposit of the three lowest bidders will be returned within seven (7) days after the contracts and required bonds of the Successful Bidder have been approved by the Owner, but in no event shall exceed 45 days after the bid opening date.

- 5) A performance bond in the amount of 100 percent of the contract price, with a corporate surety approved by the Owner, will be required for the faithful performance of the contract.

Attorneys-in-fact who sign bid bonds or performance bonds must file with each bond a certified and effective dated copy of their power of attorney.

The party to whom the contract is awarded will be required to execute the contract forms and obtain the performance bond within fifteen (15) calendar days from the date when notice of award is delivered to the Bidder. The notice of award shall be accompanied by the necessary contract forms and bond

forms. In case of failure of the Bidder to execute the contract, the Owner may at his/her option consider the Bidder in default, in which case the bid bond accompanying the proposal shall become the property of the Owner.

The Owner, within fifteen (15) days of receipt of acceptable performance bond and contract signed by the party to whom the contract was awarded, shall sign the contract and return to such party an executed duplicate of the contract. Should the owner not execute the contract within such period, the Bidder may, by written notice, withdraw his/her signed contract. Such notice of withdrawal shall be effective upon receipt of the notice by the Owner.

- 6) Each proposal shall be typed or written in ink using the bid form included herein, and so filled out as to make the proposals complete and free from ambiguity as to their meaning. All erasures or corrections in proposals shall be initialed by the person signing the proposal.

Any Bidder may withdraw their bid by letter or with proper identification by personally securing their bid proposal at any time prior to the time stated for the receipt of bids. No telephone requests for withdrawal of bid will be honored.

Each proposal must be signed in the firm or corporate name and must bear an original longhand signature of a principal duly authorized to make contracts for the bidding party. The Bidder's name must be fully stated where proposals are signed by an agent of the Bidder; evidence of their authority to act as the Bidder's agent shall accompany the proposal. The name of each person signing the proposal shall be typed or printed below their signature.

Proposals must be submitted in sealed envelopes to the addressee below not later than the time set forth in "Notice to Bidders" addressed as follows:

Proposal for: Chiller Replacement – Urbana City Building

To: City of Urbana
C/o William R. Gray, Director of Public Works Department
706 South Glover Avenue
Urbana, Illinois 61802

Bid Call Number: 1516-12

Show the name and address of the bidding firm in the upper left-hand corner of the envelope. Also show the bid call number and the date and time of bid closing in the lower left-hand corner.

- 7) Proposals will be opened publicly by the Owner immediately after the required time and date of submission. The Owner reserves the right to reject any or all bids, or any part thereof, or to waive any informalities in any bid, deemed to be for the best interests of the Owner.
- 8) In the "Award of Contract," the Bidder's reputation and the amount of the proposal will be considered. The Owner reserves the right to accept the bid deemed most favorable for this project after all bids have been examined and evaluated.

Prior to commencing work on this project, and within fifteen (15) days after notification of award, the Contractor is required to post a "Certificate of Insurance" with the Owner. (See No. 9 below.)

Before the contract is awarded, the successful Bidder shall furnish to the Owner for approval a complete list of all subcontractors they intend to use on the work, in any.

- 9) The Successful Bidder will be required to furnish a "Certificate of Insurance" to the Director of Public Works of the City of Urbana, indicating that the Bidder has obtained for the benefit and protection of themselves and the City of Urbana, Illinois, an adequate liability insurance policy, along with a certification by an insurance company to the effect that the Bidder has obtained public liability and workmen's compensation insurance in a sufficient amount to protect themselves and the City from any liability of damage resulting from injury to their employees or to others or to the property of others. The "Certificate of Insurance" shall also certify that the insurance will not be cancelled or allowed to lapse during the time of work without first giving notice in writing to the City of Urbana, Illinois.

The Contractor shall maintain during the entire period of their performance under this Contract the following minimum insurance:

Worker's Compensation

- Basic policy including occupational disease--statutory limits.
- Employer's liability: at least \$100,000/per person per accident and at least \$500,000 each accident.
- Contractors having offices or places of hire outside the State of Illinois shall attach or otherwise show an "all states" endorsement.

Comprehensive General Liability

A. Minimum Limits:

Bodily Injury	\$1,000,000/each occurrence \$1,000,000/aggregate
Property Damage	\$1,000,000/each occurrence \$1,000,000/aggregate

B. Included Coverage:

- Premises and Operations
- Independent Contractors
- Products and Completed Operations (including coverage for defects in materials, products or equipment installed under the contract which appear within one year after the date of substantial completion).
- Property Damage -- include Broad Form. Write on occurrence basis.
- Contractual Liability
- Bodily Injury -- include Personal Injury

- Property Damage -- remove "XC" exclusion
- Property Damage -- remove "U" exclusion

Comprehensive Automobile Liability

A. Minimum Limits:

Bodily Injury	\$1,000,000/each person
Property Damage	\$1,000,000/each occurrence

B. Included Coverage (may be in comprehensive form):

- Owned vehicles
- Non-owned vehicles
- Hired vehicles
- Property Damage -- write on occurrence basis

Excess Liability

A. Umbrella form

B. Minimum limits:

Combined bodily injury and property damage:
 \$1,000,000/each occurrence
 \$1,000,000/aggregate

Surety Ratings

Insurance required shall be written with a company having at least an "A-10" rating as listed in Best Insurance Guide, latest edition.

Maintenance of the insurance by the Contractor shall in no way relieve the Contractor from any responsibility or requirement to the Contractor of any responsibility whatsoever. The Contractor may carry, at their own expense, such additional insurance as is deemed necessary, providing such insurance does not prejudice or in any way interfere with the Owner's rights of recovery under the Owner's Builder's Risk Insurance.

- 10) The Bidder's attention is directed to the fact that all applicable Federal and State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over the project shall apply to the Contract throughout, and these will be deemed to be included in the Contract the same as though herein written out in full.

Where state and/or local codes exist, these shall be followed by all contractors for this project. Where conflicts exist between applicable codes and these specifications, the codes shall govern. The

specifications shall be considered as a minimum acceptable level of quality of materials and workmanship.

- 11) All bids shall include all taxes that are applicable to the City of Urbana. The City and State of Illinois sales tax and Federal excise taxes are not applicable to sales made to the City of Urbana and must be excluded. The City Clerk, upon request, will execute the exemption certificates in connection with all orders when Federal excise tax would otherwise be due. Building permits will be supplied to the Contractor at no charge.
- 12) Bidders and Bidders' Subcontractors shall agree to comply with the City of Urbana's Affirmative Action Ordinance and, when required, shall submit written evidence of the firm's employment practices, policies, goals and statistical data concerning employee composition on race, color, job description and compensation. "Award of Contract" is contingent upon on-site inspection or other means of verification in accordance with City of Urbana procedures.
- 13) Unless otherwise specified, materials and equipment purchased will be inspected as to meeting the quality requirements of the call for bids. When deemed necessary, samples of supplies or materials will be taken at random from stock received for submission to a commercial laboratory, or other appropriate inspection agency, for an analysis and test as to whether the material conforms in all respects to the specifications. In cases where the commercial laboratory report indicates that the material does not meet the specifications, the expense of analysis is to be borne by the Contractor and the order or balance thereof may be cancelled by the City of Urbana.
- 14) Contractor shall hold the City of Urbana, its officers, agents, and employees harmless from liability or damages of any nature or kind concerning the undertaking and execution of this Contract.

Successful Bidder is specifically denied the right of using, in any form or medium, the name of the City of Urbana for public advertising unless express permission is granted by the Director of Public Works.
- 15) No member, officer, or employee of the City of Urbana, Illinois, or its designees or agents, and no member of the governing body of the City of Urbana, Illinois, who exercises any functions or responsibilities with respect to the City of Urbana during their tenure or for one year thereafter, shall have any interest, direct or indirect, in any contract or subcontract, or the proceeds thereof, for work to be performed in connection with this Contract.
- 16) It shall be the responsibility of the Contractor to ascertain the location of all utility lines and to protect from damage all existing improvements or utilities at or near the site of the work.
- 17) The Owner will permit the Contractor to use at no cost existing utilities such as light, heat, power and water necessary to the carrying out and completion of the work.
- 18) The Contractor shall exercise proper precaution at all times for the protection of persons and property and shall be responsible for all damages to persons or property, either on or off the site, that occur as a result of the Contractor's completion of the work. The safety provisions of applicable laws and building construction codes shall be observed, and the Contractor shall take or cause to be taken such additional safety and health measures as the Director of Public Works of the City of Urbana, Illinois, may determine to be reasonably necessary.

- 19) All changes to the Contract must be mutually agreed upon in writing and signed by the parties to the Contract. If any such agreed-upon change causes an increase or decrease in the Contractor's cost of, or the time required for, the performance of any part of the work under this Contract, adjustment shall be made and the Contract modified accordingly. Any agreements not signed as heretofore indicated shall be considered null and void. The Contractor shall furnish an itemized price breakdown in connection with any proposal made for Contract modification. The price breakdown shall be in sufficient detail to permit an analysis of all material and labor costs. If the proposal includes a time extension, a justification therefore also shall be furnished.
- 20) The provisions of this Contract apply to any subcontractor. The Contractor agrees that they are fully responsible to the Owner for the acts and omission of their subcontractors and of persons either directly or indirectly employed by them as they are for the acts and omissions of themselves or persons directly employed by them. Nothing contained in the Contract documents shall create any contractual relation between any subcontractor and the Owner. The Contractor shall not contract any part of the work under this Contract, or permit their contracted work to be further subcontracted, without the prior written approval of the Director of Public Works of the City of Urbana, Illinois. The Contractor shall submit with their bid a complete list of proposed subcontractors and possible alternates.
- 21) In case the Contractor fails to furnish materials or to execute work in accordance with the provisions of this Contract, or fails to proceed with or to complete the work within the time specified in this Contract, or otherwise violates the provisions of the Contract, then in any case upon ten (10) days written notice to the Contractor by the Owner, the City of Urbana shall have the right to declare the Contractor in default in the performance of their obligations under the Contract. Said notice shall contain the reason for the Owner's intent to declare the Contractor in default. Unless, within ten (10) days after the Contractor's receipt of said notice, the violation shall cease or satisfactory arrangements shall be made for its correction, the Contractor by written notice may be declared in default and their right to proceed under the Contract may be terminated.
- In the event the Contractor is thus declared to be in default, the Owner will proceed to have the work completed and shall apply to the cost of having the work completed any money due the Contractor under the Contract. The Contractor shall be responsible for any damages resulting to the Owner by reason of said default. Notice shall be considered as given by the Owner for purpose of this agreement if mailed by regular mail to the Contractor at address listed by Contractor on proposal form.
- 22) The work provided hereunder by the Contractor shall be executed as directed by the Bid Form and Contract Specifications and shall be performed in a skillful and professional manner. All materials used in the construction, rehabilitation, renovation, remodeling and improvement shall be new unless otherwise expressly set forth in the Contract Specifications, and shall be sealed in their original containers until opened at the job site.
- 23) The Contractor shall give their personal superintendence to the work or have a competent foreman or superintendent on the work at all times during progress, with authority to act for the Contractor.

- 24) The Contractor shall keep the premises clean and orderly during the course of the work and shall remove all debris at the completion of the work. Except where otherwise noted, materials and equipment that have been removed and replaced as part of the work shall belong to the Contractor.
- 25) The Successful bidder shall begin the Work upon receipt of an executed Contract and shall complete the Work within 120 calendar days of the date of the executed Contract. The Contractor shall prepare and submit required shop drawings and product data within 10 business days of receipt of the executed Contract, and shall place the order for all new equipment immediately upon receipt of shop drawing/submittal approval by the Architect/Engineer. The City will pay for equipment (less 10% retainage) received by the Contractor and designated exclusively for use on this project, as long as it is stored in an insured warehouse listing the City as an additional insured party. Actual work on the jobsite shall not commence until the end of cooling season (on or about Oct. 1, 2016), unless the existing facility chiller equipment fails, in which case the Contractor will be requested to complete the work as expeditiously as possible.

The Successful Bidder shall furnish the Owner with an estimated time schedule setting up order of procedure and time allowed for each branch of the work. Contractor and Subcontractors shall make every effort to complete the work regularly and diligently, to adhere to these schedules, and to cause no delays to each other. Should a Subcontractor fail to maintain progress according to approved schedule, or cause delay to another subcontractor, they shall furnish, at their own expense, such additional labor and/or services as may be necessary to bring the operation up to schedule.

- 26) Payment in full will be made upon submission of an invoice at project completion. All payments are subject to satisfactory final inspection and acceptance by the Public Works Department of the City of Urbana, Illinois.
- 27) The Contractor shall pay or cause to be paid not less than the prevailing rate of wages for the local area as found by the State of Illinois Department of Labor. The Contractor may be required by the City of Urbana to provide documentation to prove compliance with prevailing wage rates.
- 28) The Contractor shall comply with City of Urbana requirements for Equal Employment Opportunity (EEO) and complete the attached Workforce Statistics form. The Contractor and their Subcontractors shall not discriminate against any qualified employee or qualified applicant available for employment to be employed in the performance of this Contract with respect to their hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of race, color, religion, national origin, or ancestry. Any violation of this covenant may result in the institution of penalties by law.

The Contractor and Subcontractors shall comply with all applicable Federal, State and local statutory or administrative prevailing wage requirements or equal employment opportunity requirements. Further, the Contractor and Subcontractor shall not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin or age. The Contractor shall take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard to their race, religion, color, sex, national origin or age. Such action shall include, but not be limited to, the following: employment upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places,

available to employees and applications for employment, notices setting forth the policies of nondiscrimination.

- 29) The Contractor shall comply with the Drug Free Workplace Act and Certification of Compliance. The Purchasing Certification form included is to be completed by the Bidder and returned with said proposal.

SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Requests for Information (RFIs).
 - 3. Project meetings.

1.3 DEFINITIONS

- A. RFI: Request from Owner, Construction Manager, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination: Each sub-contractor shall coordinate its construction operations with those of other sub-contractors and entities to ensure efficient and orderly installation of each part of the Work. Each sub-contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Project closeout activities.
 7. Startup and adjustment of systems.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Engineer will return RFIs submitted to A/E by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of A/E.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

- C. RFI Forms:
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. A/E will review each RFI, determine action required, and respond. Allow seven working days for A/E's response for each RFI. RFIs received by A/E after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of A/E's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. A/E's action may include a request for additional information, in which case A/E's time for response will date from time of receipt of additional information.
 3. A/E's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to City's Contract Modification Procedures.
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify A/E in writing within 10 days of receipt of the RFI response.

1.6 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.
- B. Preconstruction Conference: A/E will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.
1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, A/E; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.

- f. Procedures for processing field decisions and Change Orders.
- g. Procedures for RFIs.
- h. Procedures for testing and inspecting.
- i. Procedures for processing Applications for Payment.
- j. Distribution of the Contract Documents.
- k. Submittal procedures.
- l. Preparation of record documents.
- m. Use of the premises and existing building.
- n. Work restrictions.
- o. Working hours.
- p. Owner's occupancy requirements.
- q. Responsibility for temporary facilities and controls.
- r. Procedures for moisture and mold control.
- s. Procedures for disruptions and shutdowns.
- t. Construction waste management and recycling.
- u. Parking availability.
- v. Office, work, and storage areas.
- w. Equipment deliveries and priorities.
- x. First aid.
- y. Security.
- z. Progress cleaning.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Coordination Meetings: Conduct Project coordination meetings at biweekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

- 1. Attendees: In addition to representatives of Owner, A/E, each subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
- 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.

- 10) Hazards and risks.
- 11) Progress cleaning.
- 12) Quality and work standards.
- 13) Change Orders.

- 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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**SECTION 01 33 00
SUBMITTAL PROCEDURES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require A/E's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require A/E's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. A/E's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.
 - 1. A/E will furnish Contractor digital data drawing files as requested for use in preparing Shop Drawings and Project record drawings.
 - a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in AutoCAD release 2013 (or earlier upon request).
 - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to A/E.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. A/E reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on A/E's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 10 business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. A/E will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 10 days for review of each resubmittal.
- D. Electronic Submittals: All submittals shall be made to A/E electronically. Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by A/E.
 4. Transmittal Form for Electronic Submittals: Use form acceptable to Owner and A/E, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of A/E.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.
 - g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Indication of full or partial submittal.

- o. Transmittal number, numbered consecutively.
 - p. Remarks.
- E. Options: Identify options requiring selection by A/E.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer and Construction Manager on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Engineer's and Construction Manager's action stamp.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from A/E's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Submit electronic submittals via email as PDF electronic files. Where file size is too large to email, post to an FTP site with access given to the A/E, or to the A/E's FTP site.
 - a. A/E will return annotated file. Retain one copy of annotated file as an electronic Project record document file.
 - 2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 - i. Do NOT include Material Data Safety Sheets (MSDS).
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Engineer's digital data drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than 30 by 42 inches (750 by 1067 mm).
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

- G. **Manufacturer Certificates:** Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. **Product Certificates:** Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. **Material Certificates:** Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- J. **Material Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- K. **Product Test Reports:** Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. **Research Reports:** Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- M. **Compatibility Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- N. **Field Test Reports:** Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- O. **Design Data:** Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

- A. **Performance and Design Criteria:** Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to A/E.
- B. **Delegated-Design Services Certification:** In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file, signed and sealed by the responsible design

professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal prior to submitting to the A/E and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to A/E.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 - Closeout Procedures.
- C. Approval Stamp: Stamp each submittal with an approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents. A/E will not review submittals that have not been reviewed and approved by the General Contractor.

3.2 ENGINEER'S ACTION

- A. Action Submittals: A/E will review each submittal, make marks to indicate corrections or revisions required, and return it. A/E will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- B. Informational Submittals: A/E will review each submittal and will not return it, or will return it if it does not comply with requirements. A/E will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from A/E.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid: It is the intent of these specifications to provide complete and workable mechanical systems as shown on the accompanying plans and as specified herein except such parts as are specifically exempted herein. Provide all necessary supervision, coordination, labor, materials, equipment, fixtures, dryage, hoisting, tools, transportation, plant services and facilities, machinery and connections to utilities for the installation of complete and operable mechanical systems. If details or special conditions are required in addition to those shown on drawings, provide all material and equipment usually furnished with such systems or required to complete their installation, whether noted in plans and specification or not.
- B. Materials and labor shall be new (unless noted otherwise), first class and workmanlike and shall be subject at all times to the A/E's inspections, tests and approval from the commencement until the acceptance of the completed work.
- C. The layout shown on the drawings is necessarily diagrammatic but shall be followed as closely as other work will permit. The drawings provide design intent. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- D. Because of the scale of the Drawings, certain basic items, such as, pipe fittings, duct fittings, access panels, and sleeves, may not be shown. Where such items are required by Code or by other Sections, or where required for proper installation of the Work, such items shall be included, whether shown or not.
- E. In the event of any inconsistencies between the specifications, drawings, contract documents, applicable laws, statutes, ordinances, building codes, rules and regulations, the contractor shall provide the better quality or greater quantity of work and comply with or conform its work to the most stringent legal or contractual requirements.
- F. Changes from these drawings required to make this work conform to the building construction shall be made only with prior written approval of the Engineer. All proposed changes shall be shown on shop drawings. All measurements shall be verified by actual observation and all work shall fit in place meeting the approval of the Engineer.
- G. Equipment Specification may not deal individually with minute items required, such as, components, parts, controls, and devices which may be required to produce the equipment performance specified or as required to meet the equipment warranties. Where such items are required to make the system operational, they shall be included by the supplier of the equipment at no additional cost, whether or not specifically called for.

1.02 SECTION INCLUDES

- A. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.
 - 1. Submittals
 - 2. Construction Verification Checklists
 - 3. Functional Performance Tests
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Guarantee
 - 7. Work By Owner
 - 8. Equipment Furnished By Others
 - 9. Provisions For Future
 - 10. Operation And Maintenance Instructions
 - 11. Record Documents
 - 12. Continuity Of Existing Services
 - 13. Protection Of Finished Surfaces
 - 14. Sealing And Firestopping

15. Off Site Storage
16. Regulatory Requirements
17. Certificates And Inspections
18. Coordination
19. Demolition And Existing Requirements
20. Request And Certification For Payment
21. Sleeves And Openings
22. Omissions
23. Definitions
24. Project/Site Conditions
25. Work Sequence And Scheduling
26. Salvage Materials
27. Training
28. Access Panels And Doors
29. Identification
30. Demolition
31. Cutting And Patching
32. Building Access
33. Equipment Access
34. Lubrication
35. Housekeeping And Clean Up

1.03 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. This section applies to all Division 23 sections.

1.04 SUBMITTALS

- A. Submit shop drawings for equipment under each section per requirements listed in that section, as well as per Division 1.
- B. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Do not submit hard copies of web pages. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
- C. On request from the A/E, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.
- D. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.
- E. The submittals must be approved before fabrication is authorized.
- F. Provide electronic copies of all submittals for review.
- G. Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Include a statement on the shop drawing transmittal to the engineer that the equipment submitted and the motor starter schedule is in agreement or indicate any discrepancies.

1.06 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in other sections are as follows:
 1. AABC Associated Air Balance Council
 2. ADC Air Diffusion Council
 3. AMCA Air Movement and Control Association
 4. ANSI American National Standards Institute
 5. AHRI Air-Conditioning, Heating and Refrigeration Institute
 6. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers

7. ASME	American Society of Mechanical Engineers
8. ASTM	American Society for Testing and Materials
9. AWWA	American Water Works Association
10. AWS	American Welding Society
11. EPA	Environmental Protection Agency
12. ETL	Edison Testing Laboratories
13. FM	Factory Mutual Insurance Company
14. ICC	International Code Council
15. IEEE	Institute of Electrical and Electronics Engineers
16. ISA	Instrument Society of America
17. ISO	International Organization for Standardization
18. MCAA	Mechanical Contractors Association of America
19. MICA	Midwest Insulation Contractors Association
20. MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
21. NBS	National Bureau of Standards
22. NEBB	National Environmental Balancing Bureau
23. NEC	National Electric Code
24. NEMA	National Electrical Manufacturers Association
25. NFPA	National Fire Protection Association
26. OSHA	Occupational Safety and Health Administration
27. SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. Inc.
28. TABB	Testing, Adjusting and Balancing Bureau
29. UL	Underwriters Laboratories Inc.
30. ASTM E814	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
31. ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
32. UL1479	Fire Tests of Through-Penetration Firestops
33. UL723	Surface Burning Characteristics of Building Materials

1.07 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Division 1 for equals and substitutions.
 1. Where the following conflicts with Division 1, the requirements of Division 1 shall govern.
 2. If the Contractor wishes to submit an alternate to the named manufacturers for any equipment, he may submit a voluntary alternative minimum 7 days prior to bid, stating the manufacturer's name, model number, written, detailed product data.
 3. Where materials or equipment are specified by name the proposed material or equipment must be identical to the specified material or equipment in all characteristics of quality, function and serviceability, regardless of application in the Project and, in addition, when the Engineer deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture. Any proposed equal shall be submitted to Engineer for prior approval, which Engineer may approve or disapprove in its sole discretion. Work performed or constructed with unapproved equals is at Contractor's risk and any required correction of work incorporating unapproved equals shall be at Contractor's sole cost and expense.
 4. In all instances, Contractor shall assume full responsibility for proof of equality of the statute to the equipment hereinafter specified. All data and information necessary for proof of equality, function and space requirements shall be prepared and accompany the submittal of the substitution to the Engineer. Approval by the Engineer of equipment other than the specified does NOT relieve Contractor of this responsibility.
- B. All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.
- C. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment/electrical or accessories into the system, including but not limited to, coordination with other trades and any required changes by other trades and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

1.08 GUARANTEE

- A. Refer to Division 1 for Guarantees and Warranties. In addition to the requirements in Division 1, this Contractor shall meet the following requirements.
- B. In entering into a contract covering this work, the contractor accepts the specifications and guarantees that the work will be carried out in accordance with the requirements of this specification or such modifications as may be made under the contract documents.
- C. Contractor further guarantees that the workmanship and material will be of the best procurable and that none but experienced workmen familiar with each particular class of work will be employed.
- D. Contractor further guarantees to replace and make good at his own expense, including travel time, all defects, which may develop within 1 year after final payment and acceptance by the Engineer, due to faulty workmanship or material, upon, receipt of written notification from the Owner.

1.09 WORK BY OWNER

- A. Test and balance services will be provided by the Owner under separate contract.

1.10 EQUIPMENT FURNISHED BY OTHERS

1.11 PROVISIONS FOR FUTURE

1.12 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Provide the following documentation:
 - 1. Copies of all approved shop drawings along with approval letters.
 - 2. Manufacturer's wiring diagrams for electrically powered equipment
 - 3. Records of tests performed to certify compliance with system requirements
 - 4. Certificates of inspection by regulatory agencies
 - 5. Temperature control record drawings and control sequences
 - 6. Parts lists for manufactured equipment
 - 7. Valve schedules
 - 8. Lubrication instructions, including list/frequency of lubrication done during construction
 - 9. Warranties
 - 10. Additional information as indicated in the technical specification sections

1.13 RECORD DOCUMENTS

- A. Follow the following procedures:
 - 1. During the progress of the work, Contractor shall maintain a current (daily) record set of the drawings and specifications, indicating thereon all work installed at variance with such Contract Documents including, without limitation, work covered by Addenda, Field Work Orders, Change Orders and Engineers additional instructions, interpretations and clarification. All changes or deviations from the original layout of the work and all critical dimensions of buried or concealed work shall be recorded. It shall be Contractor's responsibility to assure that said record sets are complete, accurate and up-to-date, Engineer shall have the right to inspect and review such record sets.
 - 2. At the completion of the work, Contractor shall indicated on record sets all record changes and such additional details necessary or appropriate to provide a complete reference document for use by Engineer. If variations and details cannot be shown clearly thereon, the Contractor shall prepare supplemental drawings adequate to impart the information. The foregoing drawings collectively shall constitute the "Record" drawings for the work.
 - 3. All indication on "Record" drawings shall be executed in a legible manner at Contractor's cost, using methods and legend presentations compatible with the overall scheme of the record drawings with respect to scale, drawing sheet sizes and sequential indexing. All changes shall be marked clearly in red and clouded.
 - 4. Engineer may review Contractor's "Record" drawings and notify Contractor of observed discrepancies or deviations. Contractor shall promptly correct discrepancies, deviations or illegible markups at Contractor's expense and resubmit revised drawings for Engineer review.

5. Contractor shall provide final electronic record drawings to the Owner through the Engineer.
 6. Engineer will provide final electronic record drawings to the Owner based on Contractor's markups.
- B. In addition to the data indicated in the Division 1, maintain temperature control record drawings on originals prepared by the installing contractor. Include copies of these record drawings with the Operating and Maintenance manuals.

1.14 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval from the Owner's Project Representative. When interruption is required, coordinate scheduling of down-time with the Owner to minimize disruption to his activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.
- B. Contractor shall thoroughly familiarize himself with existing systems which will affect and be affected by relocation of existing equipment and installation of new lines and equipment. They shall plan installation of their work so that interruptions of services to any building or portion thereof will be a minimum and such interruptions shall occur only when system is not required, if possible. If not possible, Contractor shall insure the operation of services by whatever means possible, such as, installing bypasses, capping of services or providing temporary service. Each interruption shall be for as short a duration as possible.
- C. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.
- D. Contractor shall restore any circuit interruption as a result of this work to proper operation as soon as possible. Note that institutional operations are on a seven day week schedule.

1.15 PROTECTION OF FINISHED SURFACES

- A. Protect existing adjacent surfaces while performing the Work. Place plywood over roof surfaces to protect from damage while performing the Work.
- B. Furnish one aerosol spray can of touch-up paint for each different color factory finish which is to be the final finished surface of the product.

1.16 SEALING AND FIRESTOPPING

- A. Sealing, fireproofing patching, fire caulking and firestopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.
- B. Contractor shall request current life safety drawings from Owner.

1.17 OFF SITE STORAGE

- A. If payment will be requested for approved offsite stored material, then the Contractor shall complete an "Off-site Storage Agreement" which is available from the Owner. Prior approval by Owner's personnel for offsite storage will be needed. No material will be accepted for offsite storage unless submittals for the material have been approved.

1.18 REGULATORY REQUIREMENTS

- A. Comply with requirements of the local Authority Having Jurisdiction (AHJ) regarding materials and installation.

1.19 CERTIFICATES AND INSPECTIONS

- A. Contractor shall obtain and pay the costs for all required permits, regulations, utilities and taxes.
- B. Obtain and pay for all required State or local installation inspections except those provided by the Engineer in accordance with State Code. Deliver originals of these certificates to the Owner. Include copies of the certificates in the Operating and Maintenance Instructions.
- C. Coordinate and provide inspections as required by the Authority Having Jurisdiction over the site.

- D. Where applications are required for procuring services to the Building, prepare and file such application with the utility company. Furnish all information required in connection with the application in the form required by the utility company.

1.20 COORDINATION

- A. Refer to Division 1 for coordination. In addition to the requirements specified under Division 1, the following requirements apply.
- B. It shall be the responsibility of the Contractor to coordinate installation to determine space requirements and to determine that adequate space for servicing is provided for all equipment. All space priority conflicts shall be brought to the attention of the Engineer.
- C. Contractor shall thoroughly familiarize himself with existing systems which will affect and be affected by relocation of existing equipment and installation of new lines and equipment. Contractor shall plan installation of their work so that interruptions of services to any building or portion thereof will be a minimum, and such interruptions shall occur only when system is not required, if possible. If not possible, Contractor shall insure the operation of services by whatever means possible, such as installing bypasses, capping of services, or providing temporary service. Each interruption shall be for as short a duration as possible.
- D. Cooperation among installation shall be required. Any Work that is installed prior to coordination and is in conflict shall be removed and reinstalled at Contractor's cost. No cost additions to the Project will be considered due to Contractor's lack of participation in the cooperation and coordination process. The following list of items of Work shall be the priority of order for the Contractor:
 - 1. Structure
 - 2. Electrical and low voltage cable tray
 - 3. HVAC piping
 - 4. Gas piping, process piping and domestic water
 - 5. Electrical conduit and low voltage conduit
- E. The above list, in descending order, is the precedence assigned the Work items for space priority.
- F. Exception: Plumbing lines below or behind plumbing fixtures shall have precedence over all other work. Electrical conduit above or below switchgear, panelboards and control panels shall have precedence over all other work. Do not install any fluid conveying piping over electrical or elevator equipment.
- G. In the case of interconnection of the work, verify at the site or on shop drawings all dimensions relating to such work. All errors due to the failure to so verify any such dimensions shall be promptly rectified.
- H. Any installed work that is not coordinated and interferes with another contractor's work shall be removed or relocated at the installing contractor's expense.
- I. Prior to start of Construction, the Contractor shall schedule a meeting with all of the sub-contractors responsible for the work items listed above. The purpose of the meeting is to introduce the coordination program and to determine its implementation in relation to the progress schedule.

1.21 DEMOLITION AND EXISTING REQUIREMENTS

- A. Existing active services: water, gas, ventilation, sanitary waste, sanitary vent, storm, electric, and any other building systems when encountered shall be protected against damage. Where existing services are to be abandoned, the services shall be removed back to the point of origin and removed from the site unless otherwise directed by the Engineer.
- B. Submit a "Sequence of Work Schedule" in respect to all temporary and permanent utility and service cutovers after final determination. This schedule shall be submitted for approval to the Owner and Engineer. The submittal shall designate priority order, service or utility affected, date of cutover, and time of day to start and finish.
- C. Bidders should inspect the site to become familiar with conditions of the site which will affect the Work. Bidders should verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, or other obstacles.
- D. Extra payment will not be allowed for changes in the Work required because of the successful bidder's failure to make this inspection.

1.22 REQUEST AND CERTIFICATION FOR PAYMENT

- A. Within 10 days after Notice to Proceed, the successful bidder will submit to the Owner's Project Representative in a form prescribed by Division 1, a cost breakdown of the proposed values for work performed which, if approved by the owner, will become the basis for construction progress and monthly payments. The cost breakdown items shall reflect actual work progress stages as closely as feasible.
- B. In addition, if payment is requested for approved off-site stored material, then that material shall be listed as a line item in the request and certification for payment cost breakdown.

1.23 SLEEVES AND OPENINGS

- A. Openings required in new or existing construction that may be necessary for the installation of new work shall be provided by the respective contractor and all patching and repairing shall be done by workmen competent in the trade required, at the expense of the respective contractor. The respective contractor shall be responsible for arranging the work so that minimum cutting will be required. All rubbish and excess materials involved in such cutting shall be promptly removed from the site and disposed of by the contractor. Cutting through the floor or roof systems or load bearing walls shall be done only with the prior written approval of the Engineer so as to avoid damaging the structural system.

1.24 OMISSIONS

- A. No later than ten (10) days before bid opening, the Contractor shall call the attention of the A/E to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

1.25 DEFINITIONS

- A. The term "provide" includes such labor, methods, materials, equipment and transportation or other facilities required to complete the Contract and the performance of all duties thereby upon the Contractor.

1.26 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 A/E before proceeding.
- C. Tools, materials and equipment shall be confined to areas designated by the Owner's project representative.

1.27 WORK SEQUENCE AND SCHEDULING

- A. Install work in phases to accommodate Owner's occupancy requirements. During the construction period coordinate schedule and operations with Owner's Construction Representatives.
- B. All work shall be performed between the hours of 7:00 am to 5:00 pm, Monday-Friday, except as noted immediately below.
- C. Removal of the existing chiller, and installation of new equipment, including final piping and electrical connections, re-fill of chilled water system, and equipment start-up, shall occur on a single weekend (Friday 5:00 pm – Monday 8:00 am), so that no disruption of the existing building cooling system shall occur during normal business hours (Monday – Friday, 8:00 am – 5:00 pm).

1.28 SALVAGE MATERIALS

- A. No materials removed from this project shall be reused (except as specifically noted below). All materials removed shall become the property of and shall be disposed of by the Contractor.

1.29 TRAINING

- A. The contractor shall have the following responsibilities:
 - 1. Provide a training plan ten days before the planned training covering the following elements:
 - a. Equipment
 - b. Intended audience
 - c. Location of training

- d. Objectives
 - e. Subjects covered (description, duration of discussion, special methods, etc.)
 - f. Duration of training on each subject
 - g. Instructor for each subject
 - h. Methods (classroom lecture, manufacturer's quality video, site walk-through, actual operational demonstrations, written handouts, etc.).
2. Provide designated owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.
 3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.
 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated at another scheduled time, if necessary.
 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. Practical building operating expertise and in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
 6. The controls contractor shall attend sessions other than the controls training, as specified, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 7. The training sessions shall follow the outline in the table of contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 8. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
 - i. Hands-on training shall include startup, operation in all modes possible, including manual, shut-down, alarms, power failure and any emergency procedures, and preventative maintenance for all pieces of equipment.
 9. The contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the central control system.
- B. Video recording of the training sessions will be provided by the contractor and added to the O&M manuals. In addition, factory training videos identifying key troubleshooting, repair, service and/or replacement techniques shall be provided and reviewed with the owner.
 - C. Provide a minimum of 2 hours of instruction.
 - D. Provide additional training as specified in other specification sections for specific equipment.

PART 2 - PRODUCTS

2.01 IDENTIFICATION

- A. Piping and ductwork labels shall follow owner's labeling and naming standards.
- B. Stencils:
 1. Not less than 1 inch high letters/numbers for marking pipe and equipment.
- C. Snap-On Pipe Markers:

1. Cylindrical self-coiling plastic sheet that snaps over piping insulation and is held tightly in place without the use of adhesive, tape or straps. Not less than 1 inch high letters/numbers and flow direction arrows for piping marking. W. H. Brady, Seton, Marking Services.
- D. Engraved Name Plates:
 1. White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, or W. H. Brady.
- E. Valve Tags:
 1. Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains or brass "S" hooks around the valve stem, available from EMED Co., Seton Name Plate Company, Marking Services, or W. H. Brady.

PART 3 – EXECUTION

3.01 DEMOLITION

- A. Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe or duct is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the owner to minimize disruption to the existing building occupants.
- B. All pipe, wiring and associated conduit, insulation, ductwork, and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor. All piping and ductwork specialties are to be removed from the site by the Contractor unless they are dismantled and removed or stored by the owner. All designated equipment is to be turned over to the owner for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.
- C. All contractors requiring the personnel/ material hoist and or temporary construction elevator (i.e. new elevators, temporarily protected) at times other than outlined in the temporary facilities specifications will make arrangements directly with the general contractor. The general contractor is responsible for all coordination and scheduling of the use of any hoisting equipment so the flow of the project is smoothly maintained and all workers have access to the work areas to perform their work and deliver material to the areas needed according to the project schedule.
- D. If any contractor's work requires the removal and replacement of any finished materials including but not limited to such materials as ceiling tiles, wall finishes, cabinets, doors, flooring, windows, etc. after those items are installed, each contractor will be responsible, at no additional cost to the owner, to replace any damaged, soiled or lost materials with new materials to match the existing materials and those materials damaged.

3.02 CUTTING AND PATCHING

- A. Contractor shall coordinate the placing of openings in the new structure as required for the installation of each sub-contractor's work.
- B. Contractor shall furnish the accurate locations and sizes for required openings in the new work, but this shall not relieve Contractor of the responsibility of checking to assure that properly sized openings are provided. When additional patching is required due to the Contractor's failure to inspect this work, then the Contractor shall make arrangements for the patching required to properly close the openings to include patch painting, and the Contractor shall pay any additional cost incurred in this respect.
- C. If cutting and patching of the new structure is made necessary due to the Contractor's failure to install piping, ducts, sleeves, or equipment on schedule, or due to the Contractor's failure to furnish on schedule the information required for the leaving of openings, then it shall be the Contractor's responsibility to make arrangements and obtain approval from the Engineer for this cutting and patching, and the Contractor shall pay any additional cost incurred in this respect. The Contractor shall also reimburse the Owner for any additional costs incurred to the Engineer for additional services caused by the Contractor in this respect.
- D. The Contractor shall provide cutting and patching and patch painting in the existing structure as required for the installation of his Work and shall furnish lintels and supports as required for openings. Cutting of structural support members will not be permitted without prior approval of the Engineer.

Extent of cutting shall be minimized; use core drills, power saws, or other machines which will provide neat, minimum openings. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

3.03 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.04 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service. Access doors where required shall be furnished and installed by the Contractor.
- B. Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

3.05 COORDINATION

- A. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, register, grilles, and recessed or semi-recessed heating and/or cooling terminal units installed in/on architectural surfaces.
- B. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
- C. Cooperate with the test and balance agency in ensuring compliance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC. Verify system completion to the test and balance agency (flushing, pressure testing, chemical treatment, filling of liquid systems, proper pressurization and air venting of hydronic systems, clean filters, clean strainers, duct and pipe systems cleaned, controls adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing work. Install dampers, shutoff and balancing valves, flow measuring devices, gauges, temperature controls, etc., required for functional and balanced systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency can perform its work.

3.06 IDENTIFICATION

- A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.
- B. Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C. Identify piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where exposed piping passes through walls, floors or roofs. Place flow directional arrows at each pipe identification location. Piping and ductwork labels shall follow owner's labeling and naming standards. Use one coat of black enamel against a light background or white enamel against a dark background for stenciling, or provide snap-on pipe markers as specified in Part 2 – Products.
- D. Identify valves with brass tags bearing a system identification and a valve sequence number. Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device or located in another room not visible from the terminal unit. Provide a typewritten valve schedule indicating the valve number and the equipment or areas supplied by each valve; locate schedules in each mechanical room and in each Operating and Maintenance manual. Schedules in mechanical rooms to be framed under clear plastic.
- E. Use engraved name plates to identify control equipment.

3.07 LUBRICATION

- A. Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by owner. Maintain a log of all lubricants used

and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.08 HOUSEKEEPING AND CLEAN UP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

END OF SECTION

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SECTION 23 05 15
PIPING SPECIALTIES

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid: Contractor shall provide all labor and materials for a complete system in this specification section.

1.02 SECTION INCLUDES

- A. This section contains specifications for HVAC piping specialties for all piping systems. Included are the following topics:
 - 1. Thermometers
 - 2. Thermometer Sockets
 - 3. Test Wells
 - 4. P/T (Pressure/Temperature) Test Plugs
 - 5. Hose Connection Caps
 - 6. Pressure Gauges
 - 7. Flexible Piping Connections
 - 8. Flow Sensing Devices
 - 9. Differential Pressure Gauge

2.20 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 23 05 00 – Common Work Results for HVAC
- C. Section 23 05 23 – General Duty Valves for HVAC Piping
- D. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- E. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment
- F. Section 23 07 00 – HVAC Insulation
- G. Section 23 21 13 – Hydronic Piping

1.03 SUBMITTALS

- A. Refer Section 23 05 00 – Common Work Results for HVAC, Submittals. In addition to the general content specified under Section 23 05 00 – Common Work Results for HVAC, supply the following submittals:
 - 1. Thermometers
 - 2. Thermometer Sockets
 - 3. Test Wells
 - 4. P/T (Pressure/Temperature) Test Plugs
 - 5. Hose Connection Caps
 - 6. Pressure Gauges
 - 7. Flexible Piping Connections
 - 8. Flow Sensing Devices
 - 9. Differential Pressure Gauge
- B. Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, pump curves with net positive suction head requirements, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

1.04 REFERENCE STANDARDS

- A. ASME B31 Standards of Pressure Piping
- B. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

1.05 QUALITY ASSURANCE

- A. Refer to Division 1 for equals and substitutions.

1.06 DESIGN CRITERIA

- A. All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ASME B31, but not less than 125 psig unless specifically indicated otherwise.

1.09 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified in Section 23 05 00 – Common Work Results for HVAC.

PART 2 - PRODUCTS

2.01 THERMOMETERS

- A. Scale Ranges

Service	Scale Range, °F	Min. Increment, °F
Chilled Water	0 - 100	1
Glycol Water (Chilled Water)	0 - 100	1

- C. Stem type thermometers

1. Manufacturers: Ashcroft, Marsh, Taylor, H. O. Trerice, U. S. Gauge, Weiss, Weksler.
2. Stem Type, cast aluminum case, nine inch scale, clear acrylic window, adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background.

2.02 THERMOMETER SOCKETS

- A. Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

2.03 TEST WELLS

- A. Similar to thermometer sockets except with a brass cap that thread into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

2.04 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

- A. Brass plug with 1/4" NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" FPT connection for standard pressure gauges.

2.05 HOSE CONNECTION CAPS

- A. Hose connection caps shall be pressure rated for 150 psig at 180 deg F.

2.06 PRESSURE GAUGES

- A. Manufacturers: Ametek/U. S. Gauge Division, Ashcroft, Marsh, Taylor, H. O. Trerice, Weiss, Weksler.
- B. Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:

Service	Scale Range, psig	Min. Increment, psig
Chilled Water	0 – 100	2
Glycol Water	0 – 100	2

- C. Pressure Snubbers: Bronze construction, suitable for system working pressure, 1/4" size.
- D. Coil Syphons: Bronze or steel construction, suitable for system working pressure, 1/4" size.
- E. Gauge Valves: Use valves as specified in Section 23 05 23 – General Duty Valves for HVAC. For water systems, use 1/4" ball valves. For steam systems, use 1/4" gate valves suitable for system working pressure.

2.07 FLEXIBLE PIPING CONNECTIONS

- A. Refer to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

2.08 FLOW SENSING DEVICES

- A. For water flow sensing devices 2 inch and smaller, use balance valves as specified in Section 23 05 23 – General Duty Valves for HVAC Piping.
- B. Pitot Tube Flow Sensors - Type 1:
 - 1. Dieterich Standard/Annubar, Preso, ABB.
 - 2. Multi-port averaging type flow sensor designed to sense the velocity of a fluid flowing in a pipe and produce a pressure output that is proportional to the fluid velocity. Sensor to consist of a type 316 stainless steel probe with a diamond or elliptical shape of sufficient length to sense flow completely across the pipe section and to accommodate the insulation specified for the pipeline; brass body gate, needle, or ball instrument connection valves with appropriate fitting for connection to a meter; single forged steel weld type installation fitting for pipe sizes through 6 inch, double forged steel weld type installation fittings for use on opposite ends of the sensor for larger pipe sizes if recommended by the manufacturer for the application; accurate within 2% of the actual flow with a turndown ratio of 10:1 or better; permanently stamped nameplate attached to the sensor indicating the flow/differential pressure characteristics of the sensor; suitable for use on systems to 150 psig at 250°F.
- C. Pitot Type Flow Sensors - Type 2 (Hot Tap):
 - 1. Dieterich Standard/Annubar, Preso, ABB.
 - 2. Multi-port averaging type flow sensor designed to sense the velocity of a fluid flowing in a pipe and produce a pressure output that is proportional to the fluid velocity. Sensor to consist of a type 316 stainless steel probe with a diamond or elliptical shape; brass body gate, needle, or ball instrument connection valves with appropriate fitting for connection to a meter; single forged steel weld type installation fitting for pipe sizes through 6 inch, double forged steel weld type installation fittings for use on opposite ends of the sensor for larger pipe sizes if recommended by the manufacturer for the application; non-asbestos packing in a type 316 stainless steel packing gland; carbon steel mounting hardware; ball or gate type isolation valve extended from the system pipe to accommodate pipeline insulation; accurate within 2% of the actual flow with a turndown ratio of 10:1 or better; permanently stamped nameplate attached to the sensor indicating the flow/differential pressure characteristics of the sensor; suitable for use on systems to 150 psig at 366°F and 200 psig at 100°F.
 - 3. Include one differential pressure meter kit that includes a six inch diameter gauge having an accuracy of 3% of full scale or better and suitable for the differential pressures of the valves supplied for this project, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.

2.09 AIR VENTS

- A. Manual Key Type Vents: Bell and Gossett Model 4V; Eaton/Dole Model 9, 9B, or 14A.
 - 1. Bronze body with nonferrous internal parts, screwdriver operated, designed to relieve air from the system when vent is opened, rated at not less than 125 psig at 220°F.
- B. Manual Ball Valve Vents: Provide ¼" ball valves for manual venting of air. Reference Section 23 05 23 – General Duty Valves for HVAC.
- C. Automatic Vents:
 - 1. Thrush Model 720, Bell and Gossett Model 107, Watson McDaniel Model AV813W
 - 2. Cast iron body with nonferrous internal parts, designed to vent air automatically with float principle without allowing air to enter the system, rated at not less than 125 psig at 220°F.

2.10 DIFFERENTIAL PRESSURE GAUGES

- A. Barton 247A, Midwest 809, Ashcroft.
- B. Bellows type differential pressure meter kit that includes a six inch diameter gauge with a 270° arc having an accuracy of $\pm 1\%$ of full scale or better and suitable for the differential pressures of the flow

meters supplied for this project, over range protection on the meter, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, inline strainers, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

3.02 THERMOMETERS

- A. Stem Type: Install in piping systems as indicated on the drawings and/or details using a separable socket in each location. Install thermometers where these can be easily read from normal operating level.

3.03 THERMOMETER SOCKETS

- A. Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

3.04 TEST WELLS

- A. Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

3.05 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

- A. Install in piping systems as indicated on the drawings and/or details. Do not insulate over test plugs.

3.06 PRESSURE GAUGES

- A. Install in locations where indicated on the drawings and/or details, including any gauge piping, with scale range appropriate to the system operating pressures. Install where pressure gauges where these can be easily read from normal operating level.
- B. Pressure Snubbers: Install in gauge piping for all gauges used on water services.
- C. Coil Syphons: Install in gauge piping for all gauges used on steam services.
- D. Gauge Valves: Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

3.07 AIR VENTS

- A. Manual Key Type Vents: Bell and Gossett Model 4V; Eaton/Dole Model 9, 9b, or 14a.
 - 1. Install at all high points where air may collect and not be carried by the system fluid. Use a soft Type L copper "pigtail" so the vent can be positioned for venting and collecting any water that might escape.
- B. Manual Ball Valve Vents: Install at all high points where air may collect and not be carried by the system fluid, on air handling coils, and where indicated elsewhere as shown on drawings and details. Vents included at terminal units are acceptable only where terminal unit is at the high point of the system.
- C. Automatic Vents: Install on the top of air separators on systems using bladder type expansion tanks. Install at other locations as indicated on the drawings or details. All locations to have a ball valve installed upstream of the vent for maintenance purposes. Provide vent tubing to nearest drain. Coordinate routing with owner before installation.

3.26 CONSTRUCTION VERIFICATION ITEMS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under this specification in accordance with the procedures defined for construction verification checklists.

END OF SECTION

SECTION 23 05 23
GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Base Bid: Contractor shall provide all labor and materials for a complete system in this specification section.

1.02 SECTION INCLUDES

- A. This section includes valve specifications for all HVAC systems except where indicated under Related Work. Included are the following topics:
 - 1. Bypass Valves
 - 2. Water System Valves
 - a. Gate Valves (Hydronic)
 - b. Ball Valves (Hydronic)
 - c. Butterfly Valves (Hydronic)
 - d. Globe Valves (Hydronic)
 - e. Balance Valves

1.03 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 23 05 00 – Common Work Results for HVAC
- C. Section 23 05 15 – Piping Specialties

1.04 SUBMITTALS

- A. Refer to Section 23 05 00 – Common Work Results for HVAC. In addition to the general content specified under Section 23 05 00 – Common Work Results for HVAC, supply the following submittals:
 - 1. Bypass Valves
 - 2. Water System Valves
 - a. Gate Valves (Hydronic)
 - b. Ball Valves (Hydronic)
 - c. Butterfly Valves (Hydronic)
 - d. Globe Valves (Hydronic)
 - e. Balance Valves
- B. Contractor shall submit a schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation
- C. Contractor shall submit critical flow capacity data supplied by the manufacturer for all steam pressure reducing valves. The calculation from the manufacturer shall be the largest obtainable by internal trim change of the reducing valve.

1.05 QUALITY ASSURANCE

- A. Refer to Division 1 for equals and substitutions.

1.06 DESIGN CRITERIA

- A. Where valves are specified for individual mechanical services (i.e. hot water heating, steam, etc.) all valves shall be of the same manufacturer unless prior written approval is obtained from owner.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified in Section 23 05 00 – Common Work Results for HVAC.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Anvil, Apollo, Armstrong, Bell & Gossett, Cash-Acme, Dresser Consolidated, Conval, Crane, Anderson Greenwood and Crosby, Danfoss-Flomatic, DeZurik, Durco, Fisher, Grinnell, Griswold, Hammond, Hancock, Hoffman, Jamesbury, Keystone, Kunkle, Leslie, Lunkenheimer/Cincinnati, Metraflex, Milwaukee, Mueller, Newco, Nexus, Nibco, Powell, RP&C, Sarco, Spence, Stockham, Taco, Tasco, Thrush-Amtrol, Vogt, Watts.
- B. All valves shall be manufactured in the United States.
- C. All valves shall be designed for operation with not less than 125 lbs. working pressure and of a type permitting repacking while under pressure. Rising stems shall be used wherever possible. Provide valves to allow control of all major branches. All valves 2 inches and larger installed 7 feet on centerline or higher above the floor shall have chain operators.

2.02 WATER SYSTEM VALVES

- A. All water system valves to be rated at not less than 125 psig water working pressure at 240°F unless noted otherwise.
- B. GATE VALVES:
 - 1. 2" and smaller: Use ball valves; gate valves will not be accepted in sizes 2" and smaller.
 - 2. 2-1/2" and larger: Use butterfly valves; gate valves will not be accepted in sizes 2-1/2" and larger.
- C. BALL VALVES:
 - 1. 2" and smaller: Two piece bronze body; threaded or soldered ends, as appropriate to the pipe material; stainless steel or chrome plated brass/bronze ball; conventional port; glass filled teflon seat; threaded packing gland follower; blowout-proof stem; 600 psig WOG.
 - 2. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.
 - 3. Apollo 70-100/200 series, Hammond 8301/8311, Milwaukee BA100/150, Nibco T/S 585-70, Stockham S206/216.
 - 4. 2-1/2" and over: Ball valves will not be accepted in sizes over 2 inch.
- D. BUTTERFLY VALVES:
 - 1. 2" and smaller: Use ball valves; butterfly valves will not be accepted in sizes 2 inch and smaller.
 - 2. 2-1/2" and larger: Cast iron body; stainless steel shaft; Teflon, nylatron, or acetal bearings; EPDM resilient seat. Disk to be bronze, aluminum-bronze, nickel plated ductile iron, cast iron with welded nickel edge, or stainless steel. Pressure rated to 150 psig. Valve assembly to be bi-directionally bubble tight to 150 psig with no downstream flange/pipe attached. Polyimide or polyamide coated valves are not acceptable.
 - 3. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.
 - 4. Use threaded lug type valves for installation with class 125/150 flanges.
 - 5. Centerline series 200, DeZurik BGS II, Keystone Fig. 222, Nibco LD2000 (2-1/2"-12")/LD1000 (14" and above), Victaulic 300 series (2-1/2"-12")/709 series (14"-24").
 - 6. Provide ten-position lever actuators for valves 6" and smaller. Provide worm gear operators for valves 8" and larger.
 - 7. Where butterfly valves are indicated or specified to be installed at the location of a flow sensing device, provide the butterfly valves with a memory stop.
- E. GLOBE VALVES:
 - 1. Do not use globe valves for water service, except in temperature control applications.
- F. BALANCE VALVES:
 - 1. 2" and smaller: Bronze or copper alloy body with calibrated ball, globe or venturi/valve arrangement, integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, threaded or soldered ends, with or without integral unions, P/T or Shraeder pressure taps with integral check valves and seals, adjustable memory stop, protective Yoke, and suitable for 200 psig water working pressure at 250°F.
 - 2. Armstrong CBV, Bell & Gossett Circuit Setter Plus, Griswold Quickset, Nexus Orturi, Nibco 1710 Series, Taco Accu-Flo, Tour & Anderson STAS/STAD, Victaulic series 786/787, Hays Fluid Controls.

3. Include one bellows type differential pressure meter kit that includes a six inch diameter gauge with 270° arc readout and having an accuracy of $\pm 1\%$ of full scale or better and suitable for the differential pressures of the valves supplied for this project, over-range protection, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.
4. Barton 247A, Midwest 809.
5. 2-1/2" and larger: Use butterfly valves as specified in this section along with a flow sensing device as specified in Section 23 05 15.

PART 3 – EXECUTION

3.01 GENERAL

- A. Properly align piping before installation of valves in an upright position; operators installed below the valves will not be accepted.
- B. Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.
- C. Install all temperature control valves.
- D. Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal position only where space limitations do not allow installation in an upright position or where large valves are provided with chain wheel operators. Where valves 2-1/2" and larger are located more than 12'-0" above mechanical room floors, install valve with stem in the horizontal position and provide a chain wheel operator. Valves installed with the stems down, will not be accepted.
- E. Install stem extensions when shipped loose from valve.
- F. Prior to flushing of piping systems, place all valves in the full-open position.

3.02 SHUT-OFF VALVES

- A. Install shut-off valves on both sides of all equipment, on major piping loops, at each branch take-off from mains, at vertical risers, at strainers, and at each automatic valve for isolation or repair. All shut-off valves shall be located to allow proper access for operation for servicing.
- B. WATER SYSTEM:
 1. Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

3.03 BALANCING VALVES

- A. Provide balancing valves for all equipment, on major piping loops, at vertical risers, at each major branch takeoff, and at the discharge of each pump. Provide balancing valve at all terminal devices. Refer to drawings and details for additional locations.

3.04 CALIBRATED BALANCING VALVES

- A. Install where indicated on the drawings and details for balancing of hydronic systems. Retain the shipping container for use as removable insulation.

3.05 DRAIN VALVES

- A. Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, equipment locations specified or detailed including reheat coils, other locations required for drainage of systems.

END OF SECTION

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

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid:
 - 1. Contractor provide vibration isolators and flexible connections for the following equipment specified and indicated on the drawings:
 - a. Air Cooled Chiller

1.02 SECTION INCLUDES

- A. This section includes specifications for vibration isolation material for equipment, piping systems, and duct systems. Included are the following topics:
 - 1. Type D: Restrained Spring with Neoprene
 - 2. Flexible Piping Connections

1.03 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 23 05 00 – Common Work Results for HVAC
- C. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- D. Section 23 21 13 – Hydronic Piping
- E. Section 23 64 23 – Air Cooled Chillers

1.04 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals. At a minimum, provide submittals for the following items:
 - 1. Type D: Restrained Spring with Neoprene
 - 2. Flexible Piping Connections
- B. Include isolator type, materials of construction, isolator free and operating heights, and isolation efficiency based on the lowest operating speed of the equipment supported.

1.05 QUALITY ASSURANCE

- A. Refer to Division 1 for equals and substitutions.

1.06 DESIGN CRITERIA

- A. Isolate all motor driven mechanical equipment from the building structure and from the systems which they serve to prevent equipment vibrations from being transmitted to the structure. Consider equipment weight distribution to provide uniform isolator deflections.
- B. For equipment with variable speed capability, select vibration isolation devices based on the lowest speed.
- C. Provide flexible piping connections for all piping to rotating or reciprocating equipment mounted on vibration isolators except do not use flexible piping connectors on any type of gas piping or with inline pumps. Piping connected to a coil which is in an assembly mounted on vibration isolators is to have flexible piping connections and piping vibration hangers as specified below. Piping connected to a coil which is in an assembly where the fan is separately isolated by means of vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.
- D. Credit will not be given for flexibility and vibration absorption characteristics of mechanical grooved pipe connections.
- E. Coordinate the selection of devices with the isolator and equipment manufacturers. All isolation material used by contractor shall be supplied by one manufacturer.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Use materials that will retain their isolation characteristics for the life of the equipment served. Use industrial grade neoprene for elastomeric materials.
- B. Treat all isolators to resist corrosion. For isolation devices exposed to the weather or used in high humidity areas, hot dip galvanize steel parts, apply a neoprene coating on all steel parts, or use stainless steel parts; include limit stops to resist wind.
- C. Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.
- D. Use isolators with a ratio of lateral to vertical stiffness not less than 1.0 or greater than 2.0.

2.02 VIBRATION ISOLATOR MANUFACTURERS

- A. Mason Industries, Amber/Booth Co., Vibration Mounting & Controls, Peabody Noise Control.

2.03 TYPE D: RESTRAINED SPRING WITH NEOPRENE

- A. Combination spring and neoprene with rib molded anti-friction base, but with a housing that includes vertical limit stops to prevent spring extension when weight is removed such that the installed and operating heights are the same. Maintain a minimum clearance of 1/2" around restraining bolts, and between the housing and the spring, so as not to interfere with the spring action. Design isolator so limit stops are out of contact during normal operation. Use height saving brackets when appropriate to the application.

2.04 FLEXIBLE PIPING CONNECTIONS

- A. Suitable for pressure, temperature, and fluid involved; minimum pressure rating for any system is 125 psig at the design temperature of the fluid. Use 12 inch minimum line length of flexible hose or length required to absorb 3/4" lateral movement, whichever is greater. When providing for future flexible connections, construct spool pieces to exact size.
- B. Manufacturers:
 1. Flexonics, Mason, Mercer Rubber, Metraflex, Proco.
- C. Water:
 1. Multiple plies of nylon tire cord fabric reinforced with an EPDM cover and liner. Do not use steel wire or rings as pressure reinforcement. Use threaded or soldered connections for sizes 2" and smaller and floating steel or ductile iron flanges for sizes 2-1/2" and larger; design the steel flange end so the steel flange is recessed to lock a steel wire bead ring in the raised face of the EPDM flange. Construct straight-through connections with twin spheres. Use control rods when recommended by the manufacturer.

2.05 PERFORMANCE

- A. Select vibration isolation devices as indicated below or to provide not less than 95% isolation efficiency, whichever is greater.

TYPE OF EQUIPMENT	----- Floor Span or Column Spacing -----							
	--On Grade--		---20 Feet---		---30 Feet---		---40 Feet---	
	Min.		Min.		Min.		Min.	
	Iso.	Defl.	Iso.	Defl.	Iso.	Defl.	Iso.	Defl.
	Type	In.	Type	In.	Type	In.	Type	In.
REFRIGERATION								
MACHINES:								
AIR-COOLED	D	0.75	D	1.50	D-S	1.50	D-S	2.50
CHILLER								

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install seismic and vibration isolation devices in accordance with the manufacturer's installation instructions. The isolation manufacturer and the manufacturer's authorized representative shall be responsible for:
 - 1. Selection of the proper size and type of isolation materials.
 - 2. Preparation of the submittal material required.
 - 3. Field inspection of the installation and, if, necessary, accompanying the Architect/Engineer on a field inspection of the installation.
 - 4. Written certification that the isolation is installed and operating as designed.
- B. Unless otherwise noted on the equipment schedule, all mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accord with weight distribution of the isolated equipment to provide reasonably uniform deflection. Deflections shall be provided by the equipment manufacturer.
- C. Bolt isolators to equipment and to supporting structure where isolator bolt holes are supplied.
- D. Shim or adjust leveling screws to level equipment. Shims shall not interfere with isolator action.
- E. Verify actual deflected height with design operating height and replace the isolator when they differ by 25% or more.
- F. Correct interferences with the isolator action or report to the Architect/Engineer when interference is caused by another contractor.
- G. Set steel and inertia bases for one inch clearance between the concrete floor or housekeeping pad and the base.
- H. Do not allow installation practices to short circuit any isolation device.
- I. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Install flexible piping connections on the equipment side of shut-off valves. Inspect piping layout; notify Architect/Engineer of additional anchors or expansion joints to adequately protect system. Provide inspection services by flexible pipe connector manufacturer's representative to certify installations are in accordance with manufacturer's recommendations. Install flexible pipe connectors at right angles to displacement.
- J. For flexible pump connectors: shall be supported such that no weight will be supported by the connector. Piping shall be installed so that connector is not deformed by misalignment.

3.02 ISOLATION DEVICES OUTDOORS OR IN HIGH HUMIDITY AREAS

- A. Use only hot dip galvanized, stainless steel, or neoprene coated steel parts.

END OF SECTION

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SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING FOR HVAC

THIS SECTION IS INCLUDED FOR CONTRACTOR'S INFORMATION AND COORDINATION ONLY. HVAC HYDRONIC BALANCING WILL BE HIRED AND PAID BY THE CITY OF URBANA.

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Contractor provide:
 - 1. Personnel to accompany and assist Architect/Engineer and air balancer during test, adjust and balancing of piping system(s).
 - 2. Have the temperature control manufacturer's representative set and adjust automatically operated devices to achieve specified sequence of operations.
 - 3. Have the temperature control manufacturer's representative accompany and assist Architect/Engineer and Air Balancer during test, adjust and balancing of piping system(s).
- B. Work by others:
 - 1. The balancing will be performed by a subcontractor retained by the City of Urbana.

1.02 SECTION INCLUDES

- A. This section includes air and water testing, adjusting and balancing for the entire project. Included are the following topics:
 - 1. Performing Testing, Adjusting and Balancing
 - 2. Hydronic System Differential Pressure Control Setpoint
 - 3. Hydronic Systems

1.03 RELATED WORK

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and General Requirements in Division 1 govern work under this section.
- B. Section 23 05 00 – Common Work Results for HVAC
- C. Section 23 05 23 – General Duty Valves for HVAC Piping
- D. Section 23 07 00 – HVAC Insulation

1.04 SUBMITTALS

- A. Refer to Division 1 for submittals. At a minimum, provide submittals for the following items:
 - 1. Testing, Adjusting and Balancing Report
- B. Submit testing, adjusting and balancing reports bearing the seal and signature of the NEBB or AABC Certified Test and Balance Supervisor. The reports certify that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.
- C. Submission: Distribute electronic copies of the Report to the Contractor, the Project Coordinator, Architect/Engineer, and the owner.
- D. Format: Cover page identifying project name, project number and descriptive title of contents. Divide the contents of the report into the below listed divisions:
 - 1. General Information
 - 2. Summary
 - 3. Hydronic Systems
 - 4. Special Systems
- E. Contents: Provide the following minimum information, forms and data:
 - 1. General Information: Inside cover sheet identifying Test and Balance Agency, Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.

2. Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.
3. The remainder of the report to contain the appropriate standard NEBB or AABC forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate same.
4. Instruments:
 - a. Air balance instruments - Ranges shown are guides. Actual ranges used are subject to Architect/Engineer approval
 - b. Velometer with probes and Pitot tube.
 - c. Rotating vane anemometer.
 - d. ASHRAE Standard Pitot tubes, stainless steel 5/16 outside diameter, lengths 18" and 36".
 - e. Magnehelic Differential Air Pressure Gauges, 0 to 0.5", 0 to 1.0" and 0 to 5.0" water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube.
 - f. Combination inclined-vertical portable manometer, range 0 to 5.0" water.
 - g. Portable type hook gage, range 0 to 12" water.
 - h. Portable flexible U-tube manometer, magnetic mounting clips, range 0 to 18" water.
 - i. Conical or pyramidal shaped hood.
5. System performance measuring instruments:
 - a. Insertion thermometers, with graduations at 0.5° F.
 - b. Sling Psychrometer.
 - c. Tachometer, Centrifugal Type
 - d. Revolution Counter
 - e. Clamp-On Volt-Ammeter
 - f. Recorders, Portable Type for temperature and humidity.

1.05 FUNCTIONAL TESTS

- A. Refer to Section 23 05 00 – Common Work Results for HVAC, Functional Tests. In addition to the general content specified under Section 23 05 00 – Common Work Results for HVAC, perform the following function tests:
 1. Performing Testing, Adjusting and Balancing
 2. Hydronic System Differential Pressure Control Setpoint
 3. Hydronic Systems

1.06 REFERENCE STANDARDS

- A. AABC National Standards for Total System Balance, Sixth Edition, 2002.
- B. ASHRAE ASHRAE Handbook, 2007 HVAC Applications, Chapter 37, Testing Adjusting and Balancing.
- C. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, Seventh Edition, 2005.

1.07 QUALITY ASSURANCE

- A. Qualifications:
 1. An independent Firm specializing in the Testing and Balancing of HVAC systems for a minimum of 3 years. A Firm not engaged in the commerce of furnishing or providing equipment or material generally related to HVAC work other than that specifically related to installing Testing and Balancing components necessary for work in this section such as, but not limited to sheaves, pulleys, and balancing dampers.
 2. A certified member of AABC or certified by NEBB in the specific area of work performed. Maintain certification for the entire duration of the project. If certification of firm or any staff performing work is terminated or expires during the duration of the project, contact owner immediately.
 3. Technicians on this project must have satisfactorily completed work on a minimum of (3) three projects of at least 50% in size, and of similar complexity. Size is defined as the quantity of each

specific individual item requiring testing and balancing such as, but not limited to, equipment, devices, terminal devices, and grilles and diffusers.

4. Submit Qualifications of firm and project staff to the owner upon request.

1.08 DESCRIPTION

- A. The City of Urbana will separately contract with an independent test and balance agency to perform all testing, adjusting, and balancing of air and hydronic systems required for this project. Work related to the testing, adjusting, and balancing that must be performed by the installing mechanical contractor is specified in other section of these specifications.
- B. Provide total mechanical systems testing, adjusting and balancing. Requirements include the balance of air and water distribution, adjustment of new and existing systems and equipment to provide design requirements indicated on the drawings, electrical measurement and verification of performance of all mechanical equipment, all in accordance with standards published by AABC or NEBB.
- C. Test, adjust and balance all air and hydronic systems so that each room, piece of equipment or terminal device meets the design requirements indicated on the drawings and in the specifications.
- D. Accomplish testing, adjusting and balancing work in a timely manner that allows partial occupancy of major buildings, occupancy of one building when the project involves many buildings, and completion of the entire project in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.
- E. Verify that provisions are being made to accomplish the specified testing, adjusting and balancing work. If problems are found, handle as specified in Part 3 under Deficiencies.

1.09 PRE-INSTALLATION MEETING AND SCHEDULING

- A. The test and balance agency is required to attend a pre-installation meeting with all other project contractors before the construction process is started. The test and balance agency shall give the Lead Contractor a detailed schedule of testing and balancing tasks for incorporation into the project schedule. Reference General Conditions Division 1 for Lead Contractor responsibilities for scheduling.

1.10 PRE-BALANCE CONFERENCE

- A. 90 days prior to beginning testing, adjusting and balancing, schedule and conduct a conference with the owner and the mechanical system and temperature control system installing Contractors. Provide AE with a complete copy of the TAB plan for the project. The objective is final coordination and verification of system operation and readiness for testing, adjusting and balancing procedures and scheduling procedures with the above mentioned parties. Indicate work required to be completed prior to testing, adjusting, and balancing and identify the party responsible for completion of that work.

PART 2 – PRODUCTS

2.01 INSTRUMENTATION

- A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB or AABC Standards and instrument manufacturer's specifications.
- B. All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by owner upon request. Calibration and maintenance of all instruments to be in accordance with the requirements of NEBB or AABC Standards.
- C. Air balance instruments - Ranges shown are guides. Actual ranges used are subject to Architect/Engineer approval.
 1. Velometer with probes and Pitot tube.
 2. Rotating vane anemometer.
 3. ASHRAE Standard Pitot tubes, stainless steel 5/16 outside diameter, lengths 18" and 36".
 4. Magnehelic Differential Air Pressure Gauges, 0 to 0.5", 0 to 1.0" and 0 to 5.0" water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube.
 5. Combination inclined-vertical portable manometer, range 0 to 5.0" water.
 6. Portable type hook gage, range 0 to 12" water.
 7. Portable flexible U-tube manometer, magnetic mounting clips, range 0 to 18" water.

8. Conical or pyramidal shaped hood.
- D. System performance measuring instruments:
 1. Insertion thermometers, with graduations at 0.5oF.
 2. Sling Psychrometer.
 3. Tachometer, Centrifugal Type
 4. Revolution Counter
 5. Clamp-On Volt-Ammeter
 6. Recorders, Portable Type for temperature and humidity.

PART 3 – EXECUTION

3.01 DAILY REPORTS

- A. Submit to owner daily work activity reports for each day on which testing and balancing work is performed. Reports shall include description of day's activities and description of any system deficiencies.

3.02 PRELIMINARY PROCEDURES

- A. Review preconstruction meeting report, applicable construction bulletins, applicable change orders and approved shop drawings of equipment, outlets/inlets and temperature controls.
- B. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals. Inspect all systems components for proper installation and operation. Use manufacturer's ratings for all equipment to make calculations except where field test shows ratings to be impractical. Verify that all instruments are accurately calibrated and maintained.
- C. Check filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and hydronic systems for proper charge and purging of air.
- D. Notify owner on a daily basis during balancing. Identify deficiencies preventing completion of testing, adjusting and balancing procedures. Do not proceed until systems are fully operational with all components necessary for complete testing, adjusting and balancing. Installing Contractors are required to provide personnel to check and verify system completion, readiness for balancing and assist Balancing Agency in providing specified system performance.

3.03 EXISTING EQUIPMENT

3.04 PERFORMING TESTING, ADJUSTING AND BALANCING

- A. Perform testing, adjusting and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards except as may be modified below.
- B. Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.
- C. Measure and record system measurements at the fan and/or pump to determine total flow. Adjust equipment as required to yield specified total flow at terminals. Proceed taking measurements in mains and branches as required for final terminal balancing. Test and record motor full load amperes and current draw. Test and record system static pressure suction and discharge. Perform terminal balancing to specified flows balancing branch dampers, deflectors, extractors and valves prior to adjustment of terminals.
- D. Check and record the following items at each cooling coil:
 1. Inlet water and air temperature.
 2. Leaving water and air temperatures.
 3. Pressure drop of each coil.
 4. Pressure drop across bypass valve.
 5. Pump operating suction and discharge and final total dynamic head.
 6. All mechanical specifications of pumps.
 7. Actual/rated running amperage of pump motor.
- E. Final water system measurements must be within the following range of specified gpm:

1. Cooling flow rates -5% to +5%
- F. Contact the temperature control contractor for assistance in operation and adjustment of controls during testing, adjusting and balancing procedures. Cycle controls and verify proper operation and setpoints. Include in report description of temperature control operation and any deficiencies found.
- G. Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.
- H. Leave systems in proper working order, replacing belt guards, closing access doors and electrical boxes, and restoring temperature controls to normal operating settings.
- I. Coordinate and assist commissioning agent with all verification activities defined within this specification including providing all required sampling data necessary for the commissioning process.

3.05 HYDRONIC SYSTEM DIFFERENTIAL PRESSURE CONTROL SET POINT

- A. For hydronic systems with variable speed pumping, determine the minimum required system differential pressure set point needed to insure that all terminal devices are operating at their design water flows with the most demanding terminals device control valve wide open. Provide the differential control setting set point to the DDC temperature control contractor and record them in the T&B report for each system.

3.06 HYDRONIC SYSTEMS

- A. Complete air balance must have been accomplished before water balance is begun. Open all valves to full position, including pump discharge valves, coil balancing fittings and return line balancing fittings. Close bypass valves.
- B. For HVAC pumps 10 horsepower or less, valve throttling alone may be used for hydronic system balancing.
- C. Check Pump Rotation.
- D. Throttling of triple-duty valves shall not exceed 50% closed. Where additional throttling would be necessary to achieve the system design flow the impellor shall be trimmed.
- E. Verify Triple duty valve utilized on systems with Variable Frequency Drives are 100% open when balancing work is complete.
- F. The pressure drop across triple duty valves shall not exceed 25 ft. w.g. Where additional throttling would be necessary to achieve the system design flow the impellor shall be trimmed.
- G. For HVAC pumps greater than 10 horsepower through 60 horsepower, trim the impellor where valve throttling will result in a draw that exceeds 3 horsepower.
- H. Future fouling of an open piping system may be considered when determining impellor trim requirements.
- I. Check expansion tanks to make sure they are not air bound and that the system is full of water. Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Make certain all air is removed from circulating system.
- J. Verify butterfly valves utilized for hydronic system balancing are provided with position-lock operators (memory stops) in accordance with Section 23 05 23 – General Duty Valves for HVAC Piping. The adjustment and marking of lever-lock operators that use throttling notches will not be accepted. Lock all memory stops so the valves can be reopened to their balanced positions if they are used for isolation purposes.
- K. Examine water in system to determine if it has been treated and is clean. Record your findings in report.

3.07 DEFICIENCIES

- A. Division 23 00 00 contractor to correct any installation deficiencies found by the test and balance agency that were specified and/or shown on the Contract Documents to be performed as part of that division of work. Test and balance agency will notify the owner and engineer of these items and instructions will be issued to the Division 23 00 00 contractor for correction of the deficient work. All corrective work to be done at no cost to the owner. Retest mechanical systems, equipment, and devices once corrective work is complete as specified.

END OF SECTION

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SECTION 23 07 00
HVAC INSULATION

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid:
 - 1. Contractor provide insulation for:
 - a. Chilled Water Systems
 - b. All existing chilled water supply and chilled water return piping that has had insulation removed will be reinsulated according to this section and rejacketed.
 - c. Refrigerant Suction Lines
 - d. Cold Surfaces on Chillers

1.02 SECTION INCLUDES

- A. This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:
 - 1. Insulation Types
 - a. Elastomeric Insulation
 - b. Phenolic Insulation
 - 2. Metal Covering and Jackets
 - a. PVC Fitting Covers And Jackets (PFJ)
 - 3. Insulation Inserts and Pipe Shields
 - 4. Expansion Joint and Valve Insulation Blankets
 - 5. Accessories

1.03 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 23 05 00 – Common Work Results for HVAC
- C. Section 23 05 15 – Piping Specialties
- D. Section 23 21 13 – Hydronic Piping
- E. Section 23 64 23 – Air Cooled Chillers

1.04 SUBMITTALS

- A. Refer to Division 1 for submittals. At a minimum, provide submittals for the following items:
 - 1. Insulation Types
 - a. Elastomeric Insulation
 - b. Phenolic Insulation
 - 2. Metal Covering and Jackets
 - a. PVC Fitting Covers And Jackets (PFJ)
 - 3. Insulation Inserts and Pipe Shields
 - 4. Expansion Joint and Valve Insulation Blankets
 - 5. Accessories
- B. Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

1.05 REFERENCE STANDARDS

- A. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate
- B. ASTM C165 Test Method for Compressive Properties of Thermal Insulations
- C. ASTM C177 Heat Flux and Thermal Transmission Properties
- D. ASTM C195 Mineral Fiber Thermal Insulation Cement
- E. ASTM C240 Cellular Glass Insulation Block
- F. ASTM C302 Density of Preformed Pipe Insulation

G.	ASTM C303	Density of Preformed Block Insulation
H.	ASTM C355	Test Methods for Test for Water Vapor Transmission of Thick Materials
I.	ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulation Cement
J.	ASTM C518	Heat Flux and Thermal Transmission Properties
K.	ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
L.	ASTM C534	Preformed Flexible Elastomeric Thermal Insulation
M.	ASTM C578	Preformed, Block Type Cellular Polystyrene Thermal Insulation
N.	ASTM C591	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
O.	ASTM C610	Expanded Perlite Block and Thermal Pipe Insulation
P.	ASTM C612	Mineral Fiber Block and Board Thermal Insulation
Q.	ASTM C921	Properties of Jacketing Materials for Thermal Insulation
R.	ASTM C1136	Flexible Low Permeance Vapor Retarders for Thermal Insulation
S.	ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
T.	ASTM D1000	Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
U.	ASTM D1621	Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
V.	ASTM D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
W.	ASTM D1940	Method of Test for Porosity of Rigid Cellular Plastics
X.	ASTM D2126	Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
Y.	ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
Z.	ASTM E84	Surface Burning Characteristics of Building Materials
AA.	MICA	National Commercial & Industrial Insulation Standards
BB.	NFPA 225	Surface Burning Characteristics of Building Materials
CC.	UL 723	Surface Burning Characteristics of Building Materials

1.06 QUALITY ASSURANCE

- A. Refer to Division 1 equals and substitutions
- B. Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.
- C. Insulation systems shall be applied by experienced contractors. Within the past five (5) years, the contractor shall be able to document the successful completion of a minimum of three (3) projects of at least 50% of the size and similar scope of the work specified in this section.
- A. Fluid-applied ductwork insulation is a roofing product that shall be applied only by qualified contractors. Contractor shall be recognized by the manufacturer of the Polyurea 2-part liquid membrane system as an “approved” or “authorized” applicator. Only manufacturer recognized, qualified and authorized Contractor’s who’s labor and material are fully covered, without exception, by the manufacturer’s warranty, as required by this section, will be allowed to perform the work. Manufacturer must submit letterhead document verifying the Contractor as an authorized applicator of their product and able to receive the specified warranty.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified in Section 23 05 00 – Common Work Results for HVAC.

1.08 DESCRIPTION

- A. Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:
 - 1. Pipe Insulation
- B. Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the Owner.

1.09 DEFINITIONS

- A. Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.
- B. Protect installed insulation work with plastic sheeting to prevent water damage.
- C. Delivery, Storage And Handling:
 - 1. Deliver field applied material to site in factory fabricated containers with manufacturer's stamp or label showing fire hazard rating of products.
 - 2. Store in original wrappings and protect from weather and construction traffic.
 - 3. Protect against dirt, water, chemical and mechanical damage.
 - 4. Remove damaged insulation from project site, do not install.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Manufacturers: Armacell, Certainteed, Manson, Childers, Dow, Extol, Fibrex, Halstead, H.B. Fuller, Imcoa, Johns Manville, Knauf, Owens-Corning, Partek, Pittsburgh Corning, Rubatex, VentureTape.
- B. Materials or accessories containing asbestos will not be accepted.
- C. Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM E84, NFPA 255 or UL 723, with the following exceptions:
- D. Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

2.02 INSULATION TYPES

- A. Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.
- B. Elastomeric Insulation: Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 degrees F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment.
- C. Phenolic Insulation: Rigid closed cell, minimum nominal density of 2.2 lbs. per cu. ft., thermal conductivity of not more than 0.13 at 75 degrees F, minimum compressive strength of 31 psi parallel and 18 psi perpendicular, maximum water vapor permeability 0.117 perm inch, maximum water absorption of .5% by volume, rated for service range of -290 degrees F to 250 degrees F.

2.03 JACKETS

- A. PVC Fitting Covers And Jackets (PFJ):
 - 1. White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum .03" for piping 12" and smaller, .04" for piping 15" and larger.

2.04 INSULATION INSERTS AND PIPE SHIELDS

- A. Manufacturers: B-Line, Pipe Shields, Value Engineered Products
- B. Construct inserts with calcium silicate or polyisocyanurate (service temperatures below 300 degrees F only), minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

- C. Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered/premanufactured product described above. On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.
- D. Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x6" block for piping through 2-1/2" and three 1"x6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/premanufactured product described above.
- E. Wood blocks will not be accepted.

2.05 EXPANSION JOINT AND VALVE INSULATION BLANKETS

- A. Manufacturers: Advance Thermal Corporation, TANI Division B.D. Schiffler, Universal Insulation Products.
- B. Jacket shall be 7 ounce per square yard Teflon coated Nomex fabric which is designed for wet and dry steam applications to 550°F. Equal to Advance Thermal Corp. Steamguard-1 cloth. The covers shall be installed to shed water and have a 1-inch rain flap.
- C. All seams shall be sewn twice with double locked stitching. One seam shall be sewn with 3-ply Nomex and the other with 3-ply stainless steel. Hog rings and staples shall not be used.
- D. The insulation shall be a 2-inch thick, 6 lb. density ceramic fiber which is held in place with 12 gauge stainless quilt pins which do not puncture the inner surface of the cover.
- E. Covers shall be designed to allow access to the expansion and ball joints packing cylinder plungers for repacking with removing the covers.
- F. Adjacent pipe insulation must be installed to allow the piping to expand into expansion joints without damaging the insulation or removable covers.

2.06 ACCESSORIES

- A. All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.
- B. Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.
- C. Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch for aluminum and .010 inch for stainless steel.
- D. Tack fasteners to be stainless steel ring grooved shank tacks.
- E. Staples to be clinch style.
- F. Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.
- G. Finishing cement to be ASTM C449.
- H. Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.
- I. Bedding compounds to be non-shrinking and permanently flexible.
- J. Vapor barrier coatings to have maximum applied water vapor permeance of .05 perms.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.
- B. Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

3.02 INSTALLATION

- A. All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations. Surfaces to be insulated must be clean and dry. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and

- insulation cements. Maintain temperature during and after installation for minimum period of 24 hours.
- B. Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.
 - C. Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.
 - D. Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.
 - E. Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.
 - F. Existing or new insulation damaged and/or removed by the Contractor during remodeling work shall be repaired or replaced with new insulation as directed by the Owner.
 - G. All pipe insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor barriers shall be maintained continuous through all penetrations.
 - H. Provide a continuous unbroken moisture vapor barrier on insulation applied to systems noted below. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.
 - I. Provide a complete vapor barrier for insulation on the following systems:
 - 1. Chilled Water
 - 2. Refrigerant
 - 3. Equipment or piping with a surface temperature below 65 degrees F

3.03 PROTECTIVE JACKET INSTALLATION

- A. PVC Fitting Covers And Jackets (PFJ): Lap seams and joints a minimum of 2 inches and continuously seal PVC with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used. Secure PVC fitting covers with tack fasteners. For systems requiring a vapor barrier, apply a 1-1/2" band of mastic over ends, throat, seams and penetrations.

3.04 PIPING, VALVE AND FITTING INSULATION

- A. General:
 - 1. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally secure with staples along seams and butt joints. Coat staples, longitudinal and transverse seams with vapor barrier mastic on systems requiring vapor barrier.
 - 2. Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required or where roller hangers are not being used, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.
 - 3. Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.
- B. Insulation Inserts And Pipe Shields:
 - 1. Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer's installation instructions, however the inserts shall be no less than 12" in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.
 - 2. Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

- C. Fittings And Valves: Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperature exceeds 150 degrees F, cover insulation with fabric reinforcing and mastic. Where the ambient temperatures do not exceed 150 degrees, furnish and install PVC fitting covers.
- D. Elastomeric: Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. Cover elastomeric insulation on systems operating below 40 degrees F with vapor barrier mastic.

3.05 PIPING PROTECTIVE JACKETS

- A. In addition to the jackets specified in the pipe insulation schedule below the following protective jackets are required:
 - 1. Provide a protective PVC jacket (PFJ) for the following insulated piping:
 - a. Chilled water piping and valves in walk-thru tunnels and valve pits
 - b. Piping exposed in finished locations

3.06 PIPE INSULATION SCHEDULE

- A. Provide insulation on new and existing remodeled piping as indicated in the following schedule:

<u>Service</u>	<u>Insulation</u>	<u>Jacket</u>	<u>Insulation Thickness by Pipe Size</u>				
			$\leq 1\frac{1}{4}"$	$1\frac{1}{2}"$	2" to <4"	4" to 6"	8" and larger
Chilled Water	Elast./Phenol	PFJ	0.5"	1"	1"	1"	1.5"

- B. For systems with fluid temperatures 65° F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor barrier.
- C. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints and valves with insulation of like material and thickness as adjoining pipe and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.07 CONSTRUCTION VERIFICATION ITEMS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under this specification in accordance with the procedures defined for construction verification checklists.

END OF SECTION

SECTION 23 21 13 HYDRONIC PIPING

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid: Contractor shall provide all labor and materials for a complete system in this specification.

1.02 SECTION INCLUDES

- A. This section contains specifications for all HVAC hydronic pipe and pipe fittings for this project. Included are the following topics:
 - 1. Chilled Water
 - 2. Vents and Relief Valves
 - 3. Unions and Flanges
 - 4. Gaskets

1.03 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 23 05 00 – Common Work Results for HVAC
- C. Section 23 05 15 - Piping Specialties
- D. Section 23 05 23 - General-Duty Valves for HVAC Piping
- E. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- F. Section 23 07 00 - HVAC Insulation

1.04 SUBMITTALS

- A. Refer to Section 23 05 00 – Common Work Results for HVAC. In addition to the general content specified under Section 23 05 00 – Common Work Results for HVAC, supply the following submittals:
 - 1. Chilled Water
 - 2. Vents and Relief Valves
 - 3. Unions and Flanges
 - 4. Gaskets
- B. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

1.05 REFERENCE STANDARDS

- A. ANSI B16.3 Malleable Iron Threaded Fittings
- B. ANSI B16.4 Cast Iron Threaded Fittings
- C. ANSI B16.5 Pipe Flanges and Flanged Fittings
- D. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
- E. ASTM A105 Forgings, Carbon Steel, for Piping Components
- F. ASTM A126 Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings
- G. ASTM A181 Forgings, Carbon Steel for General Purpose Piping
- H. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

1.06 QUALITY ASSURANCE

- A. Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.
- B. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.
- C. All hydronic piping shall be manufactured in the United States.

1.07 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B. Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.
- C. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- D. Where ASTM A53 type F pipe is specified, ASTM A53 grade A type E or S, or ASTM A53 grade B type E or S may be substituted at Contractor's option. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- E. Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Promptly inspect shipments to insure that the material is undamaged and complies with specifications.
- B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve the contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.09 WELDER QUALIFICATIONS

- A. Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.
- B. The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continuity Records for each welder.
- C. The A/E or owner reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor's expense.

PART 2 – PRODUCTS

2.01 CHILLED WATER

- A. 2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings.
- B. 2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
- C. Contractor may use ASTM B88 seamless, type L, hard temper copper tube with ANSI B16.22 wrought copper solder-joint fittings in lieu of steel pipe for all sizes.

2.02 VENTS AND RELIEF VALVES

- A. Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

2.03 UNIONS AND FLANGES

- A. 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use ANSI B16.18 cast copper alloy unions on copper piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.

- B. 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

2.04 GASKETS

- A. Water and Glycol Systems: Branded, compressed, non-asbestos sheet gaskets. Klingsil C4401, Garlock 3000, JM Clipper 978.

PART 3 – EXECUTION

3.01 ERECTION

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job site immediately. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion will be rejected.
- B. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.
- C. Remove all loose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.
- D. During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.
- E. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.
- F. Furnish and install all flanges, caps, bypasses, drains, valves, etc. required to facilitate flushing and draining all system piping.
- G. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult all project drawings for location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- H. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- I. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- J. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
- K. Install drains throughout the systems to permit complete drainage.
- L. Unless written authorization by the A/E, do not route piping through transformer vaults or above transformers, panelboards, motor control centers or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- M. Install all valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in the specifications and drawings.

3.02 WELDED PIPE JOINTS

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
- B. All pipe welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.
- C. Contractor will ensure that these steps are followed where pipe sections will be joined by welding:

1. Cleaning – Welding surfaces will be clean and free of defects.
 2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16”.
 3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.
- D. Girth Butt Welds:
1. Girth butt welds shall be complete penetration welds.
 2. Concavity will not exceed 1/32”
 3. Under cuts will not exceed 1/32”
 4. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.
- E. Electrodes shall be manufactured in the U.S.A. with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.03 THREADED PIPE JOINTS

- A. Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.04 WATER SYSTEM

- A. Run water mains level or pitch horizontal mains up 1 inch in 40 feet in the direction of flow. Install manual air vents at all high points where air may collect. If vent is not in an accessible location, extend air vent piping to the nearest code acceptable drain location with vent valve located at the drain.
- B. Main branches and runouts to terminal equipment may be made at the top, top 45 degree, side, and/or bottom 45 degree of the main provided that there are drain valves suitably located for complete system drainage and manual air vents are located at all top and top 45 degree connections. Bottom connections are not acceptable unless approved by the Owner.
- C. Use top or top 45 degree connection to main for upfeed risers and bottom 45 degree connection to main for downfeed risers. Bottom connections are not acceptable unless approved by the Owner.
- D. Use a minimum of two elbows in each pipe line to a piece of terminal equipment to provide flexibility for expansion and contraction of the piping systems. Offset pipe connections at equipment to allow for service, such as removal of the terminal device.
- E. Use eccentric fittings for changes in horizontal pipe sizes with the fittings installed for proper air venting. Concentric fittings may be used for changes in vertical pipe sizes.

3.05 VENTS AND RELIEF VALVES

- A. Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

3.07 UNIONS AND FLANGES

- A. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.
- B. Dielectric Connections:
1. Comply with manufacturer’s recommendations.
 2. Install in following locations:
 - a. Pipe joints connecting dissimilar metals
 - b. Pipe joints connecting similar metals where required for cathodically protecting pipe lines from adjoining pipe sections.
 3. Joints and gasketing materials rated to withstand temperature, pressure and other characteristics of services for which used including testing pressure.
 4. Make screwed joints with insulating unions.
 5. Make flanged joints with insulating jackets, bolt sleeves and washers.
 6. Bronze valve between dissimilar metals without the above insulating dielectric connections shall not be considered a dielectric connection.

3.08 GASKETS

- A. Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.
- B. Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.
- C. Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

3.09 PIPING SYSTEM LEAK TESTS

- A. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.
 - B. Provide all piping, fittings, blind flanges, and equipment to perform the testing.
 - C. Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Owner's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
 - D. Do not insulate pipe fittings or welds until test has been successfully completed.
 - E. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
 - F. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.
- | | | | |
|---------------|----------|--------|----------|
| System | Pressure | Medium | Duration |
| Chilled water | 100 psig | Water | 8 hr. |
- G. All pressure tests are to be documented on attached form included in this specification.
 - H. On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Do not penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system.

3.10 HYDRONIC PIPING SYSTEM FLUSHING

- A. The new CHS and CHR piping shall be flushed with a hose prior to installation. The short sections of new pipe shall be cleaned to be free of all scale, dirt, and foreign material.

3.11 CONSTRUCTION VERIFICATION CHECKLISTS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under these specifications in accordance with the procedures defined for construction verification checklists.

END OF SECTION

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PIPING SYSTEM LEAKAGE TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____

Project No: _____

Contractor: _____

☐ HVAC

☐ Refrigeration

☐ Controls

☐ Power Plant

☐ Plumbing

☐ Sprinkler

Test Medium: ☐ Air

☐ Water

☐ Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours

Specified Test Pressure _____ PSIG

System Identification: _____

Describe Location: _____

Test Date: _____

Start Test Time: _____

Initial Pressure: _____ PSIG

Stop Test Time: _____

Final Pressure: _____ PSIG

Tested By: _____

Witnessed By: _____

Title: _____

Title: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

Comments: _____

PIPING SYSTEM FLUSHING REPORT

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

System Identification (check one):

☐ Chilled Water

☐ Process Chilled Water

☐ Heat Reclaim

☐ Heating Hot Water

☐ Other _____

Describe procedure: _____

Flush Date: _____ Start Time: _____ Stop Time: _____

Pressure of Water Source: _____ PSIG Describe water source and method of connection to source:

Flushed By: _____

Witnessed By: _____

Title: _____

Title: _____

Company: _____

Agency: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

Describe results: _____

SECTION 23 64 23
AIR COOLED CHILLERS

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid: Contractor shall provide all labor and materials for a complete system in this specification section.

1.02 SECTION INCLUDES

- A. This section includes specifications for water chillers with scroll compressors. Included are the following topics:
 - 1. Packaged Air Cooled Chillers

1.03 RELATED WORK

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Section 23 05 00 – Common Work Results for HVAC
- C. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment
- D. Section 23 32 13 – Hydronic Piping

1.04 SUBMITTALS

- A. Refer to Section 23 05 00 – Common Work Results for HVAC, Submittals. In addition to the general content specified under Section 23 05 00 – Common Work Results for HVAC, supply the following submittals:
 - 1. Packaged Air Cooled Chillers
- B. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
 - 1. Performance at AHRI standard conditions and at conditions scheduled (provide COP/EER/KW per Ton and IPLV for water, COP/EER/KW per Ton and NPLV for 30% PG conditions).
 - 2. Partload Performance at AHRI standard unloading conditions scheduled (provide COP/EER/KW per Ton and IPLV for water and COP/EER/KW per Ton and NPLV for 30% PG conditions).
 - 3. Minimum evaporator flow rate & maximum rate of change.
 - 4. Refrigerant type and capacity of water chiller.
 - 5. Oil capacity of water chiller.
 - 6. Fluid capacity of evaporator.
 - 7. Fluid capacity of condenser.
 - 8. Characteristics of safety relief valves.
 - 9. Minimum entering condenser-air temperature
 - 10. Sound data.
 - 11. If manufacturer requires control of external devices provide a description of the control required and the proposed method of control including hardware.
 - 12. Standard training video for owner and commissioning authority review if it is to be used as an alternate to videotaping of training.
- C. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Size and location of piping and wiring connections.
 - 5. Wiring Diagrams: Power, signal, and control wiring. Single line schematic drawing of all power field hookup requirements, indicating all items that are furnished.
 - 6. Schematic diagram of control system indicating points for field connection. Diagram shall fully delineate field and factory wiring.
- D. Certificates: For certification required in "Quality Assurance" Article.
- E. Source quality-control test reports.

- F. Startup service reports. Submit written reports documenting the activities required by this section. These reports are to be submitted two weeks after the startup is completed.
- G. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
- H. Warranty: Sample of special warranty.
- I. Training Reports: Submit training reports documenting dates and attendance.

1.05 FUNCTIONAL TESTS

- A. Refer to Section 23 05 00 – Common Work Results for HVAC, Functional Tests. In addition to the general content specified under Section 23 05 00 – Common Work Results for HVAC, supply the following functional tests:
 - 1. Packaged Air Cooled Chillers

1.06 REFERENCE STANDARDS

- A. AHRI 550/590-2003 Performance rating of Water-Chilling Packages using the Vapor Compression Cycle
- B. AHRI 575 Method of Measuring Machinery Sound Within an Equipment Space
- C. ASHRAE 15 Safety Code for Mechanical Refrigeration
- D. ASHRAE 90.1 Energy Standard for Building except Low Rise Residential Buildings
- E. ASME SEC 8 Boiler and Pressure Vessel Code
- F. NEMA MG1 Motors and Generators
- G. UL 1995 Central Cooling Air Conditioners

1.07 QUALITY ASSURANCE

- A. Refer to Section 23 05 00 for equals and Substitutions.
- B. Construct, test and rate chiller performance in accordance with AHRI 590 with exceptions as noted in this specification. Exceptions: Systems using glycol.
- C. Construct, install and operate chillers in accordance with ANSI/ASHRAE 15- Safety Code for Mechanical Refrigeration.
- D. Construct and test chillers in accordance with ASME SEC 8.
- E. Construct and label chillers in accordance with UL 1995.
- F. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- G. Comply with NFPA 70.

1.08 WARRANTY

- A. Provide a one year all-inclusive warranty to begin upon acceptance of project by owner.
- B. Provide an additional four (4) year material and labor warranty extension for compressor motor, compressor assembly and unit controls.

1.09 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified in Section 23 05 00 – Common Work Results for HVAC.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory-shipping covers in place until installation.
- C. Shipping of the chillers to the project and unloading shall be the responsibility of the chiller manufacturer. The chiller manufacturer is responsible for coordinating delivery and unloading time and location with the installing Mechanical Contractor.
- D. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

1.11 OPERATING SOUND PRESSURE LEVEL

- A. The sound pressure levels in all octave bands must be met as scheduled for full load and part load conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following
 - 1. Carrier; a United Technologies Company.
 - 2. McQuay International.
 - 3. Trane Company
 - 4. York; a Johnson Controls Company.

2.02 PACKAGED AIR-COOLED WATER CHILLERS

- A. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- B. Cabinet:
 - 1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
 - 2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
 - 3. Casing: Galvanized steel.
 - 4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500 hour salt-spray test according to ASTM B 117.
 - 5. Sound-reduction package consisting of the following:
 - a. Acoustic enclosure around compressors.
 - b. Reduced-speed fans with acoustic treatment.
 - c. Designed to reduce sound level without affecting performance.
- C. Compressors:
 - 1. Description: Positive-displacement direct drive with hermetically sealed casing.
 - 2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
 - 3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
 - 4. Capacity Control: (Digital scroll unloading control, On-off compressor cycling).
 - 5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
 - 6. Vibration Isolation: Mount individual compressors on vibration isolators.
- D. Compressor Motors:
 - 1. Hermetically sealed and cooled by refrigerant suction gas.
 - 2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- E. Compressor Motor Controllers:
 - 1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
- F. Refrigeration:
 - 1. Refrigerant: R-410a and R-134a.
 - 2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
 - 3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
- G. Evaporator:
 - 1. Brazed Plate:
 - a. Direct-expansion, single or two pass, brazed-plate design.
 - b. Type 316 stainless-steel construction.
 - c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
 - d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
 - e. The water-side working pressure shall be a minimum of 150 psig
 - f. The refrigerant-side working pressure shall be a minimum of 300 psig

2. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F in the off-cycle.
- H. Air-Cooled Condenser:
1. Plate-fin coil with integral sub cooling on each circuit
 - a. Construct coils of seamless copper tubes mechanically bonded to aluminum alloy fins with full drawn collars.
 - b. Design working pressure shall be 656 psig for R-410a refrigerant.
 - c. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
 2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
 3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in over current- and thermal-overload protection.
 4. Fan Guards: Steel safety guards with corrosion-resistant coating.
- I. Electrical Power:
1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
 2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
 3. Wiring shall be numbered and color-coded to match wiring diagram.
 4. Install factory wiring outside of an enclosure in a raceway.
 5. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
 6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
 - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - b. NEMA KS 1, heavy-duty, nonfusible switch.
 - c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 7. Provide each motor with over current protection.
 8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
 9. Phase-Failure and Under voltage: Solid-state sensing with adjustable settings.
 10. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
 - a. Power unit-mounted controls where indicated.
 11. Control Relays: Auxiliary and adjustable time-delay relays.
 12. Indicate the following for water chiller electrical power supply:
 - a. Current, phase to phase, for all three phases.
 - b. Voltage, phase to phase and phase to neutral for all three phases.
 - c. Three-phase real power (kilowatts).
 - d. Three-phase reactive power (kilovolt amperes reactive).
 - e. Power factor.
 - f. Running log of total power versus time (kilowatt hours).
 - g. Fault log, with time and date of each.
- J. Controls:
1. Stand-alone, microprocessor based.
 2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
 3. Lockable enclosures.
 4. Operator Interface: Multiple-character liquid-crystal display with LED backlighting for nighttime viewing, and keypad. Provide one keypad and display panel per chiller. Display module shall have a NEMA 4x housing suitable for outdoor environments. At a minimum, display the following conditions:

- a. Date and time.
 - b. Operating or alarm status.
 - c. Operating hours.
 - d. Outside-air temperature if required for chilled-water reset.
 - e. Temperature and pressure of operating set points.
 - f. Entering and leaving temperatures of chilled water.
 - g. Refrigerant pressures in evaporator and condenser.
 - h. Saturation temperature in evaporator and condenser.
 - i. No cooling load condition.
 - j. Elapsed time meter (compressor run status).
 - k. Antirecycling timer status.
 - l. Percent of maximum motor amperage.
 - m. Current-limit set point.
 - n. Number of compressor starts.
5. Control Functions:
- a. Manual or automatic startup and shutdown time schedule.
 - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Leaving chilled water reset control based on return water temperature, outdoor air temperature or a 4 to 20 mA input signal from the BAS.
 - c. Current limit and demand limit.
 - d. External water chiller emergency stop.
 - e. Antirecycling timer.
 - f. Automatic lead-lag switching.
 - g. Energy usage monitoring with output to the BAS.
6. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
- a. Low evaporator pressure or high condenser pressure.
 - b. Low chilled-water temperature.
 - c. Refrigerant high pressure.
 - d. High or low oil pressure (each compressor circuit).
 - e. High oil temperature.
 - f. Loss of chilled-water flow.
 - g. Control device failure.
 - h. Loss of refrigerant charge
7. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display water chiller status and alarms. Unit controller shall be compatible with standard BAS protocols.
8. Factory mounted DDC controller(s) shall support operation on a BACnet® or LONMARK ® network.
- K. Insulation:
- 1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
 - 2. Thickness: 3/4 inch
 - 3. Factory-applied insulation over cold surfaces of water chiller components.
 - a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
 - 4. Apply protective coating to exposed surfaces of insulation.
- L. Accessories:
- 1. Factory-furnished, chilled water flow switches for field installation.
 - 2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
 - 3. Factory-furnished neoprene or spring isolators for field installation.

M. Capacities and Characteristics:

1. Efficiency:
 - a. Chiller shall have a COP, NPLV and IPLV better than ASHRAE Standard 90.1 – latest edition under AHRI test procedures. When chillers with higher efficiencies than the Standard are scheduled on the drawings, the more efficient value shall be the minimum project requirement.
2. Evaporator Configuration: Integral to chiller
3. Evaporator Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu
4. Number of Refrigeration Circuits: Two or more.
5. Controls Power Connection: Fed through integral transformer
6. Noise Rating: Achieve the sound level performance indicated on the equipment schedules when measured according to AHRI 370.

2.03 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to AHRI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
 1. Allow Owner access to place where water chillers are being tested. Notify Engineer 14 days in advance of testing.
- C. Rate sound power level according to AHRI 370 procedure.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine area to receive chiller for compliance with installation tolerances and other conditions affecting chiller performance. Examine proposed route of moving chiller into place and verify that it is free of interferences. Verify piping rough-in locations. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Final locations of the chiller on the Drawings are approximate, unless dimensioned. Determine exact locations before roughing-in piping and electrical work.

3.02 WATER CHILLER INSTALLATION

- A. Equipment Mounting: Install water chiller on existing equipment supports. Follow manufacturer's installation instructions for isolator installation.
 1. Trane CGAM100 is the basis of design and will fit on existing equipment supports. If a different unit is selected that does not fit existing equipment supports, contractor shall incur cost to provide new equipment supports and necessary roof repairs to accommodate different unit.
- B. Maintain manufacturer's recommended clearances for service and maintenance
- C. Install separate devices furnished by manufacturer.
- D. Install and anchor chillers plumb and level.
- E. Install vibration isolators according to isolator manufacturer's recommendations and as scheduled or specified.
- F. Insulate cooler, suction lines, and other surfaces where condensation might occur.
- G. Install piping connections, maintaining clearances for service and maintenance.
- H. Install flanged connections at chillers.
- I. Install flexible pipe connections.
- J. Install shutoff valves at chiller inlet and outlet connections.
- K. Provide additional unit trim as indicated on drawings and details.
- L. Electrical Wiring: Power supply wiring to equipment is specified in Division 26. Field installed control and interlock wiring required for a complete and functioning system shall be furnished and installed under this Section.

3.03 CONNECTIONS

- A. Comply with requirements in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Connections: At a minimum connect inlet to evaporator with isolation valve, P&T tap, manual air vent, controller-bulb well, thermometer, pressure gauge, differential pressure switch, flex connector, and union or flange. At a minimum connect outlet to evaporator with isolation valve, calibrated balance valve, P&T tap, thermometer, controller-bulb well, pressure gauge, differential pressure switch, drain connection valve, flex connector and union or flange. See drawings for additional requirements. Utilize a single pressure gauge with isolation valves across the evaporator inlet and outlet in lieu of individual gauges to eliminate gauge error. The water strainer is factory-installed with taps for the pressure gauges on the inlet and outlet. Install valved pressure gauges in order to measure differential pressure across the strainer.
- D. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to roof drain. Provide a shutoff valve at each connection if required.

3.04 CLEANING

- A. Clean units internally, on completion of installation, according to manufacturer's written instructions.
- B. Clean exterior prior to transfer to Owner.

3.05 CONTRACTOR STARTUP AND REPORTING

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.
 - 3. Verify that thermometers and gages are installed.
 - 4. Operate water chiller for run-in period according to manufacturer's written instructions.
 - 5. Check bearing lubrication and oil levels.
 - 6. Verify proper motor rotation.
 - 7. Verify vibration isolators and flexible pipe connections are properly installed and check static deflection including during startup and shutdown
 - 8. Verify pressure relief piping is installed in accordance with local Mechanical code.
 - 9. Verify controls, safety interlocks and all chiller protection devices are installed and functioning properly.
 - 10. Verify labels and safety instructions are clearly visible
 - 11. Verify required clearances have been maintained
 - 12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.
- E. Occupancy Adjustments: When requested within 12 months of date of preliminary acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.06 TRAINING

- A. See Section 23 05 00 – Common Work Results for HVAC for general training requirements.
- B. In addition to the training provided in Section 23 05 00 – Common Work Results for HVAC, provide an additional 4 hours of training for each type of water cooled chiller provided on the project.
- C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining chillers. The training will occur after the

- startup report has been provided to the owner and the trainer will provide four Installation and Operation manuals for the use of the Owner's personnel during training.
- D. Demonstrate proper operation of equipment to commissioning agent or designated Owner's personnel. The scope of the demonstration shall include functional performance requirements under both local and building automation control as well as any commissioning requirements in Division 01 and 23.
 - E. Video record the training sessions. The manufacturer may submit a standard training video training CD for review as an alternate to videotaping of the training session. The standard video must be reviewed and accepted by the owner/commissioning authority for the alternate to be acceptable.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Contractor provide: It is the intent of these specifications to provide complete and workable electrical systems as shown on the accompanying plans and as specified herein except such parts as are specifically exempted herein. Provide all necessary supervision, coordination, labor, materials, equipment, fixtures, dryage, hoisting, tools, transportation, plant services and facilities, machinery and connections to utilities for the installation of complete and operable electrical systems. If details or special conditions are required in addition to those shown on drawings, provide all material and equipment usually furnished with such systems or required to complete their installation, whether noted in plans and specification or not.
- B. Materials and labor shall be new (unless noted otherwise), first class and workmanlike and shall be subject at all times to the A/E's inspections, tests and approval from the commencement until the acceptance of the completed work.
- C. The layout shown on the drawings is necessarily diagrammatic but shall be followed as closely as other work will permit. The drawings provide design intent. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- D. All sizes as given are minimum except as noted.
- E. Because of the scale of the Drawings, certain basic items, such as, pipe fittings, duct fittings, access panels, and sleeves, may not be shown. Where such items are required by Code or by other Sections, or where required for proper installation of the Work, such items shall be included, whether shown or not.
- F. In the event of any inconsistencies between the specifications, drawings, contract documents, applicable laws, statutes, ordinances, building codes, rules and regulations, the contractor shall provide the better quality or greater quantity of work and comply with or conform its work to the most stringent legal or contractual requirements.
- G. Changes from these drawings required to make this work conform to the building construction shall be made only with prior written approval of the Architect/Engineer. All proposed changes shall be shown on shop drawings. All measurements shall be verified by actual observation and all work shall fit in place meeting the approval of the Architect/Engineer.
- H. Equipment Specification may not deal individually with minute items required, such as, components, parts, controls, and devices which may be required to produce the equipment performance specified or as required to meet the equipment warranties. Where such items are required to make the system operational, they shall be included by the supplier of the equipment at no additional cost, whether or not specifically called for.

1.02 SECTION INCLUDES

- A. The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.
 - 1. Submittals
 - 2. Construction Verification Checklists
 - 3. Functional Performance Tests
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Guarantee
 - 7. Work By Owner
 - 8. Equipment Furnished By Others
 - 9. Provisions For Future
 - 10. Operation And Maintenance Instructions
 - 11. Record Documents
 - 12. Continuity Of Existing Services

13. Protection Of Finished Surfaces
14. Sealing And Firestopping
15. Off Site Storage
16. Regulatory Requirements
17. Certificates And Inspections
18. Coordination
19. Demolition And Existing Requirements
20. Request And Certification For Payment
21. Temporary Electrical Work
22. Approved Electrical Testing Laboratories
23. Sleeves And Openings
24. Omissions
25. Definitions
26. Project/Site Conditions
27. Work Sequence And Scheduling
28. Work by Other Trades
29. Salvage Materials
30. Training
31. Identification
32. Demolition
33. Cutting And Patching
34. Building Access
35. Equipment Access
36. Housekeeping And Clean Up

1.03 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Division 23 – Heating, Ventilating and Air Conditioning

1.04 SUBMITTALS

- A. Submit shop drawings for equipment under each section per requirements listed in that section, as well as per Division 1.
- B. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Do not submit hard copies of web pages. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
- C. On request from the A/E, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.
- D. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.
- E. The submittals must be approved before fabrication is authorized.
- F. Provide electronic copies of all submittals for review.

1.05 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:
 1. ANSI American National Standards Institute
 2. ASTM American Society for Testing and Materials
 3. EPA Environmental Protection Agency
 4. ETL Electrical Testing Laboratories, Inc.
 5. IEEE Institute of Electrical and Electronics Engineers
 6. IES Illuminating Engineering Society
 7. ISA Instrument Society of America

- 8. NBS National Bureau of Standards
- 9. NEC National Electric Code
- 10. NEMA National Electrical Manufacturers Association
- 11. NESC National Electrical Safety Code
- 12. NFPA National Fire Protection Association
- 13. UL Underwriters Laboratories Inc.

1.06 QUALITY ASSURANCE

- A. Substitution of Materials:
 - 1. Where the following conflicts with Division 1, the requirements of Division 1 shall govern.
 - 2. If the Contractor wishes to submit an alternate to the named manufacturers for any equipment, he may submit a voluntary alternative minimum 7 days prior to bid, stating the manufacturer's name, model number, written, detailed product data.
 - 3. Where materials or equipment are specified by name the proposed material or equipment must be identical to the specified material or equipment in all characteristics of quality, function and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture. Any proposed equal shall be submitted to Architect/Engineer for prior approval, which Architect/Engineer may approve or disapprove in its sole discretion. Work performed or constructed with unapproved equals is at Contractor's risk and any required correction of work incorporating unapproved equals shall be at Contractor's sole cost and expense.
 - 4. In all instances, Contractor shall assume full responsibility for proof of equality of the statute to the equipment hereinafter specified. All data and information necessary for proof of equality, function and space requirements shall be prepared and accompany the submittal of the substitution to the Architect/Engineer. Approval by the Architect/Engineer of equipment other than the specified does NOT relieve Contractor of this responsibility.
- B. All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.
- C. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system, including, but not limited to, coordination with other trades and any required changes by other trades and for obtaining the intended performance from the system into which these items are placed.
- D. All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by A/E, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, except for medium voltage equipment and components, shall be so labeled.

1.07 GUARANTEE

- A. In entering into a contract covering this work, the contractor accepts the specifications and guarantees that the work will be carried out in accordance with the requirements of this specification or such modifications as may be made under the contract documents.
- B. Contractor further guarantees that the workmanship and material will be of the best procurable and that none but experienced workmen familiar with each particular class of work will be employed.
- C. Contractor further guarantees to replace and make good at his own expense, including travel time, all defects, which may develop within 1 year after final payment and acceptance by the Architect/Engineer, due to faulty workmanship or material, upon, receipt of written notification from the Owner.

1.08 WORK BY OWNER

- A. Electrical testing not described in these contract documents will be by the Owner under separate contract.

1.09 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Provide the following documentation:
 - 1. Manufacturer's wiring diagrams for electrically powered equipment.
 - 2. Copies of all approved submittals along with approval letters.

1.10 RECORD DOCUMENTS

- A. Follow the following procedures.
 - 1. During the progress of the work, Contractor shall maintain a current (daily) record set of the drawings and specifications, indicating thereon all work installed at variance with such Contract Documents including, without limitation, work covered by Addenda, Field Work Orders, Change Orders and Engineers additional instructions, interpretations and clarification. All changes or deviations from the original layout of the work and all critical dimensions of buried or concealed work shall be recorded. It shall be Contractor's responsibility to assure that said record sets are complete, accurate and up-to-date, Engineer shall have the right to inspect and review such record sets.
 - 2. At the completion of the work, Contractor shall indicated on record sets all record changes and such additional details necessary or appropriate to provide a complete reference document for use by Engineer. If variations and details cannot be shown clearly thereon, the Contractor shall prepare supplemental drawings adequate to impart the information. The foregoing drawings collectively shall constitute the "Record" drawings for the work.
 - 3. All indication on "Record" drawings shall be executed in a legible manner at Contractor's cost, using methods and legend presentations compatible with the overall scheme of the record drawings with respect to scale, drawing sheet sizes and sequential indexing. All changes shall be marked clearly in red and clouded.
 - 4. Engineer may review Contractor's "Record" drawings and notify Contractor of observed discrepancies or deviations. Contractor shall promptly correct discrepancies, deviations or illegible markups at Contractor's expense and resubmit revised drawings for Engineer review.
 - 5. Contractor shall provide final electronic record drawings to the Owner through the Engineer.
 - 6. Engineer will provide final electronic record drawings to the Owner based on Contractor's markups.

1.11 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval from the Owner's Project Representative. When interruption is required, coordinate scheduling of down-time with the Owner to minimize disruption to his activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.
- B. Each Contractor shall thoroughly familiarize himself with existing systems which will affect and be affected by relocation of existing equipment and installation of new lines and equipment. They shall plan installation of their work so that interruptions of services to any building or portion thereof will be a minimum and such interruptions shall occur only when system is not required, if possible. If not possible, each Contractor shall insure the operation of services by whatever means possible, such as, installing bypasses, capping of services or providing temporary service. Each interruption shall be for as short a duration as possible.
- C. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.
- D. This Contractor shall restore any circuit interruption as a result of this work to proper operation as soon as possible. Note that institutional operations are on a seven day week schedule.

1.12 OFFSITE STORAGE

- A. If payment will be requested for approved offsite stored material, then the Contractor shall complete an "Off-site Storage Agreement" which is available from the Owner. Prior approval by Owner's personnel for offsite storage will be needed. No material will be accepted for offsite storage unless submittals for the material have been approved.

1.13 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of the Wisconsin State Electrical Code Volumes 1 and 2, the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, present manufacturing standards (including NEMA) and the Authority Having Jurisdiction (AHJ).
- B. All Division 26 work shall be done under the direction of a currently certified State of Illinois Certified Master Electrician.

1.14 CERTIFICATES AND INSPECTIONS

- A. Refer to Division 1 for permits, regulations, utilities and taxes.
- B. Obtain and pay for all required State or local installation inspections except those provided by the Architect/Engineer in accordance with State Code. Deliver originals of these certificates to the Owner. Include copies of the certificates in the Operating and Maintenance Instructions.
- C. Coordinate and provide inspections as required by the Authority Having Jurisdiction over the site.
- D. This contractor is responsible for coordination of Owner's electrical inspection. Inspection requirements will be issued at a pre-installation meeting, arranged by this contractor and the Owner's Electrical Inspector.

1.15 COORDINATION

- A. Refer to Division 1 and Section 23 05 00 for coordination.

1.16 DEMOLITION AND EXISTING REQUIREMENTS

- A. Existing active services and any other building systems when encountered shall be protected against damage. Where existing services are to be abandoned, the services shall be removed back to the point of origin and removed from the site unless otherwise directed by the Owner's Representative.
- B. Submit a "Sequence of Work Schedule" in respect to all temporary and permanent utility and service cutovers after final determination. This schedule shall be submitted for approval to the Owner and Architect/Engineer. The submittal shall designate priority order, service or utility affected, date of cutover, and time of day to start and finish.
- C. Bidders should inspect the site to become familiar with conditions of the site which will affect the Work. Bidders should verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, or other obstacles.
- D. Extra payment will not be allowed for changes in the Work required because of the successful bidder's failure to make this inspection.

1.17 REQUEST AND CERTIFICATION FOR PAYMENT

- A. Within 10 days after Notice to Proceed, the successful bidder will submit to the Owner's Project representative in a form prescribed by Division 1, a cost breakdown of the proposed values for work performed which, if approved by the Owner's project representative, will become the basis for construction progress and monthly payments. The cost breakdown items shall reflect actual work progress stages as closely as feasible.
- B. In addition, if payment will be requested for approved off-site stored material, then that material shall be listed as a line item in the request and certification for payment cost breakdown.

1.18 APPROVED ELECTRICAL TESTING LABORATORIES

- A. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
 - 1. Underwriters Laboratories Inc.
 - 2. Electrical Testing Laboratories, Inc.

1.19 SLEEVES AND OPENINGS

- A. Openings required in new or existing construction that may be necessary for the installation of new work shall be provided by the respective contractor and all patching and repairing shall be done by workmen competent in the trade required, at the expense of the respective contractor. The respective contractor shall be responsible for arranging the work so that minimum cutting will be required. All rubbish and excess materials involved in such cutting shall be promptly removed from the site and

disposed of by the contractor. Cutting through the floor or roof systems or load bearing walls shall be done only with the prior written approval of the Architect/Engineer so as to avoid damaging the structural system.

1.20 OMISSIONS

- A. No later than ten (10) days before bid opening, the Contractor shall call the attention of the A/E to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

1.21 DEFINITIONS

- A. The term "provide" includes such labor, methods, materials, equipment and transportation or other facilities required to complete the Contract and the performance of all duties thereby upon the Contractor.

1.22 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 A/E before proceeding.
- C. Tools, materials and equipment shall be confined to areas designated by the Owner's project representative.

1.23 WORK SEQUENCE AND SCHEDULING

- A. Install work in phases to accommodate Owner's occupancy requirements. During the construction period coordinate schedule and operations with Owner's Construction Representatives.

1.24 WORK BY OTHER TRADES

- A. Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this Trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.
- B. Electrical details on drawings for equipment to be provided by others are based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others.

1.25 SALVAGE MATERIALS

- A. No materials removed from this project shall be reused (except as specifically noted below). All materials removed shall become the property of and shall be disposed of by the Contractor.

PART 2 - PRODUCTS

2.01 PRODUCTS NOT INCLUDED IN THIS SECTION

PART 3 – EXECUTION

3.01 DEMOLITION

- A. Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.
- B. All devices, fixtures, equipment, wiring and associated conduit, insulation and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor except as specifically noted otherwise. All designated equipment is to be turned over to the owner for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

- C. All contractors requiring the personnel/ material hoist and or temporary construction elevator (i.e. new elevators, temporarily protected) at times other than outlined in the temporary facilities specifications will make arrangements directly with the Mechanical contractor. The Mechanical contractor is responsible for all coordination and scheduling of the use of any hoisting equipment so the flow of the project is smoothly maintained and all workers have access to the work areas to perform their work and deliver material to the areas needed according to the project schedule.
- D. If any contractor's work requires the removal and replacement of any finished materials including but not limited to such materials as ceiling tiles, wall finishes, cabinets, doors, flooring, windows, etc. after those items are installed, each contractor will be responsible, at no additional cost to the owner, to replace any damaged, soiled or lost materials with new materials to match the existing materials and those materials damaged.

3.02 CUTTING AND PATCHING

- A. Contractor shall coordinate the placing of openings in the new structure as required for the installation of Contractor's work.
- B. Contractor shall provide cutting and patching and patch painting in the existing structure as required for the installation of his Work and shall furnish lintels and supports as required for openings. Cutting of structural support members will not be permitted without prior approval of the Architect/Engineer. Extent of cutting shall be minimized; use core drills, power saws, or other machines which will provide neat, minimum openings. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

3.03 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.04 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Provide access doors where required.
- B. The approximate location of all equipment and devices is shown on the drawings. The Architect/Engineer reserves the right to change the location of all equipment or devices 6 feet in any direction at no additional cost provided such changes are requested before final installation.
- C. Install all equipment with ample space allowed for removal and repair. Provide ready accessibility to removable parts of equipment and to all wiring without moving equipment which is installed or which is already in place.
- D. In mechanical and electrical equipment spaces, expose ceiling outlets and conduit with due consideration to ventilating ducts and mechanical piping. Where numerous ducts occur, install conduits and outlets after the ventilating ducts. Puncturing of ductwork or hanging equipment such as light fixtures, ceiling hangers and conduits from ductwork is prohibited unless specifically noted otherwise.
- E. Electrical equipment shall be installed to maintain minimum clearances per Article 110 of NEC and ANSI C2 (National Electrical Safety Code).
- F. No piping carrying fluids shall be installed directly over electrical equipment.
- G. Equipment shall be installed in accordance with manufacturer's recommendation. Where conflicts occur between Contract Document and these recommendations, a ruling shall be requested of the Architect for decision before proceeding with such work.

3.05 COORDINATION

- A. The Contractor shall cooperate with other trades in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.
- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-

recessed heating units installed in/on architectural surfaces. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls and other structural components as they are constructed.

- C. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
- D. Coordinate arrangements, mounting and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays and busways will be clear of obstructions and of the working and access space of other equipment.
- E. Coordinate with the Mechanical Contractor and equipment vendors for proper location, quantity and capacity of all required conduits, back boxes, device rings and power supplies required to support systems specified.

3.06 HOUSEKEEPING AND CLEAN UP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid: The work under this section includes furnishing and installing required wiring and cabling systems to disconnect the existing chiller and reconnect the new chiller.

1.02 SECTION INCLUDES

- A. General
- B. Manufacturers
- C. Building Wire
- D. Underground Wire For Exterior Work
- E. Wiring Connectors

1.03 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 05 00 – Common Work Results for Electrical
- C. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- D. Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- E. Section 26 05 53 – Identification for Electrical Systems.

1.04 SUBMITTALS

- A. Submit product data: Provide for each cable assembly type.
- B. Submit factory test reports: Indicate procedures and values obtained.
- C. Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.
- D. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.05 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code
- B. IPCEA S-61-402/NEMA WC-5 Thermoplastic Insulated Wire and Cable
- C. IPCEA S-66-524/NEMA WC-7 Cross-linked Thermosetting Polyethylene-Insulated Wire and Cable
- D. UL 83
- E. ASTM

1.06 FUNCTIONAL PERFORMANCE TESTS

- A. Refer to Section 26 05 00 – Common Results for Electrical – Functional Performance Tests
- B. Acceptance tests shall be performed in accordance with the current version of ASNI/NETA ATS and by an independent testing agency. Specify only the independent testing agencies listed in the latest electrical Trades Preferred Manufacturers List.
- C. Tests shall be performed in accordance with applicable codes, standards, and equipment manufacturers' instructions.
- D. The Contractor shall provide all test equipment, materials and labor necessary to perform the tests, and shall coordinate with the other trades for necessary services, such as scaffolding and the uncoupling of motors.
- E. Tests shall consist of visual inspections, manual operations, and electrical testing under all normal and expected abnormal operating conditions.
- F. The A/E & Owner shall be notified a minimum of 3 working days in advance of all tests. Tests shall be witnessed by the owner unless such witnessing is waived in writing.
- G. The A/E & Owner shall be provided with a written test report, signed and dated, for all tests. Include a copy of the test report with O&M manual.

- H. Dielectric absorption tests shall be performed with a 2,500 volt DC megger.
- I. Megger tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-200 volt rated equipment.
- J. A continuity check and a 1,000 volt DC megger test shall be performed on 600 volt power cables No. 4 AWG and larger. The megger test shall be performed between each pair of conductors and from each conductor to ground. Each test shall be performed for 15 seconds or until the insulation resistance value stabilizes.
- K. The insulation resistance between conductors, and from each conductor to ground, shall be 100 megohms minimum in one minute or less. In addition, the lowest insulation resistance value shall not differ from the highest value by more than 20 percent. If all megger readings for a given circuit are above 1000-megohms, the 20 percent balance requirement may be waived.

1.07 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper.
- C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.
- D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.
- B. All conductors shall be copper.
- C. All cable and wire shall have 600 volts insulation, have a conductivity of 98 percent, and shall be annealed coated copper per ASTM B33 or B189.
- D. Wire sizes No. 12 AWG and smaller shall be solid wire, and wire No. 10 AWG and larger shall be stranded, Class B, ASTM B8.
- E. Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.
- F. Minimum wire sizes shall be as follows:
 - 1. Power wiring- #12 AWG
 - 2. Control Wiring- #18 AWG
- G. All conductors shall be continuous without splices except at locations approved for the purpose.

2.02 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. Alcan Products Corporation; Alcan Cable Division
 - 2. American Insulated Wire Corp.; a Leviton Company
 - 3. General Cable Corporation
 - 4. Senator Wire & Cable Company
 - 5. Southwire Company
 - 6. Houston Wire & Cable
 - 7. AFC Cable Systems, Inc.
 - 8. Hubbell Power Systems, Inc.
 - 9. O-Z/Gedney; EGS Electrical Group, LLC
 - 10. 3M; Electrical Products Division
 - 11. Tyco Electronics Corp.
 - 12. Insert Manufacturer's Name

2.03 BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Insulation: Type THHN/THWN, XHHW-2 insulation for feeders and branch circuits.

2.04 WIRING CONNECTORS

- A. Split Bolt Connectors: Not acceptable.
- B. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.
- C. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- D. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.
- E. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
- F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

PART 3 – EXECUTION

3.01 GENERAL WIRING METHODS

- A. All wire and cable shall be installed in conduit.
- B. Do not use wire smaller than 12 AWG for power and lighting circuits.
- C. All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).
- D. Make conductor lengths for parallel conductors equal.
- E. Splice only in junction or outlet boxes.
- F. No conductor less than 10 AWG shall be installed in exterior underground conduit.
- G. Identify ALL low voltage, 600v and lower, wire per section 26 05 53.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

3.02 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Completely and thoroughly swab raceway system before installing conductors.
- D. Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.

3.03 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice only in accessible junction boxes.
- B. Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.
- C. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.
- D. Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.
- E. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.04 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 04.
- B. Additional testing as follows shall be performed if aluminum conductors are used:
- C. Equipment terminated with aluminum conductors shall be tested with a thermal imager and recorded.
- D. Conductors shall be closely checked for loose or poor connections, and for signs of overheating or corrosion.
- E. Test procedures shall meet NETA guidelines.
- F. Test results and report shall be provided to the engineer.
- G. Contractor shall correct all deficiencies reported in the test report.

3.05 WIRE COLOR

- A. General:
 - 1. For wire sizes 10 AWG and smaller - Wire shall be colored as indicated below.
 - 2. For wire sizes 8 AWG and larger – Use colored wire, or identify wire with colored tape at all terminals, splices and boxes. Colors to be as indicated below.
 - 3. In existing facilities, use existing color scheme.
 - 4. In new facilities, use black and red for single phase circuits at 120/240 volts, use Phase A black, Phase B red and Phase C blue for circuits at 120/208 volts single or three phase, and use Phase A brown, Phase B orange and Phase C yellow for circuits at 277/480 volts single or three phase. Note: This includes fixture whips except for Listed whips mounted by the fixture manufacturer on the fixture and Listed as a System.
 - 5. All switch legs shall be the same color as their associated circuit. Traveler conductors run between 3 and 4 way switches shall be colored pink or purple.
 - 6. Isolation panel branch circuits: The isolated circuit conductors shall be identified as follows:
 - a. Isolated Conductor No. 1: Orange with at least one distinctive colored stripe other than white, green or gray along the entire length of the conductor.
 - b. Isolated Conductor No. 2: Brown with at least one distinctive colored stripe other than white, green or gray along the entire length of the conductor.
 - c. For 3-phase systems, the third conductor shall be identified as yellow with at least one distinctive colored stripe other than white, green or gray along the entire length of the conductor. Where isolated circuit conductors supply 125-volt, single-phase, 15- and 20-ampere receptacles, the striped orange conductor(s) shall be connected to the terminal(s) on the receptacles that are identified in accordance with NEC 200.10(B) for connection to the grounded circuit conductor.
- B. Neutral Conductors: White for 120/208V and 120/240V systems, Gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with a different stripe.
- C. Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color coded.
- D. Feeder Circuit Conductors: Each phase shall be uniquely color coded.
- E. Ground Conductors: Green for 6 AWG and smaller. For 4 AWG and larger, identify with green colored wire, or with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, contractor shall provide green with yellow tracer.

3.06 BRANCH CIRCUITS

- A. The use of single-phase, multi-wire branch circuits with a common neutral are not permitted. All branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductors.

3.07 CONSTRUCTION VERIFICATION CHECKLISTS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under these specifications in accordance with the procedures defined for construction verification checklists.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid: The work under this section includes grounding electrodes, connectors, equipment grounding conductors, bus and bonding.

1.02 SECTION INCLUDES

- A. Manufacturers
- B. Mechanical Connectors
- C. Compression Connectors
- D. Wire
- E. Bus
- F. Chemical-Enhanced Grounding Electrodes

1.03 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 05 00 – Common Work Results for Electrical

1.04 SUBMITTALS

- A. Product Data: Provide data for grounding electrodes and connections.
- B. Test Reports: Indicate overall resistance to ground [and resistance of each electrode].
- C. Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

1.05 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.
- B. ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.06 FUNCTIONAL PERFORMANCE TESTING

- A. Refer to section 26 05 00- Common Work Results for Electrical- Functional Performance Testing.
- B. Tests shall be performed in accordance with applicable codes, standards, and equipment manufacturers' instructions.
- C. The Contractor shall provide all test equipment, materials, and labor necessary to perform the tests.
- D. Tests shall consist of visual inspections, manual operations, and electrical testing under all normal and expected abnormal operating conditions.
- E. The resistance to ground shall be measured using either the three point method or the fall-of-potential method.
- F. Grounding System Resistance: 2ohms maximum at building service entrance.
- G. Testing of grounding system resistance is to be witnessed by the electrical inspector or Field Representative. Provide test report of grounding system resistance in final O&M manuals.

1.07 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of grounding electrodes.

1.08 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide by one of the following
 - 1. Burnoy
 - 2. Erico
 - 3. Schieder Sq. D
 - 4. Thomas Betts
 - 5. Panduit
 - 6. ILSCO.

2.02 MECHANICAL CONNECTORS

- A. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.
- B. Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.
- C. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

2.03 COMPRESSION CONNECTORS

- A. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
- B. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
- C. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.
- D. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
- E. Each connector shall be factory filled with an oxide-inhibiting compound.

2.04 WIRE

- A. Material: Stranded copper (aluminum not permitted).
- B. Grounding Electrode Conductor: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.
- C. Foundation Electrodes: As shown on drawings.
- D. Primary Manhole, Main Switchgear room and Vault Bonding: No. 4/0 minimum.
- E. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

2.05 BUS

- A. Material: Copper (aluminum not permitted).
- B. Size: 1/4" X 2" minimum and 12" minimum length.
- C. Provide insulated wall standoff – 2" minimum.
- D. Pre-drilled holes.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 GENERAL

- A. Install Products in accordance with manufacturer's instructions.

- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
- C. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.
- D. Attach grounds permanently before permanent building service is energized.
- E. All grounding electrode conductors shall be installed in PVC conduit, in exposed locations.
- F. Isolated Grounding Conducts: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow type, with at least three bands of green and two bands of yellow.

3.03 LESS THAN 600 VOLT SYSTEM GROUNDING

- A. Provide code sized copper grounding electrode conductor from secondary switchboard ground bus, each separately derived system neutral, secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes. Provide bonding jumper around water meter.
- B. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
- C. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #4 AWG bare copper conductor.
- D. Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.

3.04 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION

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SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Base Bid:
 - 1. The work under this section includes conduits, fittings, boxes, surface raceways, multi-outlet assemblies, auxiliary gutters, and wall duct for electrical systems including wall and ceiling outlet boxes, floor boxes, and junction boxes.

1.02 SECTION INCLUDES

- A. General
- B. Manufacturers
- C. Rigid Metal Conduit and Fittings
- D. Liquidtight Flexible Metal Conduit and Fittings
- E. Conduit Supports
- F. Surface Metal Raceway
- G. Surface Nonmetal Raceway
- H. Pull and Junction Boxes
- I. Hinged Cover Enclosures

1.03 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 05 00 – Common Work Results for Electrical
- C. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.04 SUBMITTALS

- A. Surface Raceway System - submit product data and catalog sheets for all components.
- B. Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.
- C. Product data for conduit, wireways, fittings, floor boxes, hinged-cover enclosures or cabinets.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All steel fittings and conduit bodies shall be galvanized.
- B. No cast metal, or split-gland type fittings permitted.
- C. Mogul-type condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.
- D. All conduit covers must be fastened to the conduit body with screws and be of the same manufacture.
- E. Wireways, gutters and c-condulets shall not be used in lieu of pull boxes and condulets.
- F. All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

2.02 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.

2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co
4. Anamet Electrical, Inc.; Anaconda Metal Hose
5. Armocast Products Company
6. Arnco Corporation
7. CANTEX inc
8. Carson Industries LLC
9. CDR Systems Corporation
10. CertainTeed Corp.; Pipe & Plastics Group
11. Christy Concrete Products
12. Condux International, Inc
13. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
14. EGS/Appleton Electric
15. ElecSYS, Inc
16. Electri-Flex Co.
17. Erickson Electrical Equipment Company
18. Hoffman
19. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
20. Hubbell Incorporated; Quazite
21. Lamson & Sessions; Carlon Electrical Products
22. Manhattan/CDT/Cole-Flex
23. Maverick Tube Corporation
24. NewBasis
25. Nordic Fiberglass, Inc.
26. O-Z Gedney; a unit of General Signal
27. RACO; a Hubbell Company
28. Robroy Industries, Inc.; Enclosure Division
29. Scott Fetzer Co.; Adalet Division
30. Spring City Electrical Manufacturing Company
31. Synertech Moulded Products, Inc.; a division of Oldcastle Precast
32. Thomas & Betts Corporation
33. Walker Systems, Inc.; Wiremold Company (The)
34. Wheatland Tube Company
35. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

2.03 RIGID METAL CONDUIT AND FITTINGS

- A. Conduit: Heavy wall, galvanized steel, schedule 40, threaded. ANSI C80.1
- B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.05 PULL AND JUNCTION BOXES

- A. Pull boxes and junction boxes shall be minimum 4 inch square (100 mm) by 2 1/8th inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4 11/16 inch square (117 mm).
- B. For telecommunication, fiber optic, security, and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on telecommunication, security, other low voltage and fiber optic systems with conduits of 1 1/4" and larger, shall be sized per the NEC conduit requirements. For determining box size, the conduit is the determining factor not the wire size.
- C. Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

- D. Sheet Metal Boxes Larger Than 12 Inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.
- E. Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain tight. Galvanized cast iron or aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- F. Fiberglass or Concrete Handholes with weatherproof cover of non-skid finish shall be used for underground installations. Provide traffic rate covers.
- G. Box extensions and adjacent boxes within 48" of each other are not allowed for the purpose of creating more wire capacity.
- H. Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.
- I. Wireways shall not be used in lieu of junction boxes.

2.06 HINGED COVER ENCLOSURES

- A. NEMA 250, Type 1, with continuous hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio frequency resistant paint.

2.07 CABINETS

- A. NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
- B. Hinged door in front cover with flush latch and concealed hinges.
- C. Key latch to match panelboards.
- D. Metal barriers to separate wiring of different systems and voltage.
- E. Accessory feet where required for freestanding equipment.

PART 3 – EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT AND SUPPORT

- A. EMT is permitted to be used in sizes 4" (50 mm) and smaller for power and telecommunication systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.
- B. Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (13 mm) minimum except all homerun conduits shall be 3/4", or as specified elsewhere. Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.
- C. Size conduit for all other wiring, including but not limited to data, control, security, fire alarm, telecommunications, signal, video, etc. shall be sized per number of conductors pulled and their cross-section. 40% fill shall be maximum for all new conduit fills.
- D. Arrange conduit to maintain headroom and present a neat appearance.
- E. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- F. Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- G. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.
- H. Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- I. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.
- J. Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.
- K. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.

- L. In general, all conduit shall be concealed except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.
- M. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.
- N. For indoor conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a junction box.
- O. All conduits installed in exposed areas shall be installed with a box offset before entering box.

3.02 CONDUIT INSTALLATION

- A. Cut conduit square; de-burr cut ends.
- B. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- C. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.
- D. All conduit terminations (except for terminations into conduit bodies) shall use conduit hubs, or connectors with one locknut, or shall use double locknuts (one each side of box wall) and insulated bushing. Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 26 05 26 – Grounding and Bonding for Electrical Systems for grounding bushing requirements.
- E. Install no more than the equivalent of three 90 degree bends between boxes.
- F. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.
- G. Conduit shall be bent according to manufacturer's recommendations.
- H. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.
- I. Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.
- J. Install expansion-deflection joints where conduit crosses building expansion joints. Note: expansion-deflection joints are not required where conduit crosses building control joints if the control joint does not act as an expansion joint. Install expansion fitting in PVC conduit runs as recommended by the manufacturer.
- K. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.
- L. Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide Listed conduit seals to prevent the passage of moisture and water vapor through the conduit.
- M. Route conduit through roof openings for piping and ductwork where possible.
- N. Conduit is not permitted in any slab topping of two inches (50 mm) or less.
- O. Ground and bond conduit under provisions of Section 26 05 26.
- P. Identify conduit under provisions of Section 26 05 53.
- Q. All conduit installed underground (exterior to building) shall be buried a minimum of 24" below finished grade, whether or not the conduit is concrete encased.

3.03 CONDUIT INSTALLATION SCHEDULE

- A. Exposed Outdoor Locations: Rigid steel conduit.

3.04 NONMETALLIC SURFACE RACEWAY INSTALLATION

- A. Use flat headed screws with appropriate anchors to fasten channel to surfaces secured every twenty-four (24) inches. Mount plumb and level. All surface mounted devices shall be fastened to the wall utilizing flat head screws along with appropriate anchors. No device shall be adhered to the wall surface using two-faced tape or any means other than as described above.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. In areas where the walls cannot be fished, the station cable serving these outlets shall be covered with raceways. No exposed wire shall be permitted within offices, laboratories, and conference rooms or like facilities.
- D. The raceway shall originate from a surface mounted box mounted adjacent to and at the same height as existing electrical boxes in the room, be attached to the wall and terminate above the ceiling.

- E. All fittings including, but not limited to, extension boxes, elbows, tees, fixture bodies shall match the color of the raceway.
- F. The raceway and all systems devices shall be UL listed and exhibit nonflammable self-extinguishing characteristics, tested to specifications of UL94V-0.
- G. The raceway and all systems devices shall adhere to the EIA/TIA Category 5e bend radius standard.

3.05 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.
- D. Boxes shall not be fastened to the metal roof deck.
- E. It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.
- F. In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Architect/Engineer and install outlet as instructed by the Architect/Engineer.
- G. The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.
- H. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors.
- I. Locate and install to maintain headroom and to present a neat appearance.
- J. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

3.06 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install Owner approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.
- B. Support pull and junction boxes independent of conduit.

3.07 EXPANSION JOINT FITTINGS FOR RNC

- A. Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30° F (17° C) and that has straight run length that exceeds 25 feet (7.6 m).
- B. Install expansion joint fittings for each of the following locations and provide type and quantity of fittings that accommodate temperature change listed for location:
 - 1. Outdoor Locations not Exposed to Direct Sunlight: 125° F (70° C), <Insert temperature>, temperature change.
 - 2. Outdoor Locations Exposed to Direct Sunlight: 155° F (86° C), <Insert temperature>, temperature change.
 - 3. Indoor Spaces: Connected with the outdoors without physical separation: 125° F (70° C), <Insert temperature>, temperature change.
 - 4. Attics: 135° F (75° C), <Insert temperature>, temperature change.
- C. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
- D. Install each expansion joint fitting with position, mounting and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

END OF SECTION

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SECTION 26 29 25
MECHANICAL EQUIPMENT CONNECTIONS

1. GENERAL

1.01. WORK INCLUDES

- A. Base Bid:
 - 1. Contractor provide mechanical equipment wiring specified and indicated on the drawings.

1.02. RELATED WORK

- A. Specified elsewhere:
 - 1. 26 05 00 – Common Work Results for Electrical
 - 2. 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
 - 3. 26 05 26 – Grounding and Bonding for Electrical Systems
 - 4. 26 05 33 – Raceway and Boxes for Electrical Systems

1.03. QUALITY ASSURANCE

- A. Codes & Standards: NFPA-70 (NEC), Latest Edition

2. PRODUCTS

2.01. MATERIALS

- A. Provide all material to complete final power wiring connections to all mechanical equipment items.
- B. See applicable sections of Division 26 specifications.
- C. Motor Connections: Provide power wiring for fans, pumps, etc., and their associated control equipment furnished by others. Review mechanical plans for all motor locations. Final connections to all motors shall be made with flexible liquid-tight metallic conduit with grounding conductor. Power wiring includes feeder from distribution panel to disconnect, from disconnect to starter, and feeder from starter to motor. Provide sufficient slack in final connections to allow for minor repositioning or motor mount.

3. EXECUTION

3.01. INSTALLATION

- A. Install power wiring, power conduit, disconnects, starters, remote push button stations, fuses or breakers, and make final connections to electrically powered or motorized equipment indicated on the drawings. Final connection to equipment items shall be made in accord with sections specified in paragraph 1.02.
- B. Verify proper location of equipment, outlets, controls, mounting heights, and size and number of wires prior to roughing in. Verify motor types, voltages, and sizes with the starter types, voltages, sizes, holding coil voltages, thermal overload capacities, and interlocks.
- C. Provide power wiring and disconnect means for all motors, Per NEC.
- D. Motors shall be furnished under the section responsible for the driven machine or system. Set loose motors and wire complete, in place. Motor starters for “package” type equipment shall be factory furnished under the section responsible for the packaged equipment system.
- E. Review mechanical drawings for locations. Final connections to motors shall be made with flexible PVC

coated metallic conduit. Power wiring includes: feeder from distribution panel to disconnect, feeder from disconnect to starter, and feeder from starter to motor. Provide sufficient slack in final connection to allow for minor repositioning of motor mount. Make final connections.

- F. Provide necessary connections between controllers, starters, and motors, in conduit, and leave motors ready to start. Change connections, if necessary, to secure proper rotation of motors. The power supply leads to the motors, from the starter and controllers, shall be of the same size as the feeds indicated on the drawings.
- G. Provide fractional horsepower manual starters, surface and recessed types. Recessed types shall be installed in all finished spaces. All motor starters shall contain pilot lights. Install and wire motor starters complete, in place, and ready for operation.
- H. Unless otherwise indicated on the drawings, all 120 volt, single-phase, motors 1/3 HP and larger shall be placed on separate circuits.
- I. Provide overload heaters in starters and motor control devices requiring same. Install overload heaters, sized in accord to motor nameplate data in conformance to applicable codes.
- J. All integral packaged control panels shall be provided by the contractor furnishing the equipment. Install power control panels and complete power wiring.
- K. Verify with other contractors what electrical equipment is furnished with mechanical equipment. Provide starters, unless otherwise noted on the drawings. When starters or control panels come as an integral part of the respective equipment (e.g., packaged air conditioning units and sump pumps), provide wiring and make final connections to the line side of the starter or disconnect device. Power and control wiring from this point to the equipment shall be by the Contractor furnishing the motor.
- L. Provide assistance during start-up and installation to the contractors furnishing the various equipment. Test all motors for proper rotation and phase connection. Verify with ampere meter that motor is running under normal conditions and is not drawing excessive amperage. All motors shall have proper fuse and thermal overload protection.

3.02. CLARIFICATION OF WORK

- A. All equipment furnished by other contractors shall be placed in first class operating condition. The Contractor will be responsible for its safety.

END OF SECTION

BID SUBMISSIONS

The following must be submitted with Bid proposal:

- Proposal Form
- Bid Deposit
- List of Subcontractors
- Equal Employment Opportunity [EEO] Workforce Statistics Form
- Purchasing Certification Form

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PROPOSAL FORM

PROJECT: Chiller Replacement, Urbana City Building, 400 South Vine Street, Urbana, IL

You are invited to submit a lump sum bid for the general construction work for the projects listed above. Your bid should include all delivery, installation, and applicable taxes.

Bid will be received via traditional sealed bid. The City of Urbana reserves the right to reject all bids and accept any quote regardless of which vendor is low. All bidders are required to provide the final quotation using the attached bid form by 2:00PM on or before June 16, 2016.

BID FORM

GENERAL CONSTRUCTION

Bid 1516-12 Chiller Replacement, Urbana City Building
400 South Vine Street, Urbana, IL

DATE: _____

SUBMITTED BY: «Contractor» _____
«Address» _____
«City_State_Zip» _____
Name of Bidder: _____
Telephone Number of Bidder: _____

TO: Mr. Vince Gustafson, Public Facilities Supervisor
City of Urbana, Illinois
Public Works Department
706 S. Glover Avenue
Urbana, Illinois

Submit Via: Sealed Envelope. Mail, Fed Ex., UPS

Questions to: Mr. Vince Gustafson, Public Facilities Supervisor
(217) 384-2342
vhgustafson@urbanaillinois.us

Substitutions: Must be submitted by June 8, 2016, 2:00 pm. for review
No substitutions will be accepted after this date.
All substitutions must meet requirements established in
specification in its entirety.

PROJECT:

Chiller Replacement, Urbana City Building

1. Base Bid – Chiller Replacement, Urbana City Building

Having examined the Contract Documents in Bid 1516-12, as prepared by the City of Urbana and Henneman Engineering Inc. (including these specifications and drawings G101, MD101, M101 & E101, dated May 29, 2016) for construction of the Project, and having inspected the site and the conditions affecting and governing the construction of said Project, the undersigned Bidder hereby proposes to furnish all labor and materials, supervision, coordination, transportation, services and equipment required to construct and properly complete the work included in the Contract Documents for the lump sum of:

Dollars _____ (\$ _____)
(Words) (Figures)

2. CHANGE ORDERS

Overhead Fee	Percentage	_____ %
Profit Fee	Percentage	_____ %

3. The undersigned Bidder acknowledges receipt of the following addenda:

4. SIGNATURES:

Date: _____
Signed: _____
By: _____
Title: _____
Name of Firm: _____
Attested : _____

5. Accompanying this *Proposal* is a bank cashier's check, certified check, or bid bond, complying with the requirements of the *Specifications*, and in an **amount equal to ten percent of the total annual base bid cost, made payable to the City of Urbana**. The amount of the check or bond is:

Dollars [\$ _____]

If this *Proposal* is accepted and the undersigned shall fail to execute a *Contract* and *performance bond* as required herein, it is hereby agreed that the amount of the check or draft, or bidder's bond substituted in lieu thereof shall become the property of the Owner, and shall be considered as payment of damages due to delay and other causes suffered by the Owner because of the failure to execute the said *Contract* and *performance bond*; otherwise said check or draft or bidder's bond substituted in lieu thereof shall be returned to the undersigned as provided in the *Standard Contract Provisions*.

Attach BID BOND, BANK CASHIER'S CHECK, or CERTIFIED CHECK here.

LIST OF SUBCONTRACTORS

Mark one of the boxes below:

☐ Proposer does not propose to subcontract the work.

☐ Proposer intends to subcontract certain portions of the work to the individuals/firms listed below:

NAME:	TYPE OF WORK:
ADDRESS	
	LICENSE #:
PHONE:	

NAME:	TYPE OF WORK:
ADDRESS	
	LICENSE #:
PHONE:	

NAME:	TYPE OF WORK:
ADDRESS	
	LICENSE #:
PHONE:	

NAME:	TYPE OF WORK:
ADDRESS	
	LICENSE #:
PHONE:	

NAME:	TYPE OF WORK:
ADDRESS	
	LICENSE #:
PHONE:	

NAME:	TYPE OF WORK:
ADDRESS	
	LICENSE #:
PHONE:	

Name of Individual/Firm Submitting Proposal:

Signature of Proposer: _____

THIS FORM MUST BE COMPLETED BY THE CONTRACTOR AND INCLUDED IN THE PROPOSAL.

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<p align="center"> CITY OF URBANA HUMAN RELATIONS DIVISION 400 SOUTH VINE ST. URBANA, ILLINOIS 61801 (217) 384-2466 (phone); 384-2426 (fax) terent@city.urbana.il.us </p>	Office Use Only (05/13)	
	Requested by:	Date:
	Approved by:	Date:
	Certification Date:	
	Certificate Expiration Date:	

EQUAL EMPLOYMENT OPPORTUNITY (E.E.O.) WORKFORCE STATISTICS FORM

Please complete the sections below as instructed. Failure to properly complete this form may result in a delay or denial of eligibility to bid or do business with the City of Urbana.

Section I. Identification

1. Company Name and Address:

Name:

d/b/a:

Address:

City/State/Zip:

Telephone Number(s) include area code:

Check one of the following

Corporation	<input type="checkbox"/>	Partnership	<input type="checkbox"/>	Individual Proprietorship	<input type="checkbox"/>	Limited Liability Corp.	<input type="checkbox"/>
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FBI Number: _____ Social Security Number: _____

2. Name and Address of the Company's Principal Office *(answer only if not the same as above)*

Name:

Address:

City/State/Zip

3. Major activity of your company (product or service):

4. Project on which your company is bidding:

5. City of Urbana contact staff assigned to contract:

SECTION II. Policies and Practices

Description of EEO Policies and Practices		YES	NO
A.	Is it the Company's policy to recruit, hire, train, upgrade, promote and discipline persons without regard to race, color, creed, class, national origin, religion, sex, age, marital status, mental and/or physical disability, personal appearance, sexual preference, family responsibilities, matriculation, political affiliation, prior arrest, conviction record, or source of income ?		
B.	Has someone been assigned to develop procedures, which will assure that the EEO policy is implemented and enforced by managerial, administrative, and supervisory personnel? If so, please indicate the name and title of the official charged with this responsibility. Name: _____ Title: _____ Telephone: _____ Email: _____		
C.	Does the company have a written Equal Employment Opportunity plan or statement? Note: If no, a copy of an E.E.O statement is enclosed. You must attach an EEO Statement in order to be considered eligible to do business with the City of Urbana. Questions? (217) 384-2466 or terent@city.urbana.il.us.		
D.	Has the company developed a written policy statement prohibiting Sexual Harassment? You must attach a copy of your company's Sexual Harassment Policy in order to be considered eligible to do business with the City of Urbana.		
E.	Have all recruitment sources been notified that the company will consider all qualified applicants without regard to race, color, creed, class, national origin, religion, sex, age, marital status, mental and/or physical disability, personal appearance, sexual orientation, family responsibilities, matriculation, political affiliation, prior arrest, conviction record, or source of income?		
F.	If advertising is used, does it specify that all qualified applicants will be considered for employment without regard to race, color, creed, class, national origin, religion, sex, age, marital status, mental and/or physical disability, personal appearance, sexual orientation, family responsibilities, matriculation, political affiliation, prior arrest, conviction record, or source of income?		
G.	Has the contractor notified all of its sub-contractors of their obligations to comply with the Equal Opportunity requirements either in writing, by inclusion in subcontracts or purchase orders?		
H.	Is the company a state certified minority/women owned business? If yes, please attach a copy of state certification.		
I.	Does the company have collective bargaining agreements with labor organizations?		
J.	Have the labor organizations been notified of the company's responsibility to comply with the Equal Employment Opportunity requirements in all contracts with the City of Urbana?		
K.	Does your company perform construction, rehabilitation, alteration, conversion, demolition or repair of buildings, highways or other improvements to real property? (If yes, please complete Table B.)		
L.	Are you currently seeking to renew an existing or expired Urbana EEO certification? (If yes, you need to complete Table C.)		

SECTION III. Employment Information

Please complete the company work force analysis on the bottom of this page. Use the number of employees as of the most recent payroll period. **You must complete this form in its entirety, as instructed and submit your organization's (1) EEO Statement and (2) Sexual Harassment Policy in order to be eligible to do business with the City of Urbana. For detailed descriptions of the Job Classifications see attached descriptions.** If minorities and females are currently underrepresented in your workforce, please attach a copy of an explanation of your plan to recruit and hire qualified minorities and females.

TABLE A – TOTAL CONTRACTOR/VENDOR WORKFORCE

Job Categories	Overall Totals		White (Not of Hispanic Origin)		Black or African-American (Not of Hispanic Origin)		Hispanic or Latino		Asian or Pacific Islander		American Indian or Alaskan Native	
	M	F	M	F	M	F	M	F	M	F	M	F
Officials & Mgrs												
Professionals												
Technicians												
Sales Workers												
Office & Clerical												
Craft Workers (Skilled)												
Operatives (Semi-Skilled)												
Laborers (Unskilled)												
Service Workers												
TOTAL												
M = MALE, Column B is sum of Rows D, F, H, J and L.												
F = FEMALE, Column C is sum of Rows E, G, I, K and M.												
Date of above Data: _____												

TABLE B* – EMPLOYEES TO BE ASSIGNED TO CITY OF URBANA CONTRACT

Job Categories	TOTAL EMPLOYEES		BLACK EMPLOYEES		HISPANIC EMPLOYEES		OTHER MINORITY EMPLOYEES	
	M	F	M	F	M	F	M	F
Officials & Mgrs								
Professionals								
Technicians								
Sales Workers								
Office & Clerical								
Craft Workers (Skilled)								
Operatives (Semi-Skilled)								
Laborers (Unskilled)								
Service Workers								
TOTAL								

*Totals included under Table B should be a projection of numbers of persons to be employed in the performance of the City contract.

For Contractors:

Data provided in Table B will be verified by worksite inspections.

TABLE C WORKFORCE TURNOVER SINCE PREVIOUS EEO REPORT**

Job Categories	TOTAL EMPLOYEES SEPARATED		MINORITY EMPLOYEES SEPARATED		TOTAL EMPLOYEES HIRED		MINORITY EMPLOYEES HIRED	
	M	F	M	F	M	F	M	F
Officials & Mgrs								
Professionals								
Technicians								
Sales Workers								
Office & Clerical								
Craft Workers (Skilled)								
Operatives (Semi-Skilled)								
Laborers (Unskilled)								
Service Workers								
TOTAL								

SECTION IV. Certification

By signing below, the company certifies that it has answered all of the foregoing questions truthfully to the best of its knowledge and belief and agrees that it/he/she will comply and abide by the City of Urbana's Code of Ordinances (Section 2-119).

Signature

Typed Name and Title

Date

SECTION V. Verification

Prior to submitting this form, please check the answers to the following questions to verify your completion of this form:

1. Did you fill in all of the appropriate boxes in the table in Section III, including the "TOTAL" row?

YES _____

NO _____

2. Have you enclosed your company's EEO statement?

YES _____

NO _____

3. Have you enclosed your company's Sexual Harassment policy?

YES _____

NO _____

DEFINITIONS OF TERMS LISTED ON THE WORKFORCE STATISTICS FORM

(See previous Page)

DESCRIPTION OF RACE/ETHNIC CATEGORIES

Race /ethnic designations as used by the Department do not denote scientific definitions of anthropological origins. For the purposes of this report, an employee may be included in the group to which he or she appears to belong, identifies with, or is regarded in the community as belonging. However, no person should be counted in more than *one* race/ethnic group. The race/ethnic categories for this report are:

White (Not of Hispanic origin). All persons having origins in any of the original peoples of Europe, North Africa or the Middle East.

Black of African-American (Not of Hispanic origin). All persons having origins in any of the Black racial groups of Africa.

Hispanic or Latino. All persons of Mexican, Puerto Rican, Cuban, Central of South American, or other Spanish culture or origin, regardless of race.

Asian or Pacific Islander. All persons having origins any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands and Samoa.

American Indian or Alaskan Native. All persons having origins in any of the original peoples of North America, and who maintain cultural identification through tribal affiliation or community recognition.

DESCRIPTION OF JOB CATEGORIES

Each employee should be counted in only one job category. Select the category containing the jobs most similar to that performed by the employee. The jobs listed in each category are intended to provide an example, not a complete list, of all job titles falling into that category.

Officials and managers. Occupations requiring administrative and managerial personnel who set broad policies, exercise overall responsibility for execution of these policies, and direct individual departments or special phases of firm's operations. Includes: officials, executives, middle management, plant managers, department managers, and superintendents, salaried supervisors who are members of management, purchasing agents and buyers, railroad conductors and yard masters, ship captains, mates and other officers farm operators and managers, and kindred workers.

Professionals. Occupations requiring either college graduation or experience of such kind and amount as to provide a comparable background. Includes: accountants and auditors, airplane pilots and navigators, architects, artists, chemists, designers, dietitians, editors, engineers, layers, librarians, mathematicians, natural scientist, registered professional nurses, personnel and labor relations specialist, physical scientist, physicians, social scientist, teachers, surveyors and kindred workers.

Technicians. Occupations requiring a combination of basic scientific knowledge and manual skill which can be obtained through 2 years of post high school education, such as is offered in many technical institutes and union colleges, or through equivalent on-the-job training. Include: computer programmers, drafters, engineering aides, junior engineers, mathematical aides, licensed, practical or vocational nurses, photographers, radio operators, scientific assistants, technical illustrators, technicians (medical, dental, electronic, physical science), and kindred workers.

Sales. Occupations engaging wholly or primarily in direct selling. Includes: advertising agents and sales workers, insurance agents and brokers, real estate agents, and brokers, stock and bond sales workers, demonstrators, sales workers and sales clerks, grocery clerks, and cashiers/checkers, and kindred workers.

Office and clerical. Includes all clerical-type work regardless of level of difficulty, where the activities are predominantly non manual though some manual work not directly involved with altering or transporting the products is included. Includes: bookkeepers, collectors (bills and accounts), messengers and office helpers, office machine operators (including computer), shipping and receiving clerks, stenographers, typists and secretaries, telegraph and telephone operators, legal assistants, and kindred workers.

Craft workers (skilled). Manual workers of relatively high skill level having a thorough and comprehensive knowledge of the processes involved in their work. Exercise considerable independent judgment and usually receive an extensive period of training. Includes: the building trades, hourly paid supervisors and lead operators who are not members of occupations, compositors and typesetters, electricians, engravers, painters (construction and maintenance), motion picture projectionists, pattern and model makers, stationary hand painters, coaters, bakers, decorating occupations, and kindred workers.

Operatives (semiskilled). Workers who operate machine or processing equipment or perform other factory-type duties of intermediate skill level which can be mastered in a few weeks and require only limited training. Includes: apprentices (auto service and stitchers, dryers, furnace workers, heaters, laundry and dry cleaning operatives, milliners, mine operatives and laborers, motor operators, oilers and greasers (except auto), painters (manufactured articles), photographic process workers, truck and tractor drivers, knitting, looping, taping and weaving machine operators, welders and flame cutters, electrical and electronic equipment assemblers, butchers and meatcutters, inspectors, testers and graders, handpackers and packagers, and kindred workers.

Laborers (unskilled). Workers in manual occupations which generally require no special training who perform elementary duties that may be learned in a few days and require the application of little or no independent judgment. Includes: garage laborers, car washers and greasers, groundskeepers and gardeners, farmworkers, stevedores, wood choppers, laborers performing lifting, digging, mixing, loading and pulling operation and kindred workers.

Service workers. Workers in both protective and nonprotective service occupations. Includes: Attendants (hospital and other institutions, professional and personal service, including nurses aides, and orderlies), barbers, charworkers and cleaners, cooks, counter and fountain workers, elevator operators, firefighters and fire protection, guards, doorkeepers, stewards, janitors, police officers and detectives, porters, waiters and waitresses, amusement and recreation facilities attendants, guides, ushers, public transportation attendants, and kindred workers.

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CITY OF URBANA, ILLINOIS
PURCHASING CERTIFICATION FORM (Rev. 4/06)

The City of Urbana requires all vendors doing business at the above levels with the City to comply with certain local, state and federal requirements. By signing below, the vendor certifies, that they are familiar with and are in compliance with all of the legislative acts summarized below. False certification on this form, or the failure to fully comply with all of the requirements of these acts, may result in the termination of any contract, debarment from future contacts from either the City of Urbana, State of Illinois or any other governmental agency, and may subject the vendor to other legal actions.

DRUG FREE WORKPLACE ACT: An act to create a drug free workplace and prevent the unlawful manufacture, distribution, dispensation, possession, or use of a controlled substance by anyone while involved in the performance of a contract for the City of Urbana. (30 ILCS 580/1 et. seq.)

CERTIFICATION OF COMPLIANCE: An act to insure that all contracts for goods, services or construction are obtained only through an independent noncollusive submission of offers, the vendor must certify that it is not barred from contracting with any unit of the State of Illinois or any Illinois local governmental agency as a result of any bid-rigging or bid-rotating. (720 ILCS 5/33E 1 et. seq.)

DELINQUENT TAXPAYERS: An act to certify that any vendors doing business with the City of Urbana are not delinquent in the payment of any tax administered by the Illinois Department of Revenue. (65 ILCS 5/11-42.1-1)

SIGNATURES (COMPLETE APPROPRIATE SECTION)

INDIVIDUAL ☐ **PARTNERSHIP** ☐ **CORPORATION** ☐ (check one)

Name of the Business _____

Signed By: _____

Printed Name: _____

Business Address: _____

Business Phone Number: _____

Date _____

**City of Urbana, Illinois
C O N T R A C T**

- 1] THIS AGREEMENT, made and concluded this _____ day of _____ between the City of Urbana, Illinois, acting by and through William R. Gray, Director of Public Works, known as the party of the first part, and _____, his/her/their executors, administrators, successors or assigns, known as the party of the second part.
- 2] WITNESSETH: That for and in consideration of the payments and agreements mentioned in the Proposal, hereto attached, the party of the second part agrees with said party of the first part at his/her/their own proper cost and expense to do all the work, furnish all materials and all labor necessary to complete the work in accordance with the plans and specifications hereinafter described and in full compliance with all of the plans of this agreement for _____, **Bid No.** _____, for a total base bid amount of _____.
- 3] It is also understood and agreed that all documents accompanying the Specifications, including the Invitation to Bid, Instructions to Bidders, Proposal Form, and Drawings for:
Bid No. _____
_____ are all essential documents of this Contract and are a part hereof. The amount of this contract, unless amended, is _____, as stated in the Proposal.
- 4] IN WITNESS WHEREOF, the said parties have executed these presents on the dates mentioned above.

PARTY OF THE FIRST PART:

CITY OF URBANA, ILLINOIS
Public Works Department
706 South Glover Avenue
Urbana, Illinois 61802

Director of Public Works

PARTY OF THE SECOND PART:

Authorized Signature

(print name)

(print title)

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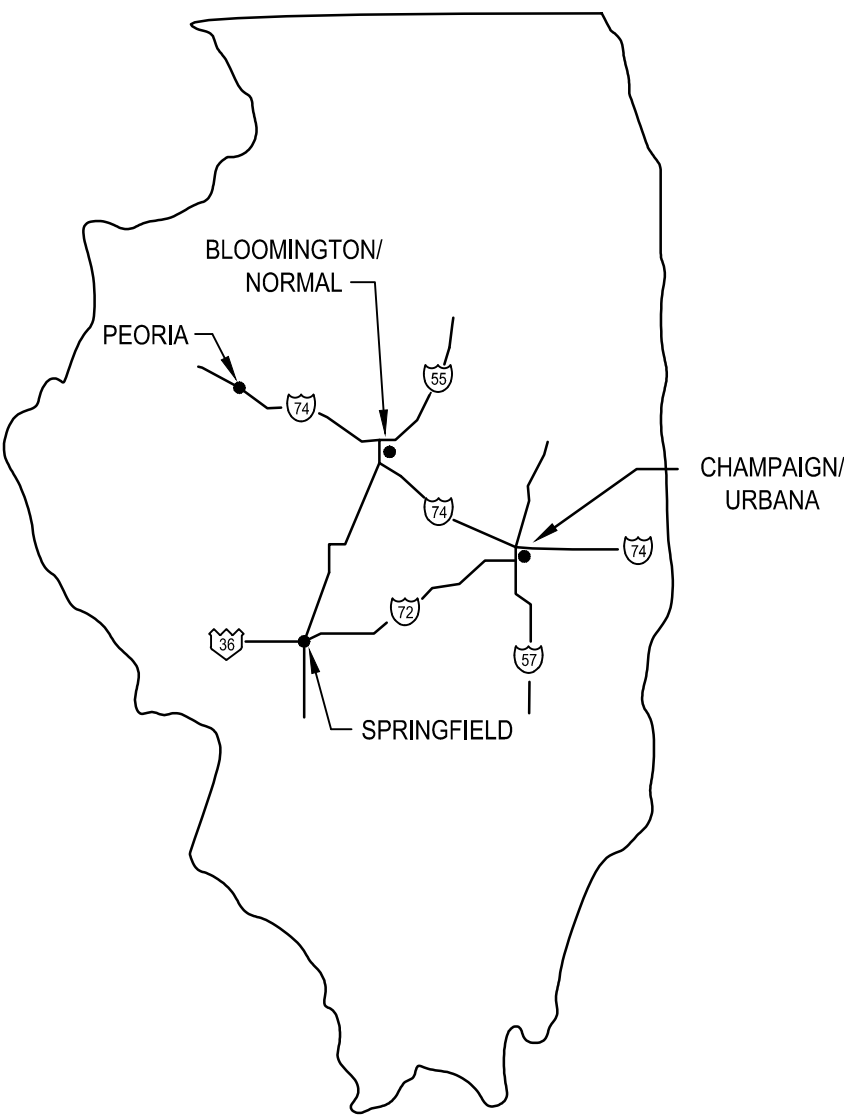
HEI NO. 16-8819

CITY OF URBANA CHILLER REPLACEMENT
CITY OF URBANA PUBLIC WORKS DEPARTMENT
URBANA, CHAMPAIGN COUNTY, ILLINOIS 61802

FOR:
CITY OF URBANA PUBLIC WORKS DEPARTMENT

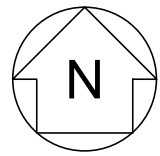
BY:
HENNEMAN ENGINEERING, INC.
2803 RESEARCH ROAD
CHAMPAIGN, ILLINOIS 61822 (217) 359-1514

INDEX OF DRAWINGS	
G101	COVER SHEET
MD101	DEMOLITION PLAN AND PHOTO – MECHANICAL
M101	NEW WORK PLAN, DETAILS AND SCHEDULES – MECHANICAL
E101	NEW WORK PLAN – ELECTRICAL



STATE LOCATION PLAN

NO SCALE STATE





Henneman Engineering Inc.
Champaign: 2803 Research Road
Champaign, Illinois 61822-1079
Email: info@henneman.com
Website: http://www.henneman.com
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T 217 359 1514
F 217 359 9354
Job Number: 16-8819



CHILLER REPLACEMENT
URBANA CITY COMPLEX
URBANA, ILLINOIS

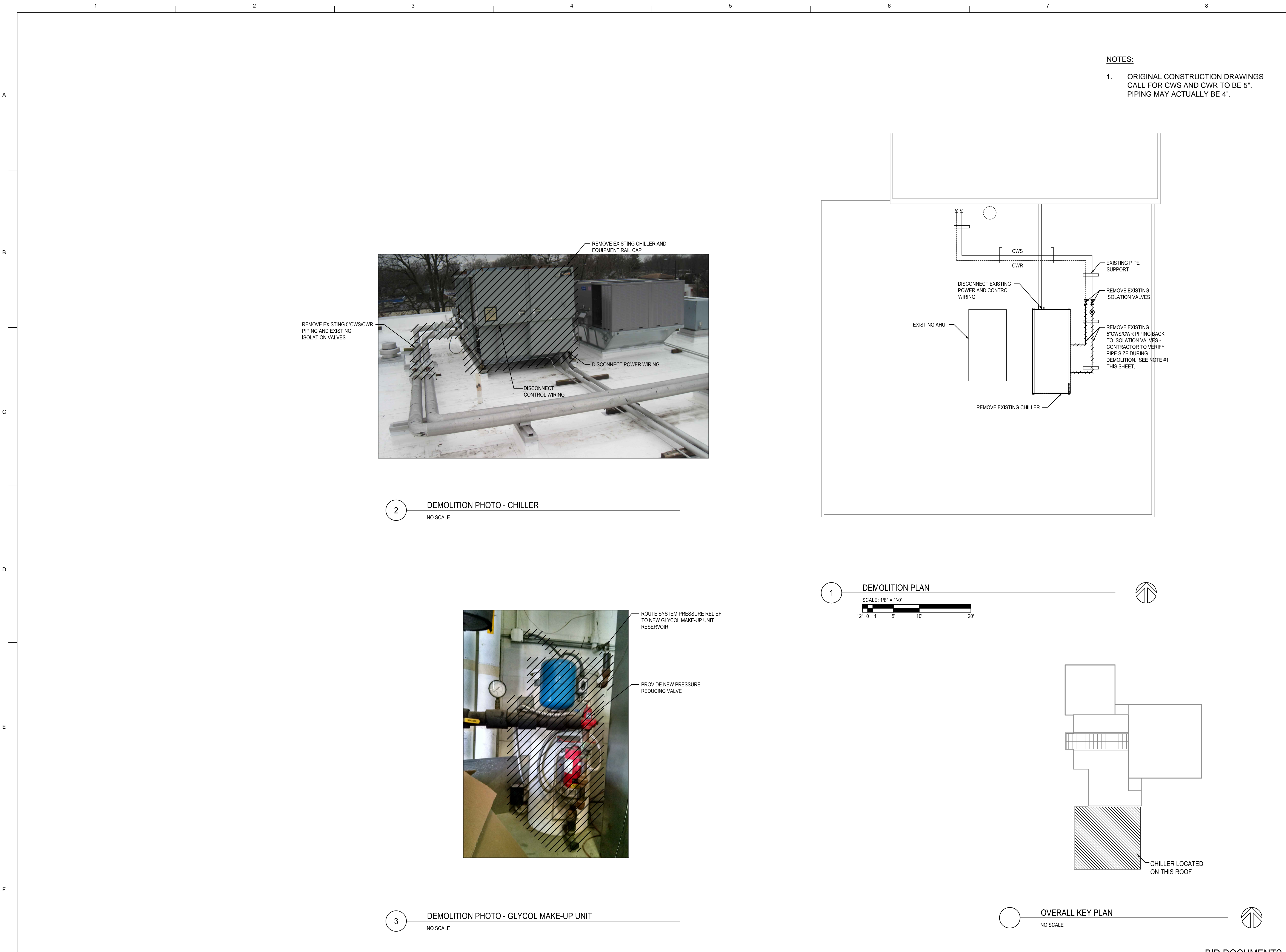
DRAWN BY	CLW	
APPROVED BY		
CHECKED BY	MB	
ISSUE DATE	MAY 29, 2016	
REVISIONS		
NO.	DATE	DESCRIPTION

SHEET TITLE:

COVER SHEET

G101

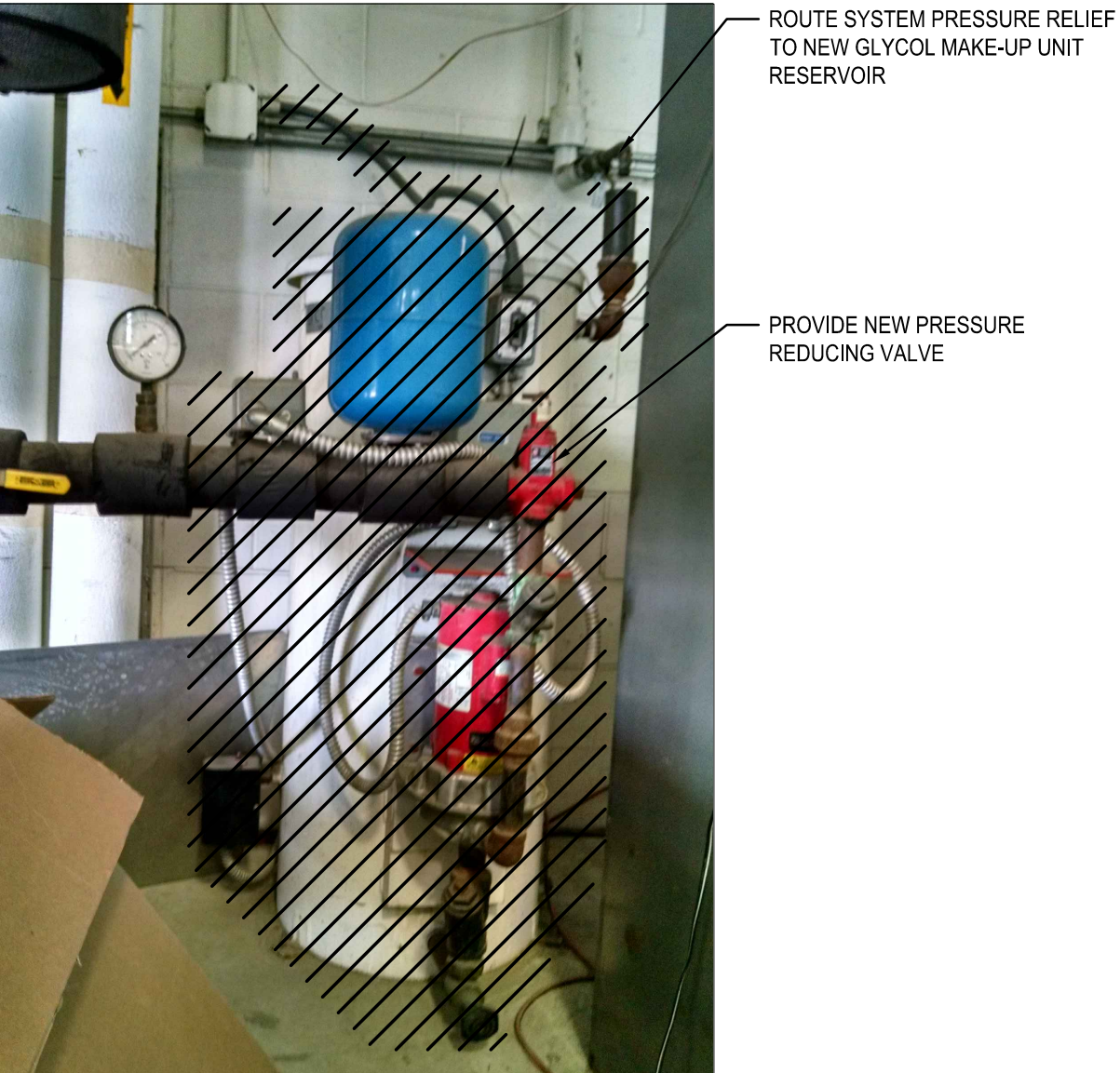
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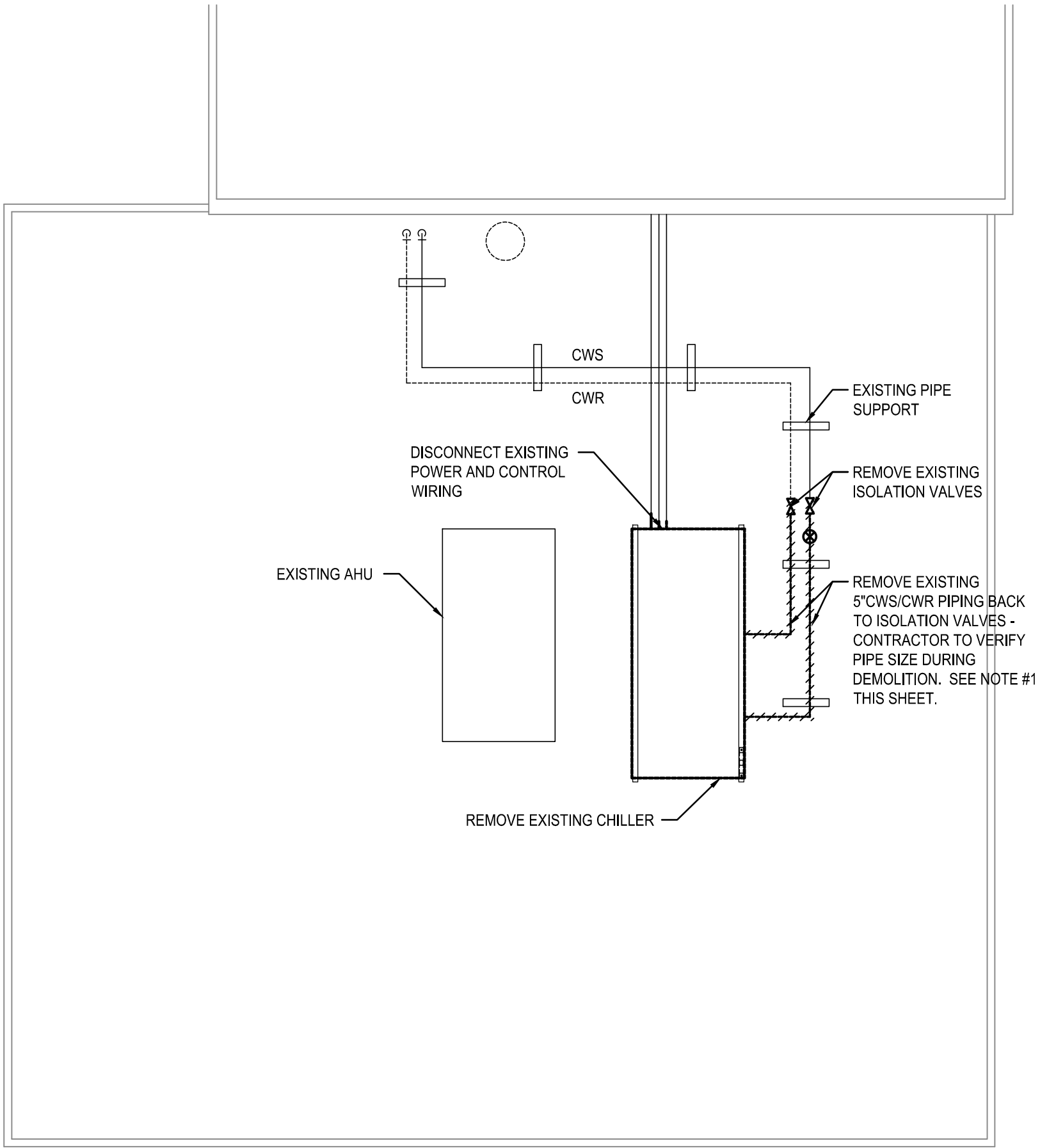
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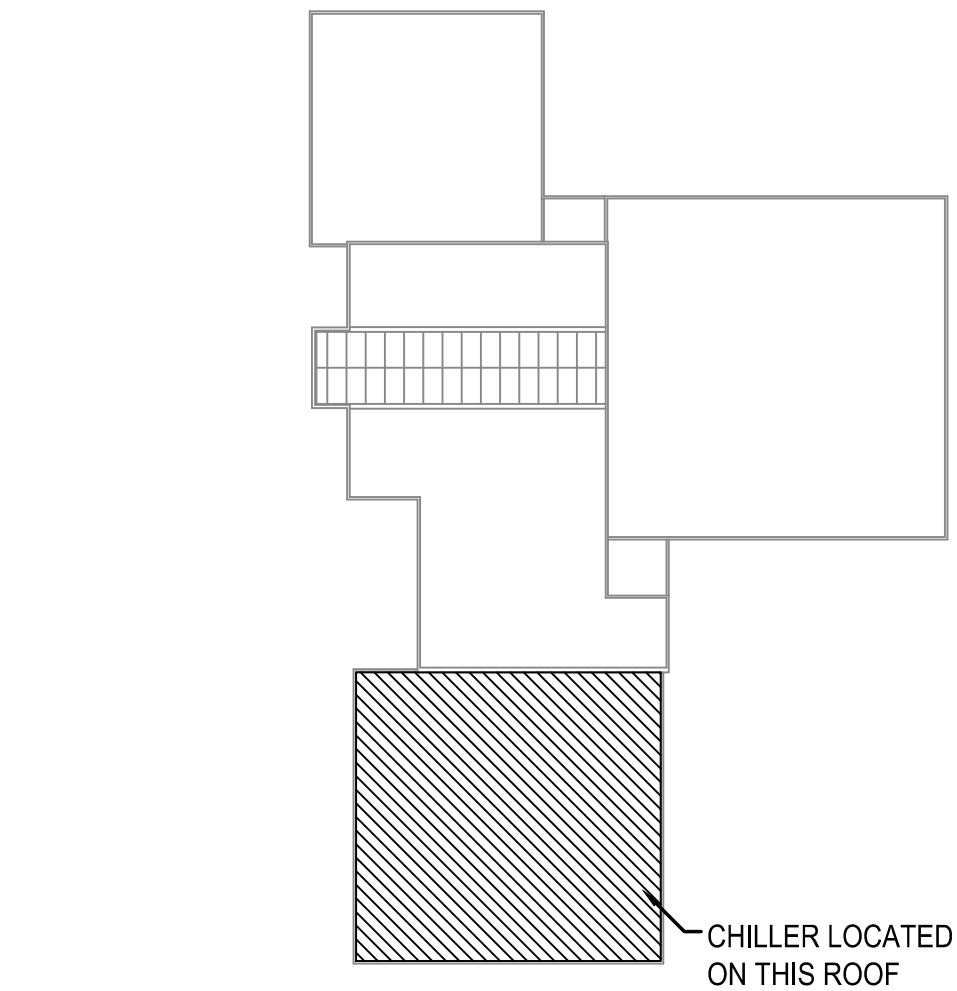
2 DEMOLITION PHOTO - CHILLER
NO SCALE



3 DEMOLITION PHOTO - GLYCOL MAKE-UP UNIT
NO SCALE



1 DEMOLITION PLAN
SCALE: 1/8" = 1'-0"
12" 0' 1' 5' 10' 20'



OVERALL KEY PLAN
NO SCALE

CHILLER REPLACEMENT
URBANA CITY COMPLEX
URBANA, ILLINOIS

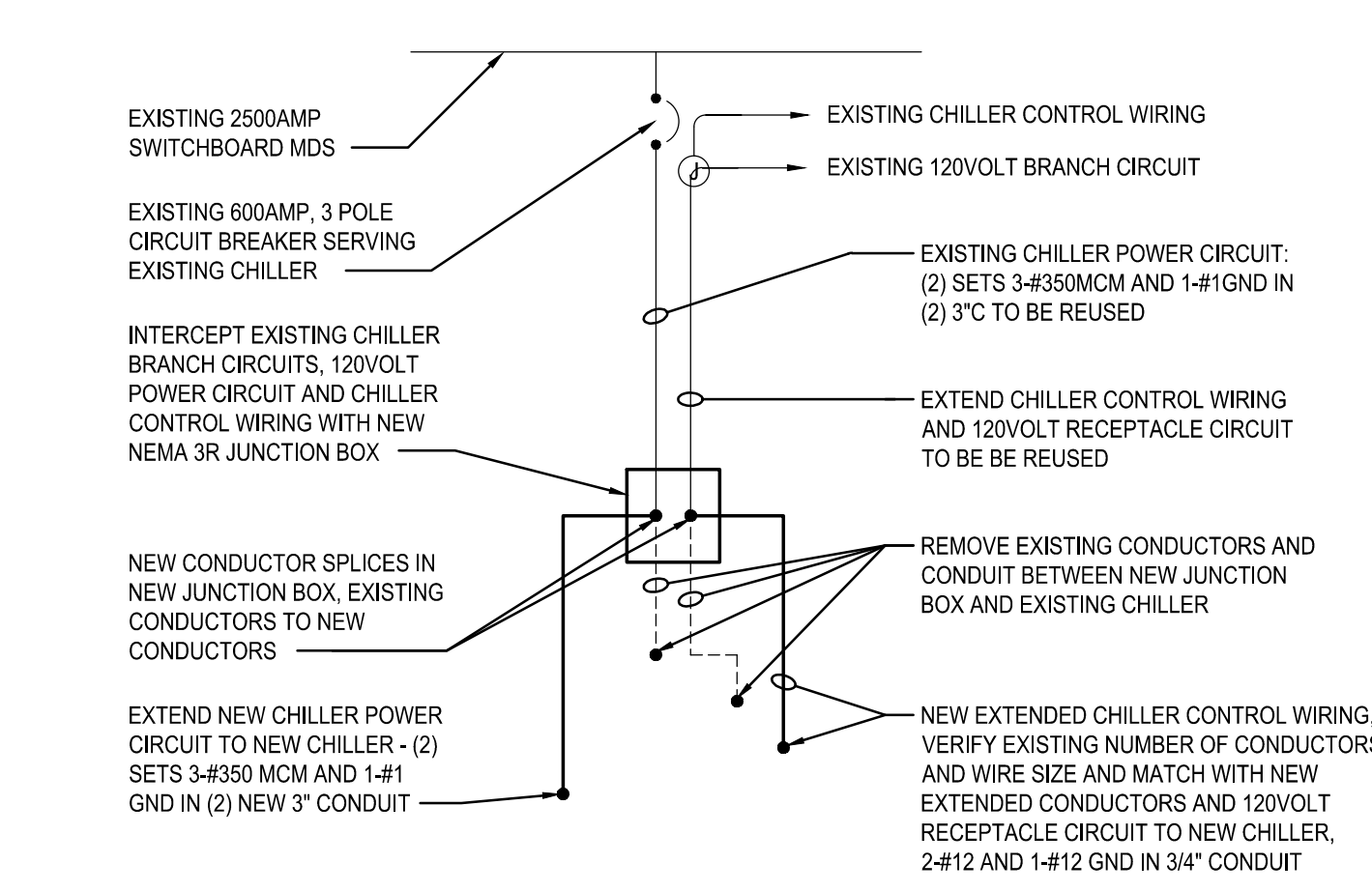
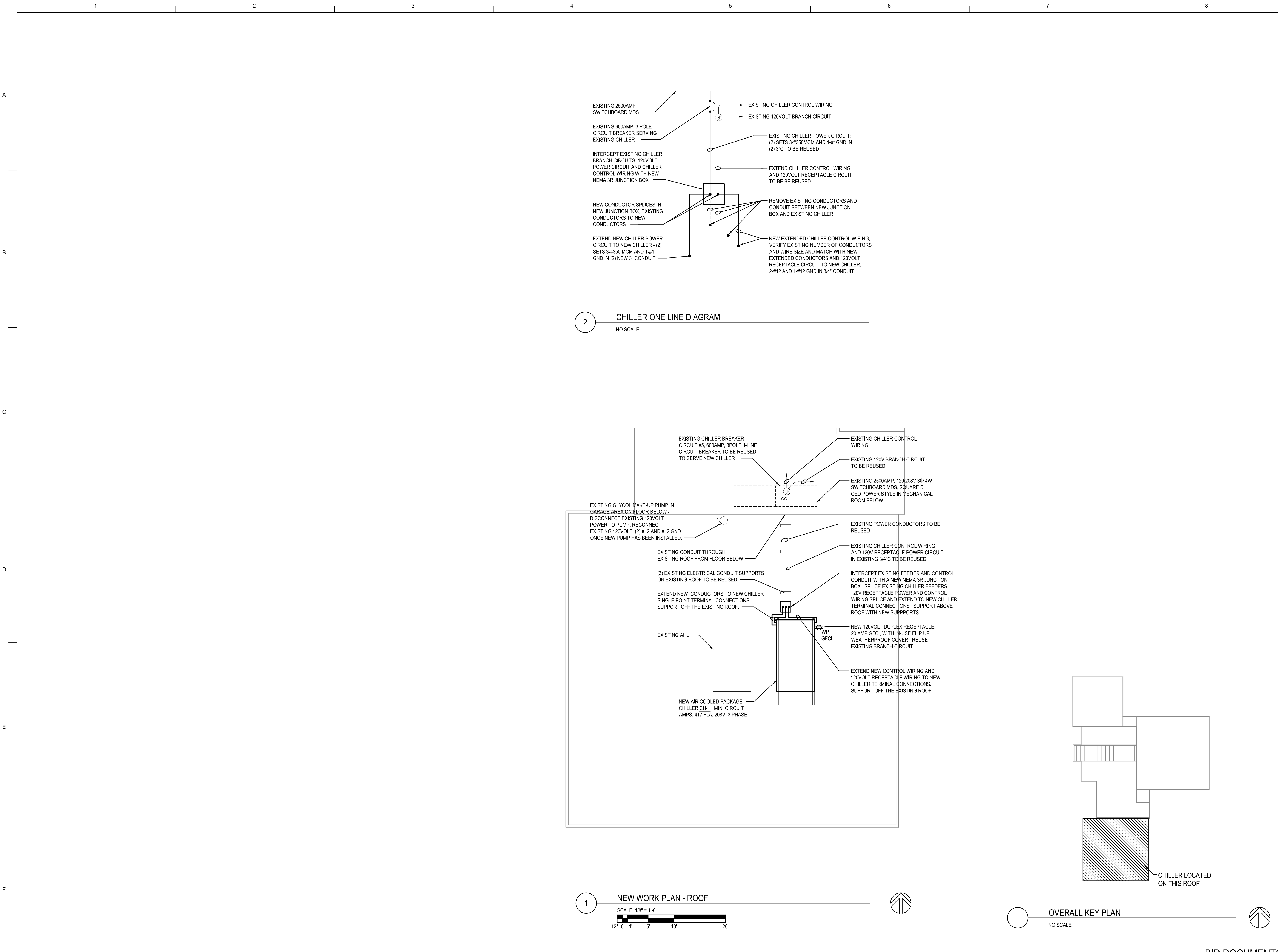
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APPROVED BY	
CHECKED BY	MB
ISSUE DATE	MAY 29, 2016

REVISIONS		
NO.	DATE	DESCRIPTION

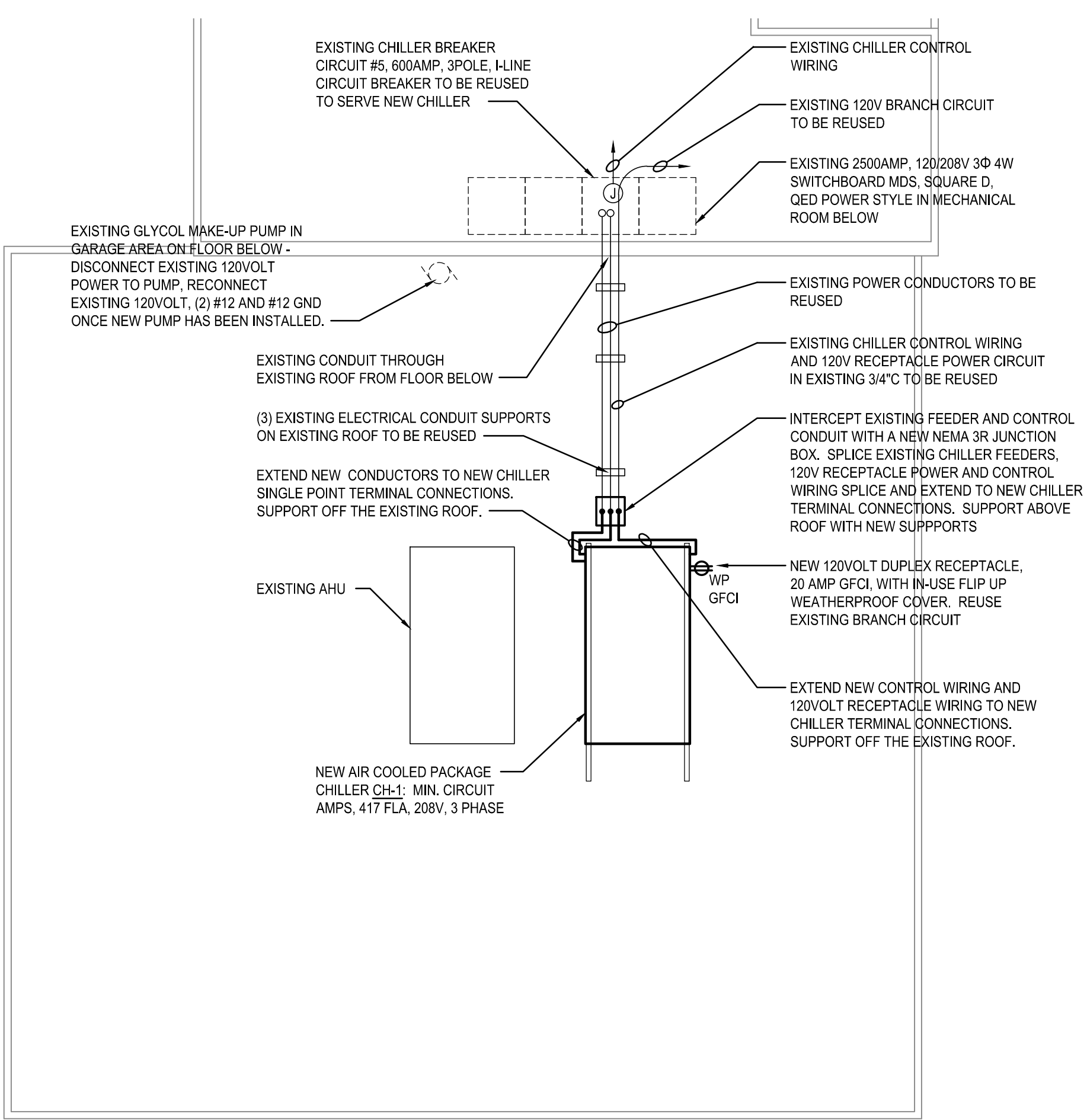
SHEET TITLE:
DEMOLITION PLAN AND
PHOTOS - MECHANICAL

MD101

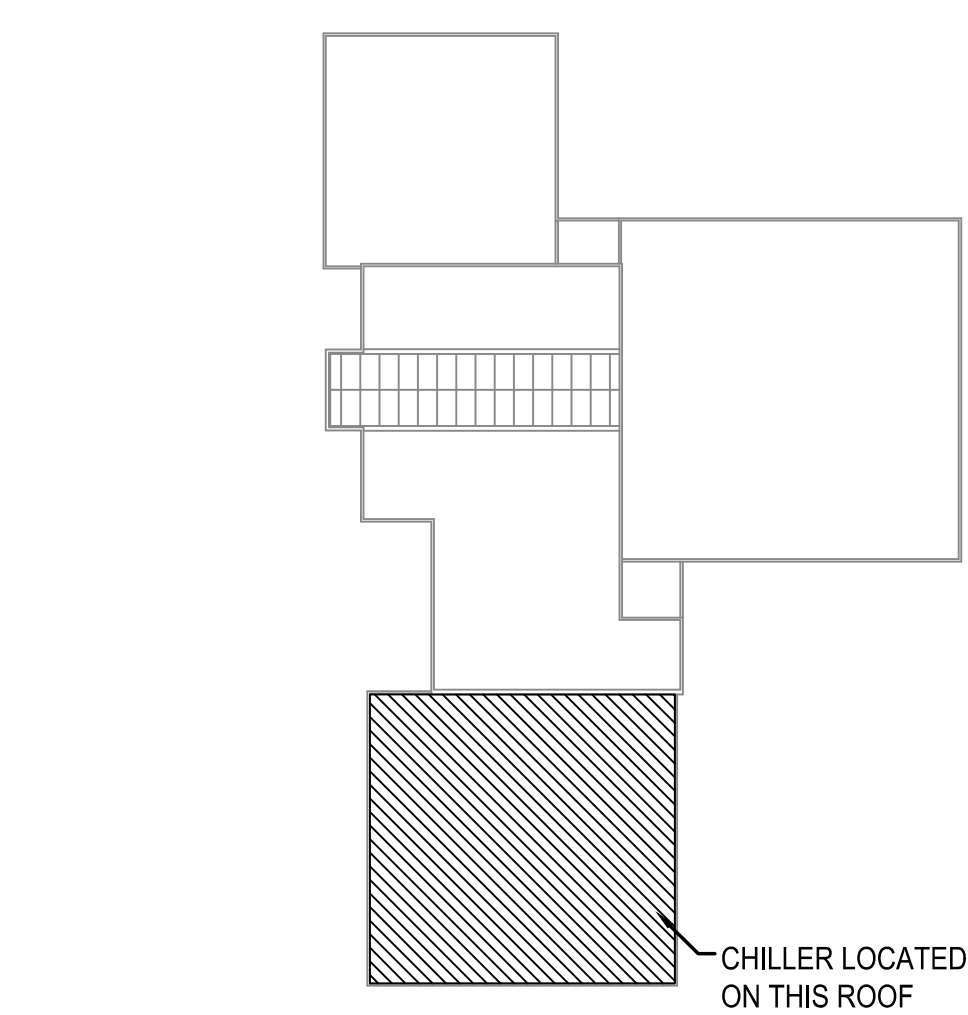
SHEET NO.



2 CHILLER ONE LINE DIAGRAM
NO SCALE



1 NEW WORK PLAN - ROOF
SCALE: 1/8" = 1'-0"
12' 0' 1' 5' 10' 20'



OVERALL KEY PLAN
NO SCALE

Henneman Engineering Inc.
Champaign: 2803 Research Road, Champaign, Illinois 61822-1079
T 217 359 1514 F 217 359 9354
Email: info@henneman.com Website: http://www.henneman.com
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**CHILLER REPLACEMENT
URBANA CITY COMPLEX
URBANA, ILLINOIS**

DRAWN BY	CLW
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CHECKED BY	JMB
ISSUE DATE	MAY 29, 2016

REVISIONS		
NO.	DATE	DESCRIPTION

SHEET TITLE:

NEW WORK PLAN -
ELECTRICAL

E101

SHEET NO.