FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY

PROJECT MANUAL

for the

Greater Columbus Convention Center North Facility
Chiller Replacement
Bid Package 2023-5

Technical Specifications Prepared By:

CMTA

October 25, 2023

CMTA
A LEGENCE Company

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NOTICE TO BIDDERS
FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY
Greater Columbus Convention Center North Facility
Chiller Replacement

Sealed proposals will be received by the Franklin County Convention Facilities Authority, hereinafter referred to as the "Owner" of the Greater Columbus Convention Center ("GCCC"), 400 N. High St., Columbus, Ohio 43215 until **November 15, 2023, at 3:30 PM** local time and will be publicly opened and read aloud immediately thereafter, for the furnishing of materials and performing the labor for the execution and construction of:

GCCC North Facility Chiller Replacement

Owner's Estimate: $850,000

in accordance with specifications prepared by CMTA. All information for bidders, including the Project Manual, Form of Proposal, Plans, Technical Specifications, Contract Bond and other Contract Documents (collectively, "Bid Documents") may be examined at:

Franklin County Convention Facilities Authority
400 N. High Street, 4th Floor
Columbus, Ohio 43215

Requests for copies of Bid Documents as well as questions regarding plans and specifications should be addressed to Jordan Edmonds, In-House Counsel, Franklin County Convention Facilities Authority, email: jedmonds@fccfa.org. Bid Documents will also be available on the Authority's website: www.meetusincolumbus.com.

No bidder may withdraw their bid within 60 days after the actual date of the bid opening, except as provided for in the Bid Documents.

Each bid must be accompanied by a Bid Guaranty and Contract Bond in the exact form included in the Bid Documents and meeting the requirements of Section 153.54 of the Ohio Revised Code.

State of Ohio prevailing wage rates and Equal Employment Opportunity requirements are applicable to this bid invitation for all work performed pursuant to this contract.

The Franklin County Convention Facilities Authority reserves the right to waive any informalities or in its sole discretion, to reject any or all bids.

Bids shall be sealed and delivered on or before November 15, 2023, at 3:30 PM EST to:

Franklin County Convention Facilities Authority
400 North High Street, 4th Floor
Columbus, Ohio 43215

INSTRUCTIONS TO BIDDERS

GENERAL REQUIREMENTS & INFORMATION

a) Bidder shall inspect all plans and specifications and visit the site of the work to verify existing conditions and to become familiar with the conditions under which the work will be performed.

b) The Form of Proposal, Bid Guaranty, Responsibility Analysis Form, Project Schedule, and all other required submittals, each fully executed, are to be submitted in sealed form and addressed to the Franklin County Convention Facilities Authority as provided for in the Notice to Bidders. **Interested bidders must provide one original and three hard copies of all required submittals.**

c) Owner & Architect:

1) The Owner is:

Franklin County Convention Facilities Authority (FCCFA)
400 North High Street, 4th Floor
Columbus, Ohio 43215-2096
Phone: 614-827-2800

2) The Architect is:

CMTA, Inc.
1650 Lake Shore Drive, Suite 380
Columbus, Ohio 43204
Phone: 614-515-1302

d) The Project consists of providing all labor, materials, equipment, and services necessary for the timely and proper completion of construction for the Replacement of three (3) chillers servicing the GCCC's North Facility as described within the Project Manual, drawings, and technical specifications. **PLEASE NOTE that the chiller units have already been purchased and pricing for the units should not be included within the bid. The submittal from Trane providing detail regarding the units is attached hereto as Exhibit A.**

Bidders are responsible for visiting the site to determine existing conditions. No plea of ignorance of conditions that exist, or of conditions or difficulties that may be encountered in the execution of the work, as a result of the failure to make such examination and investigation, will be accepted as an excuse for any failure or omission on the part of the bidders to fulfill in every respect all the requirements of the contract, nor will the same be accepted as a basis for any claim whatsoever for extra compensation or for an extension of time.

ARTICLE 1. PROPOSALS

a) For lump sum bids, separate bids will be received for any or all divisions of work shown on the Form of Proposal. If not bidding a given contract on the Form of Proposal mark it "N/A".

b) In the case of unit price bids, the Bidder shall submit bids on all items listed, unless other instructions are noted in the Form of Proposal.

Unless otherwise expressly provided in the Project Manual and related bid documents, such unit prices shall be fully-loaded rates that include, but are not limited to, all overhead, profit, labor, materials, equipment, services, insurance and bonding costs necessary for the timely and proper installation of the item for which the unit prices are requested. The unit prices quoted in the proposal shall be the basis for any change orders entered into under the contract, unless the Owner determines that the use of such unit prices will cause substantial inequity to either the bidder or the Owner.

c) **The Proposal shall contain the following documents:**

1) The Form of Proposal (bid)
2) The Bid Guaranty
3) EEO Certification Clause
4) Non-Discrimination Policy Compliance
5) Contractor's Review Certificate
6) Manufacturer's Declaration and Subcontractor Declaration
7) Declaration of Insurance
8) Project Schedule
9) Responsibility Analysis Form

d) The wording of the Form of Proposal shall be used without change, alteration, or addition (except as provided for in the Project Manual). Any other change in the wording may cause the bid to be rejected; however, the Owner reserves the right to waive any informalities not affecting the substance of the bid.

e) The forms used in submitting the bid shall be those furnished by the Owner in the Project Manual.

f) The bid shall contain the Bid Guaranty meeting the requirements of Section 153.54 of the Ohio Revised Code.

g) Bidders shall take the following precautions in preparing bids:

1) Sign the bid. Failure to do so shall result in rejection of the bid. Bids shall be signed with the name typed below the signature. A bidder that is a corporation shall sign its bid with the legal name of the corporation followed by the name

of the state of incorporation and the legal signature, including title, of an officer authorized to bind the corporation to a contract.

2) Alternates:

The Owner may request bids on alternates. If the Owner requests bids on alternates, the bidder should include the cost of the alternates requested on its Form of Proposal.

Where the Form of Proposal provides for quoting either an addition or deduction for an "Alternate," indicate whether the sum named is an addition or deduction by ruling out the words not applicable. Any alteration or erasure must be initiated by the bidder.

All requested alternates, if any, shall be bid by all bidders. If no change in the base bid is required enter "no change". Do not mark with any notation other than the cost change or "no change" (e.g., "N/A" or "No Bid", shall be taken as meaning "No Change" and a cost of $0.00 shall be used in determining the lowest and best bidder and preparation of the contract). If a bidder does not accept a value of $0.00 for any incorrectly marked alternates accepted by the Owner, the bid shall be considered non-responsive and be grounds for the rejection of the bid. At the time of awarding the contract, the Owner will select or reject alternates as it determines is in its best interest.

If, during the progress of the work, the Owner desires to reinstate any alternate not included in the contract, the Owner reserves the right to reinstate the alternate at the price bid by the bidder provided that such action is taken in sufficient time so as not to delay the progress of the work or cause the bidder additional expense.

3) Complete and sign the Equal Employment Opportunity Certification attached to the Form of Proposal.

4) Bidders shall acknowledge and note receipt of addenda on the Form of Proposal.

5) Bids shall not be submitted by facsimile transmission.

6) Bids shall be enclosed in a sealed opaque envelope with the bidder's name and the title of the project printed in the upper left-hand corner and addressed as follows: Offices of the Franklin County Convention Facilities Authority, 400 N. High St., Fourth Floor, Columbus, Ohio 43215.

h) All bids are valid for a period of sixty (60) days after the date of opening bids. A bidder for a contract with the Owner may withdraw their bid from consideration if the price

bid was substantially lower than the other bids, providing the bid was submitted in good faith and the reason for the price bid being substantially lower was a clerical mistake as opposed to a judgment mistake and was actually due to an unintentional and substantial quantity of work, labor, or material made directly in the compilation of the bid. Request to withdraw such bid must be made in writing and filed with the Owner within two (2) business days after the opening of bids.

ARTICLE 2. METHOD OF AWARD

a) The Owner will receive bids for each of the contracts as set forth on the Form of Proposal and as defined in the Project Manual.

Subject to the right of the Owner to reject any and all bids and as provided below, the Owner will award a single contract for each of the contracts/bid packages listed in the Project Manual or one or more combined contracts for combination(s) of the bid packages. Bidders must furnish all information requested on or accompanying the Form of Proposal. Failure to do so may result in disqualification of the bid.

b) Determination of Lowest and Best Bid (see Instructions to Bidder's Responsibility Analysis Form):

Subject to the right of the Owner to reject any or all bids, the Owner will award the contract for the work to the bidder submitting the lowest and best bid, taking into consideration accepted alternates. In determining which bid is the lowest and best bid, the Owner may take into consideration not only the amount of the bid but such of the following criteria as it, in its sole discretion, deems appropriate and may give such weight thereto as it deems appropriate:

1) The bidder's financial ability to complete the contract successfully and on time without resort to its Surety;

2) The bidder's prior experience with similar work on comparable or more complex projects;

3) The bidder's prior history of the successful and timely completion of similar projects;

4) The bidder's equipment and facilities;

5) The adequacy, in numbers and experience, of the bidder's work force to complete the contract successfully and on time;

6) The bidder's prior experience on other projects of the Owner, including the bidder's demonstrated ability to complete its work on these projects in accordance with the contract documents and on time, and its ability to work with the Owner.

7) The bidder's compliance with federal, state, and local laws, rules, and regulations, including but not limited to, the prevailing wage law and Occupational Safety and Health Act.

8) All of the foregoing with respect to each of the subcontractors which the bidder intends to use on the Project; and

9) Depending upon the type of work, other essential factors, as the Owner may determine.

Absent special circumstances, no bidder shall be deemed responsible unless the bidder has been in existence at least thirty-six months.

c) Acceptance of the contract within the 60-day period following the opening of bids automatically assumes that if materials, labor or subcontract cost increases, they shall be absorbed by the successful bidder. Award of contracts beyond the 60-day period shall be reviewed for increased costs after award of the contract only if the cause for delay is no fault of the successful bidder.

d) If, in the opinion of the Owner, the acceptance of the lowest bid is not in the best interest of the Owner, the Owner may accept at its discretion, another bid so opened, or reject all bids and advertise for other bids. Such advertisement will be for such time, in such form and in such newspapers as may be directed by the Owner.

e) No contract shall be awarded if the low bidder is more than 20% below the median of all others bids received for projects where the estimate is $100,000 or more, and no contract shall be awarded if the low bidder is more than 25% below the median of all other bids received for projects where the estimate is less than $100,000, unless the following occurs and/or are reviewed.

1) An interview with the bidder, the purpose of which is to determine what, if anything, has been overlooked in the bid in question, and to analyze the process envisioned by the bidder to complete the work in question.

2) The financial status of the bidder and its Surety based upon certified financial statements submitted by each.

3) Receipt of written confirmation by the Surety that it has reviewed the bid in question.

4) The record of the bidder in performing other public works projects in the past.

If after review and consideration, the acceptance of the lowest and best bid is not in the best interest of the Owner, the Owner may accept another proposal so opened or reject all proposals and advertise for other bids.

f) If individual and combined contract bids are included on the Form of Proposal and a bidder opts to submit multiple bids, a bidder shall not be permitted to be determined to be the low bidder for any individual contract bid if that bidder withdraws a lower combination contract bid for any reason (including omission of any work item or math/clerical errors).

g) The Owner reserves the right to disqualify bids, before or after opening, upon evidence of collusion with intent to defraud or other illegal practices on the part of the bidder.

h) After determination of the lowest and best bid, the selected contractor shall receive a Recommendation of Award, a copy of the full unexecuted contract and an unexecuted copy of the Notice of Authority to Proceed ("NTP") with construction. The successful bidder ("Contractor") shall then provide the required items for formal execution of the contract and NTP by the Owner all in accordance with Article 8. If the Project Schedule requires that the Contractor commence work (or make commitments and preparations to commence the work) prior to receipt of the fully executed contract and NTP, the Contractor, in order to meet the requirements of the Project Schedule, shall be solely responsible to notify the Owner in writing 10 business days before the date that such NTP is required. The Owner may direct the Contractor to proceed with the work with an executed NTP before the formal execution of the contract. If the Contractor has met all of the requirements for executing a contract and the Owner chooses not to execute the contract, the Contractor shall be reimbursed for all reasonable costs incurred as a result of starting work under the NTP and prior to receipt of a fully executed contract.

j) No contract shall be entered into until:

1) The Industrial Commission has certified that the corporation, partnership, or person so awarded the contract has complied with Sections 4123.01 to 4123.99 (Workers' Compensation), inclusive of the Ohio Revised Code;

2) If the bidder so awarded the contract is a foreign corporation, the Secretary of State has certified that such corporation is authorized to do business in this state; and, if the bidder so awarded the contract is a non-Ohio person or partnership, then until the bidder has filed with the Secretary of State a Power of Attorney designating the Secretary of State as its agent for the purpose of accepting service of summons in any action brought under Section 153.05 of the Revised Code or under Sections 4123.02 to 4123.99 inclusive, of the Ohio Revised Code.

3) The successful bidder shall notify the Owner, within 3 calendar days after receipt of the Recommendation of Award, the provisions the bidder has made or reasonably can be expected to make in order to meet the provisions of the Owner's Disadvantaged Business Participation Plan. Notification shall include a statement of the bidder's present intention concerning which portions of the contract will be awarded to disadvantaged business subcontractors and materialmen and the identity of the intended subcontractor or materialman, if

any. Within such five (5) calendar day period, the successful bidder may request in writing a longer period of time to meet the provisions of the plan. Such request shall set forth the reasons additional time is required. The Owner shall notify the successful bidder in writing of its approval or disapproval of the request. If additional time is approved by the Owner or if formal execution of the contract is delayed due to any failure of the bidder to meet the requirements of the Owner's Disadvantaged Business Participation Plan, the bidder shall remain responsible for all the requirements and timelines of the Project.

4) The required certificates of insurance coverage (as set forth in the contract) and bond are submitted to the Owner.

5) A copy of the contract is forwarded to the successful bidder by the Owner, signed by the successful bidder and returned to the Owner.

6) All requirements of Article 8 herein have been satisfied.

The contract cannot be fully executed until this information is provided. If the bidder fails to provide the documents within the required time, the bidder is solely responsible to meet all Project Schedule requirements regardless of the date of the formal execution of the contract.

ARTICLE 3. BID GUARANTY

a) All Bid Guaranties and Contract Bonds must be satisfactory to the Owner.

b) The Bid Guaranty and Contract Bond meeting the requirements of Section 153.54(B) of the Ohio Revised Code, as furnished by the Owner, shall be used without change of wording.

c) <u>If the amount is left blank, the penal sum of the Bid Guaranty and Contract Bond will be the full amount of the bidder's base bid plus add alternates; alternatively, if completed, the amount must not be less than the full amount of the base bid plus add alternates, stated in dollars and cents. A percentage is not acceptable.</u>

d) The Bid Guaranty and Contract Bond must be signed by an Authorized Agent of an acceptable Surety Bonding Company and by the bidder. The bond must be issued by a surety company authorized by the Ohio Department of Insurance to transact business in the State of Ohio. It is essential that the bond be issued by a surety company which can adequately demonstrate a record of competent underwriting, efficient management, adequate reserves, and soundness of investments.

e) Bid Guaranties and Contract Bonds must be supported by credentials showing the Power of Attorney of the Agent.

f) In lieu of the Bid Guaranty referred to in Article 2(b) above, the bidder may submit the Bid Guaranty provided in Division (C) of Section 153.54 of the Ohio Revised Code, in the form of a Certified Check, Cashier's Check, or Letter of Credit pursuant to Chapter 1305 of the Ohio Revised Code. A Bid Bond is not acceptable for use as a Bid Guaranty.

g) The amount of the Certified Check, Cashier's Check or Letter of Credit shall be equal to 10% of the base bid plus add alternates.

h) The Bid Guaranty shall be payable to the Franklin County Convention Facilities Authority.

i) Bid Guaranties shall be returned to all unsuccessful bidders immediately after the contract is executed.

j) The Certified Check, Cashier's Check or Letter of Credit shall be returned to the successful bidder upon filing of the Bond required in Division (C), Section 153.54 of the Ohio Revised Code. The Performance Bond shall not be deemed "filed" until the Contract is fully executed.

ARTICLE 4. STANDARDS – SUBSTITUTIONS

a) Those articles, devices, materials, forms of construction, fixtures, etc., named in the specifications to denote the kind and quality required shall be known as "Standards" and all bids shall be based on the same.

b) Where two or more "Standards" are named together, the Contractor may furnish any one of the "Standards" named, but the Contractor shall make their selection known to the Owner within thirty (30) days following the award of the contract. Failure to comply with this requirement will automatically hold up payment requests from the Contractor in view of possible improper materials being used on the project. The first "Standard" listed shall be considered as the basis of design. If the Contractor opts to use a named "Standard" other than the basis of design and this results in any necessary modifications to any other element of the contract documents, the Contractor shall be responsible for all associated additional costs.

c) Bidders desiring consideration for the use of material, equipment, etc., not named in the specifications may submit proposals for the substitution of same for "Standards" as specified, using the "Substitution Sheet" attached to the proposal form and listing, for each proposed change: (1) the "Standard" specified, (2) the substitution, and (3) the change in bid price, (or "no change"). Proposed substitutions must be included on the "Substitution Sheet" to be considered. Complete specifications and descriptions of any proposed substitutions being considered for acceptance shall be furnished to the Owner promptly upon request. Acceptance of substitutes shall be at the sole discretion of the Owner.

d) Any substitution accepted must be incorporated in the formal contract.

e) Substitution shall not affect the determining of lowest and best bid.

f) No substitution will be considered prior to receipt of bids unless written request for approval has been received by the Owner at least **10 days prior to the date for receipt of bids**. A statement setting forth changes in other materials, equipment, or other portions of the work, including changes in the work of other contractors that incorporation of the proposed substitution would require, shall be included. The burden of proof of the merit of the proposed substitution is upon the proposer. The Owner's decision of approval or disapproval of a proposed substitution shall be final. If the brand or product is acceptable, the Owner will approve it prior to bidding in an addendum issued by the Owner to all bidders on record.

g) In proposing a substitution, the bidder represents and warrants that each proposed substitution will not result in any changes to the project, including changes to the work of other contractors, or any decrease in the performance of any equipment or systems to be installed in the project and agrees to pay any additional costs incurred by the Owner as a result of a substitution which is accepted.

h) **Following the award of the contract, there shall be no substitutions**, except pursuant to a change order. The Owner in its sole discretion may decline to consider a substitution for a change order.

i) If the specified materials and/or manufacturers are no longer available, it is the bidder's responsibility to notify the Owner during the bidding period. Substitutions made during the construction period resulting from these conditions (i.e., failure of the bidder to notify Owner) will be made solely at the Owner's discretion.

ARTICLE 5. EXAMINATION OF DOCUMENTS

a) Each bidder shall examine all bid documents, including, but not limited to, the Project Manual, Project Schedule, Notice to Bidders, Form of Proposal, addenda, plans, specifications, form contract. etc., for all other divisions of the work as well as its own, noting particularly all requirements which will affect its work in any way. These Bid Documents shall become the Contract Documents, as defined in the contract that governs the relationship between the Contractor and the Owner when the contract is executed. Failure of a bidder to become fully acquainted with the amount and nature of work required to complete its division of the work in conformity with all requirements for the project as a whole will not be considered subsequently as a basis for extra compensation.

b) Should any requirements in the plans and/or specifications for the project, as a whole, appear to a bidder to be in disagreement with those for the part of the work on which the bidder proposes to bid or in the case of a discrepancy in the plans and specifications, a request for clarification, in writing should be addressed to the Owner at least 5 calendar days prior to the date set for opening bids. The Owner will reply to all such

inquires through an addendum. Verbal interpretations will not be honored and are not legally binding. The Owner will forward a copy of same to all individuals holding plans and specifications. If, in examining the contract documents, the bidder discovers an apparent violation of the Ohio Basic Building Code, or other applicable statute or regulation, the bidder shall report such apparent violation to the Owner promptly. However, this provision shall not be construed as imposing responsibility on the bidder to ensure conformity of the plans and specifications to the Ohio Basic Building Code and other applicable regulations.

c) No allowance will be made subsequently for any omission, error, or negligence of the bidder.

d) Unless specifically assigned to one contract for all aspects of the project, each bidder is responsible to include all requirements for all sections contained in the Project Manual, and Project Schedule, in the base bid amount. (Contract is not limited to only those specifications sections listed in the contract summary of work).

ARTICLE 6. OPENING OF BIDS

Bids shall be opened and read publicly at the time and place named in the Notice to Bidders. The time for opening bids shall be extended at the discretion of the Owner with no further advertising when an addendum to the plans or specifications is issued within 72 hours of the scheduled bid opening, excluding Saturdays, Sundays and Legal Holidays.

ARTICLE 7. ADDENDA

a) Any explanation, interpretation, correction, or modification of the Project Manual or Bid Documents will be issued in the form of an addendum, which shall be the only means considered legally binding; explanations, interpretations, etc., made by any other means shall <u>not</u> be legally binding. All addenda shall become a part of the contract documents.

b) Bidders shall submit questions to the Owner no later than 5 days prior to the advertised bid date, to allow sufficient time for the Owner to respond. All addenda will be issued except as hereafter provided and mailed or otherwise furnished to persons who have obtained Bid Documents for the project, at least 72 hours prior to the published time for the opening of bids; excluding Saturdays, Sundays, and legal holidays. If any addendum is issued within such 72-hour period, then the time for opening of bids shall be extended one week with no further advertising of bids required.

c) Copies of each addendum will be sent only to the bidders to whom Bid Documents have been issued. Receipt of addenda shall be indicated by bidders in the space provided on the Form of Proposal.

d) Each bidder shall carefully read and review the Bid Documents and immediately bring to the attention of the Owner any error, omission, inconsistency, or ambiguity therein.

e) If a bidder fails to indicate receipt of all addenda through the last addendum issued by the Owner on its Form of Proposal, the bid of such bidder will be deemed to be responsive only if:

1) The bid received clearly indicates that the bidder received the addendum, such as where the addendum added another item to be bid upon and the bidder submitted a bid on that item; or

2) The addendum involves only a matter of form or is one which has either no effect or has merely a trivial or negligible effect on price, quantity, quality, or delivery of the item bid upon.

ARTICLE 8. ADDITIONAL SUBMITTAL REQUIREMENTS

a) Upon receipt of the Notification of Recommendation of Award (NOA), the successful bidder will submit the following to the Owner:

1) One copy of the Executed Contract;
2) Contract Bond;
   a) Including Certificate of Compliance issued by the Department of Insurance, showing the Bonding Company is Licensed to do business in the State of Ohio.
   b) Including a Financial Statement of the Bonding Company.
3) Certificate of Insurance;
4) Completed W-9 Form;
5) Workers' Compensation Certificate (Industrial Commission certification of O.R.C. requirements).

If the bidder fails to provide the documents within the required time, the bidder is solely responsible to meet all Project Schedule requirements regardless of the date of the formal execution of the contract. Failure of the bidder to provide these documents within 15 days of receipt of the NOA may result in rejection of the bid.

b) The successful bidder shall notify the Owner, within three calendar days of receipt of the NOA, of the provisions the bidder has made or reasonably can be expected to make in order to meet the provisions of the Owner's Disadvantaged Business Participation Plan.

c) Within fifteen calendar days of receipt of the NOA or such longer time as may be permitted in writing by the Owner, the apparent low bidder will submit the following to Owner:

1) The list of all proposed subcontractors, suppliers, manufacturers, and vendors.

   After approval by the Owner of the list submitted by the successful bidder, the list shall not be changed unless written approval of the change is authorized by the Owner.

2) Schedule of Values including a breakdown of labor and material for the project, and the sum thereof.

3) A current name of the person or persons proposed to represent the bidder as project manager(s) or superintendent(s).

4) A shop drawing and submittal schedule (includes every submittal requirement in the specifications).

d) Within 15 calendar days of receipt of the NOA, the successful bidder is required to submit a Project Schedule to the Owner which shall, at a minimum, show detailed work operations and durations. The intent of this requirement is to allow the Owner an opportunity to more fully understand how the Contractor intends to complete the detail of the project. This detailed working schedule shall identify workforce requirements and be thoroughly coordinated with the Owner and all other subcontractors. The Contractor shall prosecute its work, at the direction of the Owner, furnishing at all times sufficient skilled workers, materials, and equipment to perform its work to meet the line-item progress required by the Project Schedule, so as not to delay the completion of the whole or any part of the work. The Owner anticipates that demolition work on the project will begin in January 2024 with chiller installation to commence in March 2024 and be completed by May 31, 2024.

ARTICLE 9. TAXES

Materials purchased for use or consumption in connection with the proposed work will be exempt from the State of Ohio Sales Tax as provided for in Section 5739.02 of the Ohio Revised Code and also from the State of Ohio Use Tax, Section 5741.01.

ARTICLE 10. LIQUIDATED DAMAGES

Liquidated damages shall apply to the terms of the contract.

ARTICLE 11. PROJECT SCHEDULE

Each bidder is required to submit a proposed schedule with the bid which shall at a minimum, show work operations and duration.

ARTICLE 12. OWNER'S RIGHT TO WAIVE DEFECTS AND IRREGULARITIES

a) The Owner reserves the right to waive any and all irregularities provided that the defects and irregularities do not affect the amount of the bid in any material respect or otherwise give the bidder a competitive advantage.

b) By submitting a bid, the bidder agrees that (i) the Owner's determination of whether a defect or irregularity affects the amount of the bid in any material respect or otherwise gives the bidder a competitive advantage will be final and conclusive, and (ii) the bidder will pay the Owner's attorneys' and consultants' fees related to any challenge to the

bid procedure or process, brought directly or indirectly by the bidder and/or any of its affiliates, which is unsuccessful.

ARTICLE 13. PRE-BID MEETING

A pre-bid meeting and site tour will be held on Monday October 30, 2023, at 9:00 AM EST. Potential bidders should plan to meet in the Eisenman/Trott Meeting Rooms located on the second floor of the Greater Columbus Convention Center at 400 N. High St., Columbus, OH 43215.

ARTICLE 14. CONTINUITY OF CONVENTION CENTER OPERATIONS

The Contractor shall plan and perform all work without creating any interruption or disruption to normal Greater Columbus Convention Center operations and functions. All necessary interruptions and disruptions must be minimized, planned, scheduled, and approved by the Owner. In preparation of the bid, bidders may not assume the use of any activity or operation that will result in the disruption of convention center activities without the prior approval of the Owner.

ARTICLE 15. PREVAILING OR MINIMUM WAGE RATES

a) Each laborer, worker or mechanic employed by the bidder for the work herein specified or by the subcontractor or by other persons performing work for the project shall be paid not less than the prevailing wage rates as determined by the Department of Industrial Relations of the State of Ohio in accordance with Chapter 4115 of the Ohio Revised Code.

b) In the event the wage rate for any labor classification is changed between the time the rates are published herein and the time the work required by the contract is performed, or in the event any class of labor employed is not included in the published schedule of prevailing wages, then the rate prevailing at the time the work is actually performed, as ascertained and determined by the Department of Industrial Relations of the State of Ohio or the US Department of Labor, shall govern the work under the contract. No increase in the contract sum will be allowed for any later increase in the prevailing rates or wages as they may apply to this work.

ARTICLE 16. PAYROLL SUBMITTAL

a) All contractors and subcontractors shall keep full and accurate payroll records covering all disbursements of wages to their employees to whom they are required to pay not less than the prevailing rate of wages, as set forth in the contract documents. Such records shall be preserved for a period of three years from the date of completion of the contract.

b) The Contractor and each subcontractor shall deliver to the Owner a certified copy of their payroll, with each month's payment application for the previous month's weekly payrolls which shall show for each employee paid any wages, their name, current address, social security number, number of hours worked each day during the pay

period and the total hours worked for each week, their hourly rate of pay, their job classification, fringe payments, and deductions from their wages. In addition, the Contractor, at the beginning of the performance under the contract, shall give to the Owner a schedule of the dates during the life of the contract with the Owner on which the Contractor is required to pay wages to employees and a complete list of all subcontractors. Upon completion of the contract and prior to final payment, the Contractor and each subcontractor shall file with the Owner an affidavit stating full compliance with Chapter 4115 of the Ohio Revised Code. The Owner will withhold payment of any monthly/partial and/or final payment until all requirements have been met in accordance with the terms of the contract.

ARTICLE 17. INSURANCE

Insurance requirements shall be defined in the contract.

DIVERSITY, EQUITY, AND INCLUSION POLICY

Through the adoption of this Diversity, Equity, and Inclusion Policy ("DEI Policy") the Franklin County Convention Facilities Authority ("FCCFA") affirms its commitment to equal opportunity and non-discrimination in all aspects of its operations including, but not limited to, contracting and procurement, employee recruitment and selection, compensation and benefits, professional development and training, promotions, transfers, layoffs, and terminations. Pursuant to this DEI Policy the FCCFA will not participate in either active or passive unlawful discrimination of any type and will strive to maintain an open, diverse, and inclusive workplace for all employees, officers, contractors, and subcontractors.

It is the position of the FCCFA that discrimination of any kind based upon age, sex, race, color, religion, disability, national origin, genetic information, ethnicity, ancestry, sexual orientation, gender identity or expression, family or marital status, military or veteran status, or any other basis prohibited by the laws of the United States, the State of Ohio, or the City of Columbus ("Protected Status") is prohibited. No person shall be unlawfully denied the benefit of, or otherwise be discriminated against in connection with their employment, the award or performance of any contract, or the modification of any contract or award.

The fundamental tenets of this DEI Policy are as follows:

- All Contractors shall have an equal opportunity to compete with respect to contracting and procurement activities of the FCCFA, regardless of age, sex, race, color, religion, disability, national origin, genetic information, ethnicity, ancestry, sexual orientation, gender identity or expression, family or marital status, military or veteran status, or any other Protected Status;

- No Contractor or FCCFA employee shall have engaged or shall engage in any kind of unlawful discrimination involving age, sex, race, color, religion, disability, national origin, ethnicity, ancestry, genetic information, sexual orientation, gender identity or expression, family or marital status, or any other Protected Status, whether or not such unlawful discrimination is related to the FCCFA or any contract with the FCCFA;

- The FCCFA and any Contractor seeking to do business with the FCCFA shall, whenever possible, craft bid specifications which enable MBE/WBE participation that is consistent with demographics for the City of Columbus;

- The FCCFA through its staff, facility management companies and other contractors will (i) monitor and provide periodic reports to the FCCFA Board of Directors regarding compliance by the FCCFA and its Contractors with this DEI Policy; (ii) collect and record information on the inclusion of minorities and women in their contracting, procurement, and workforce activities; and (iii) analyze data to evaluate the inclusion of minorities and women in the FCCFA's contracting, procurement, and workforce activities. Specific reporting requirements shall include:

- Semi-annual diversity profile updates from all key service partners and facility management companies;
- Documentation of contractor compliance with this DEI Policy in any recommendation of award presented to the FCCFA Board of Directors;
- Monthly board reports describing MWBE participation rates for all ongoing construction projects.

- The FCCFA shall review this DEI Policy periodically to ensure that it effectively promotes and achieves diversity, equity, inclusion, non-discrimination and equal opportunity in connection with the FCCFA's operations, and all contracting and procurement activities; and

- All Contractors and employees shall comply with this DEI Policy. A Contractor's success or failure to comply with this DEI Policy will be a factor in any award of a contract to such Contractor. An employee's success or failure to comply with this DEI Policy will be a factor considered in connection with any disciplinary measures or continued employment with FCCFA.

The FCCFA through its staff, facility management companies and other contractors shall be responsible for implementing, monitoring and evaluating this DEI Policy.

If the FCCFA determines that the objectives of this DEI Policy are not being achieved, the FCCFA Board of Directors may, in their discretion, direct the Executive Director to conduct further investigations into the reasons for not achieving such objectives.

This DEI Policy applies to all contracting and procurement activities of the FCCFA, including contracting for construction, professional and non-professional services and procurement of goods and supplies.

This DEI Policy shall be referenced in each bid and Request for Proposal or Qualifications document issued by the FCCFA. A Contractor's failure to comply with this DEI Policy may result in (a) debarment from participation in future FCCFA contracting opportunities, (b) liability for breach of contract and (c) the enforcement of any other remedies available under the related contract or applicable law.

FORM OF PROPOSAL

Submitted By:_____

on:_____ , 2023

To: Franklin County Convention Facilities Authority
400 North High Street, 4th Floor
Columbus, Ohio 43215-2096

having read the Project Manual, Specifications and examined the Drawings entitled:

Greater Columbus Convention Center North Facility Chiller Replacement

as prepared by the Franklin County Convention Facilities Authority for the construction of said project and having also received, read and included their provisions in the bid all addenda thereto as follows:

Addendum No:_____ Dated: _____ Addendum No: _____ Dated: _____

Addendum No:_____ Dated: _____ Addendum No: _____ Dated: _____

and having also inspected the site of and the conditions affecting and governing the construction of said project, the undersigned proposes to furnish all materials and perform all labor as specified, described, shown, and required in the Project Manual, Specifications and Drawings for the Work, for the indicated sum:

(NOTE: Fill in all spaces of items being bid and quote the sum in both words and figures.)

ESTIMATE FOR PROJECT
($850,000.00)

Total material, labor and services for the project – **Greater Columbus Convention Center North Facility Chiller Replacement** - for the lump sum amount of:

_____

Dollars ($ _____)

FORM OF PROPOSAL (continued)

EXECUTION OF PROPOSAL

NOTE A: TIME OF COMPLETION

a) It is understood and agreed that the work embodied in this contract shall be completed no later than the completion date stated within the contract, unless an extension of time is granted by the Owner.

b) Upon failure to have all work completed within the period of time above mentioned, the Contractor shall forfeit and pay, or cause to be paid, to the Owner for and as liquidated damages to be deducted from any payment due or to become due to the said contractor, the sum set forth in the following table for the size of contract, for each and every day thereafter that the said work remains in an unfinished condition.

DOLLAR AMOUNT OF CONTRACT	DOLLARS PER DAY
$0 to $100,000.00	$250.00
$100,000.01 to $500,000.00	$500.00
$500,000.01 to $1,000,000.00	$1,000.00
$1,000,000.01 to $10,000,000.00	$2,500.00
$10,000,000.01 and up	$5,000.00

NOTE B: Failure to sign proposal may result in rejection of the Bid.

THIS PROPOSAL SUBMITTED BY: _____

_____
Name of Contractor

BY: _____
Signature of Contractor or Authorized Representative

DATE: _____

Contact Person for contract processing: _____

Mailing Address if different from above: _____

_____

FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY

Diversity, Equity & Inclusion Policy

_____ (name of Contractor) hereby has reviewed the FCCFA's Diversity, Equity & Inclusion Policy.

The contractor agrees to comply with all policy requirements and, directly or indirectly, (1) has not engaged, is not engaged, and will not engage in any kind of unlawful discrimination involving race, color, sex, sexual orientation or gender identity, disability, age, religion, veteran status or national origin, whether or not such discrimination is related to a contract or procurement activity with or for the FCCFA and (2) will not, for any purpose related to its engagement by the FCCFA, employ or contract with persons or businesses which the Contractor knows or has reason to know have engaged, are engaged, or will engage in any kind of unlawful discrimination involving race, color, sex, sexual orientation or gender identity, disability, age, religion, veteran status or national origin, whether or not such unlawful discrimination is related to a contract or procurement activity with or for the FCCFA. The contractor further agrees to incorporate these requirements in all subcontracts on this project regardless of tier.

Date: _____ _____

Signature of Contractor or Authorized Representative

( ) Submitted own Affirmative Action Plan.

( ) Contractor has been certified as a minority and/or female owned business. (Submit copy of certification as received from the federal government and/or any Ohio government unit or public authority).

Note: This certification must be filled and signed. Failure to comply may invalidate your bid.

DECLARATION OF INSURANCE TO THE
FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY

THIS IS TO CERTIFY THAT THE FOLLOWING DESCRIBED POLICIES OF INSURANCE HAVE BEEN ISSUED AND ARE IN FULL FORCE AND EFFECT AT THIS TIME:

1. Name of Insured (Contractor):

2. Address:

3. Title and Location: (Contract Job Site) — Franklin County Convention Facilities Authority - Greater Columbus Convention Center

4. Project: — GCCC North Facility Chiller Replacement

5. Policy Number(s), Carriers and Expiration Dates:

TYPE OF INSURANCE		LIMITS OF LIABILITY IN $1,000 AMOUNTS Each Occurrence	Aggregate
GENERAL LIABILITY			
Comprehensive Form Premises-Operations	Bodily Injury	$	$
Explosion and Collapse Hazard Underground Hazard	Property Damage`	$	$
Products/Completed Operations Hazard	Combined	$	$
Contractual Hazard	Single Limit	$	$
Broad Form Property Damage			
Independent Contractors Personal Injury	Personal Injury	$	$
AUTOMOBILE LIABILITY Comprehensive Form	Bodily Injury Each Person	$	
Owned	Bodily Injury Each Accident	$	

Hired Non-Owned	Property Damage	$	
EXCESS LIABILITY	Combined Single Limit	$	
Umbrella Form	Combined Single Limit	$	$
Following Form	Self-Insured	$	

List any manuscript or unusual exclusions for forms and attach copies.

Check those of the following operations which are excluded:

_____ Asbestos removal or abatement _____ PCP Removal _____ Demolition

It is agreed that sixty (60) days written notice of cancellation or material change in the described policy(s) will be given to the holder of this certificate, known as the Franklin County Convention Facilities Authority, 400 North High Street, Columbus, OH 43215.

Insurance Agency:

Address: Telephone:

Contractor's Signature: **Agent's Signature:**

_____ _____

Date: _____ Date: _____

ADDITIONAL INSURED WITH RESPECT TO THIS JOB ONLY; AS THEIR INTEREST MAY APPEAR:

1. Franklin County Convention Facilities Authority, its other contractors and own forces, if any, and the subcontractors, sub-subcontractors, consultants, agents, and employees of any of them, in their individual capacities as such:
2. The Franklin County Convention Facilities Authority Board, its members, consultants, agents, and employees of any of them, in their individual capacities as such;
3. The Architect/Engineer its consultants, agents, and employees of any of them, in their individual capacities as such;
4. The Construction Manager, its consultants, agents, and employees of any of them, in their individual capacities as such.
5. ASM Global, its consultants, agents, and employees of any of them, in their individual capacities as such.

FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY
MANUFACTURER'S DECLARATION

Part A

Contractor's Name and Address:

Project Title and Location**:** GCCC North Facility Chiller Replacement

Part B (Complete for all suppliers but do not include subcontractors.)

Name: Type/Brand Name of Supplies:

Address: Phone:
Minority/Female Business: _____ Yes
_____ No

Name: Type/Brand Name of Supplies:

Address: Phone:
Minority/Female Business: _____ Yes
_____ No

Name: Type/Brand Name of Supplies:

Address: Phone:

Minority/Female Business: _____ Yes
_____ No

Name: Type/Brand Name of Supplies:

Address: Phone:

Minority/Female Business: _____ Yes
_____ No

(attach additional pages as needed)

FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY
SUBCONTRACTOR DECLARATION

Part A

Contractor's Name and Address:

Project Title and Location**:** GCCC North Facility Chiller Replacement

Part B (Complete for all subcontractors, specify brand name of their material)

Name: Type Work:

FTID#:
Address: Brand Name(s):

Minority/Female Business: _____ Yes
_____ No

Phone:

Name: Type Work:

FTID#:
Address: Brand Name(s):

Minority/Female Business: _____ Yes
_____ No

Phone:

Name: Type Work:

FTID#:
Address: Brand Name(s):

Minority/Female Business: _____ Yes
_____ No

Phone:

(attach additional pages as needed)

FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY
CONTRACTOR'S REVIEW CERTIFICATE

The undersigned acknowledges that:

(1) the contractor's authorized agent has carefully read and understood all of the Bid Documents submitted for the GREATER COLUMBUS CONVENTION CENTER NORTH FACILITY CHILLER REPLACEMENT, including, but not limited to, the Notice to Bidders, Instructions to Bidders, Form of Proposal, Substitution Sheet, Prevailing Wage Determination, Form of Bid Guaranty and Contract Bond, this Contractor's Review Certificate, Project Manuals, Specifications and Drawings; and

(2) the Bid Documents are sufficient and adequate for the undersigned to perform the Work; and

(3) the contractor's authorized agent has carefully reviewed the site and conditions under which the Work will be performed, or has been given ample opportunity to do so, and fully assumes the risk for any condition at the site that could have been discovered by a careful and diligent review of the site; and

(4) the contractor's authorized agent has confirmed that the contractor's surety is authorized to do business in the State of Ohio.

Dated: _____

CONTRACTOR: _____

By: _____
SIGNATURE

_____
TYPED OR PRINTED NAME

Its: _____

NOTE: The Bidder should review the Bid Documents and the site and conditions under which the Work will be performed so that the Bidder can give the acknowledgments contained in this Certificate.

BID GUARANTY AND CONTRACT BOND

KNOW ALL MEN BY THESE PRESENT, that we, the undersigned

(Name and Address)

as Principal and

(Name of Surety)

as Surety, are hereby held and firmly bound unto the Franklin County Convention Facilities Authority as Obligee in the penal sum of the dollar amount of the bid submitted by the Principal to the Obligee on this _____day of _____, 2023 to undertake the project known as the Greater Columbus Convention Center North Facility Chiller Replacement. The penal sum referred to herein shall be the dollar amount of the Principal's bid to the Obligee, incorporating any additive or deductive alternative proposals made by the Principal on the date referred to above to the Obligee, which are accepted by the Obligee. In no case shall the penal sum exceed the amount of _____ dollars ($_____).

(If the above line is left blank, the penal sum will be the full amount of the Principal's bid, including add alternates.) Alternatively, if completed, the amount stated must not be less than the full amount of the bid, including add alternates, in dollars and cents. A percentage is not acceptable. For the payment of the penal sum well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors, and assigns.

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, that whereas the above-named Principal has submitted a bid on the above referred to Project;

NOW, THEREFORE, if the Obligee accepts the bid of the Principal and the Principal fails to enter into a proper contract in accordance with the bid, plans, details, specifications, and bills of material; and in the event the Principal pays to the Obligee the difference, not to exceed ten percent of the penalty hereof, between the amount specified in the bid and such larger amount for which the Obligee may in good faith contract with the next lowest bidder to perform the Work covered by the bid; or in the event the Obligee does not award the Contract to the next lowest bidder and resubmits the Project for bidding, the Principal will pay the Obligee the difference, not to exceed ten percent of the penalty hereof, between the amount specified in the bid, or the costs, in connection with the resubmission, or printing new contract documents, required advertising and printing and mailing notices to prospective bidders, whichever is less, then this obligation shall be null and void, otherwise to remain in full force and effect. If the Obligee accepts the bid of the Principal and the Principal, within ten days after the awarding of the Contract, enters into a proper contract in accordance with the bid, plans, details, specifications, and bills of material, which said Contract is made a part of this Bond the same as though set forth herein; and

IF THE SAID Principal shall well and faithfully perform each and every condition of such Contract; and indemnify the Obligee against all damage suffered by failure to perform such Contract according to the provisions thereof and in accordance with the plans, details,

specifications, and bills of material therefor; and shall pay all lawful claims of subcontractors, materialmen, and laborers, for labor performed and materials furnished in the carrying forward, performing, or completing of said Contract; we agreeing and assenting that this undertaking shall be for the benefit of any materialman, subcontractor or laborer having a just claim, as well as for the Obligee herein; then this obligation shall be void; otherwise the same shall remain in full force and effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall in no event exceed the penal amount of this obligation as herein stated.

THE SAID Surety hereby stipulates and agrees that no modifications, omissions, or additions, in or to the terms of said Contract or in or to the plans and specifications therefor shall in any way affect the obligations of said Surety on its Bond, and it does hereby waive notice of any such modifications, omissions or additions to the terms of the Contract or to the Work or to the specifications.

SIGNED AND SEALED This _____ day of _____, 2023.

PRINCIPAL:

BY:

TITLE:

SURETY

SURETY COMPANY ADDRESS:

Street

City State Zip

Telephone:

BY:

Attorney-in-Fact

If the requirements of Section 3905.41 of the Ohio Revised Code are applicable or if Surety Agent's Address is other than Ohio, and the Ohio Department of Insurance's Certificate of Compliance is not attached, please complete Ohio Resident Agent Information as follows:

SURETY AGENT'S ADDRESS:

_____
Agency Name:

_____
Street

_____
City State Zip

_____
Telephone

_____
Agency Name:

_____
Street

_____
City State Zip

_____
Telephone

NOTE Failure by any party to sign this Bid Guaranty and Contract Bond shall result in rejection of bid.

INSTRUCTIONS TO BIDDERS
RESPONSIBILITY ANALYSIS FORM

FRANKLIN COUNTY CONVENTION FACILITIES AUTHORITY
DETERMINATION OF LOWEST AND BEST BID

This form must be completed in its entirety and submitted with the Bid Form. Attach additional sheets if necessary to provide complete answers to the questions below. Do not include any misleading statements and make sure to include all facts necessary to make the statements made not misleading. The term "Project" means the project for which the attached bid is submitted. All references to "**Bidder**" should be answered with respect to the **actual legal entity** submitting the bid.

Subject to the right of the Owner to reject any or all bids, the Owner will award the Contract for the Work to the Bidder submitting the lowest and best bid, taking into consideration accepted alternates. In determining which bid is the lowest and best bid, the Owner may take into consideration not only the amount of the bid but such of the following criteria as the Owner, in its sole discretion, deems appropriate, and may give such weight thereto as it deems appropriate:

Bidder Name _____

Bid Package No.: 2023-5_____ Contract No(s).: _____

Trade/Service _____

Product (s) Supplied _____

1. Bidder shall provide all information listed below with its bid, unless otherwise noted. Failure to do so may, at the Owner's discretion, result in rejection of the bid.

2. The Owner reserves the right to reject all bids.

3. Will the Bidder employ supervisory personnel on this Project that have three (3) or more years in the specific trade and/or maintain the appropriate state license?

   _____Yes _____No

4. On a separate sheet, provide information to demonstrate the following:

   - Bidder's previous performance to complete its work on projects of similar size and scope.
   - Bidder's previous ability to complete these same projects on time.
   - Bidder's previous ability to work with this Owner, Architect, Engineer and/or Construction Manager.

5. Bidder shall not have an EMR (Workers' Compensation Interstate/Intrastate Experience Modification Rate) greater than 1.5. If Bidder's EMR is above 1.0, Bidder shall provide a letter from Insurance Broker providing EMR for the most recent five (5) years, reasoning for EMR being above 1.0 and incident rates for that time period.

6. Has the Bidder been in existence at least 36 months?

_____Yes _____No

7. Has the Bidder, or any principal, owner, officer, stockholder, affiliate or any person involved in the bidding, contracting or leasing process been cited in the last five (5) years for violations of or failure to comply with any laws including without limitation:

a. Workers' compensation laws _____Yes _____ No

b. Wage and hour laws (including the Davis-Bacon Act and the Ohio Prevailing Wage Act) _____Yes _____ No

c. Unemployment laws _____Yes _____ No

d. Tax laws _____Yes _____ No

e. Fair Labor Standards Act _____Yes _____ No

f. Immigration laws _____Yes _____ No

g. Licensing requirements _____Yes _____ No

h. OSHA _____Yes _____ No

i. EPA _____Yes _____ No

j. Any items below: _____Yes _____ No

1. A judgment or conviction for any business-related conduct constituting a crime under federal, state or local government law including, but not limited to, fraud, extortion, bribery, racketeering, price-fixing or bid collusion or any crime related to truthfulness and/or business conduct.

2. A criminal investigation or indictment for any business-related conduct constituting a crime under federal, state or local government law including, but not limited to, fraud, extortion, bribery, racketeering, price-fixing or bid collusion or any crime related to truthfulness and/or business conduct.

3. An unsatisfied judgment, injunction or lien for any business-related conduct obtained by any federal, state or local government agency including, but not limited to, judgments based on taxes owed and fines and penalties assessed by any federal, state, or local government agency.

4. An investigation for a civil or criminal violation for any business-related conduct by any federal, state or local agency.

5. A grant of immunity for any business-related conduct constituting a crime under federal, state or local governmental law including, but not limited to, fraud,

extortion, bribery, racketeering, price-fixing, bid collusion or any crime related to truthfulness and/or business conduct.

6. An administrative proceeding or civil action seeking specific performance or restitution in connection with any federal, state or local contract or lease.

7. A sanction imposed as a result of judicial or administrative proceedings relative to any business or professional license.

8. A consent order with the Ohio Environmental Protection Agency, or a federal, state or local government enforcement determination involving a violation of federal, state, or local environmental laws.

If yes, on a separate sheet, provide complete details including the date of each citation or violation; the nature of each violation; and the sanction for each violation. If the Bidder was fined, include the dollar amount.

For purposes of 7.a. above, a violation of the Workers' compensation laws is a determination by the Ohio Bureau of Workers Compensation that the contractor is not in compliance with Ohio Workers' Compensation laws and regulations.

For purposes of 7.b. above, a violation of the Ohio Prevailing Wage Act is a determination by the Ohio Department of Commerce, Division of Labor and Worker Safety, Wage and Hour Division, or successor that the contractor is not in compliance with the provisions, duties, obligations and is subject to the remedies and penalties of Chapter 4115 of the Ohio Revised Code.

8. Does Bidder have any outstanding liens? If yes, on a separate sheet identify each circumstance and Bidder's response.

_____Yes _____ No

9. Has Bidder been party to litigation or arbitration proceedings in connection with any work performed, services rendered, or products supplied in the last five years? If yes, on a separate sheet, provide complete details, including dates, parties, whether Bidder was a plaintiff/claimant or defendant/respondent, the nature of the dispute and the ultimate determination or other resolution (i.e. settlement).

_____Yes _____ No

10. In the last five years, has Bidder had work rejected as defective (other than minor re-work accomplished without formal notice)? If yes, on a separate sheet identify each circumstance and Bidder's response.

_____Yes _____ No

11. In the last five years, has Bidder's contract or employment been terminated prior to completion of a project for any reason other than convenience of the Owner? If yes, on a separate sheet identify each such circumstance and provide full details.

_____Yes _____ No

12. Bidder shall secure any required bonds from a surety licensed to do business in the State of Ohio with an A.M. Best Company rating of at least A. Has Bidder met this requirement?

_____Yes _____ No

13. Has Bidder's construction license ever been revoked in any state?

    _____Yes _____ No

14. In the last five years, has Bidder had its own forces supplemented by an Owner, contractor or construction manager or had a claim made against it for defective, delayed or non-compliant work? If yes, on a separate sheet identify each such circumstance and provide full details.

    _____Yes _____ No

15. Bidder for a skilled contract (i.e. plumbing, electrical, HVAC, or fire safety) shall certify that Bidder will not subcontract greater than 50% of its awarded contract.

16. Does Bidder provide a minimum healthcare medical plan for those employees working on the project? If yes, list the healthcare plan provider below.

    _____Yes _____No

    Healthcare Medical Plan Provider: _____

17. Does Bidder contribute to an employee pension or retirement plan for those employees working on the project? If yes, list the pension or retirement plan provider below.

    _____Yes _____No

    Pension Plan or Retirement Plan Provider: _____

    The contractor may be asked to provide ERISA form 5500 for the retirement plan.

18. Has Bidder implemented an OSHA compliant Safety Program?

    _____Yes _____No

19. Does Bidder maintain a substance abuse policy that meets or exceeds requirements of the Ohio BWC and that its personnel are subject to on this Project?

    _____Yes _____No

20. Is the bidder a foreign corporation (i.e. not incorporated under the laws of Ohio) or an individual or partnership?

    _____Yes _____No

21. If yes to Item 20 above, provide proof of a Certificate of Good Standing from the Secretary of State showing the right of the Bidder to do business in the State and/or proof of filing with the Secretary of State a Power of Attorney designating the Secretary of State as Bidder's agent.

22. Bidder shall certify that the Bidder's subcontractors / vendors shall meet all requirements contained herein.

23. The Owner reserves the right to request the following information within 48 hours of the bid date:

a. On a separate sheet, list all projects greater than $1,000,000 completed by Bidder in the preceding five years and for each, provide Bidder's original contract amount, final contract amount and a reference name and phone number.

b. For the three largest projects listed from Item 3 above list your average manpower and peak manpower along with the original duration of the project and final duration of the project.

c. On a separate sheet, provide Bidder's current work load under contract. List each current project and its respective contract amount and scheduled duration.

d. On a separate sheet, provide information on Bidder's equipment and facilities.

e. Bidder shall provide sufficient financial information to demonstrate fiscal capability to perform the project. All financial information identified by the Bidder as a trade secret and contained herein shall be treated as a trade secret and exempt from Ohio's Public Records laws, but the Owner's sole duty shall be to notify Bidder of any requests for that information so that Bidder is afforded the opportunity, at Bidder's expense, to contest in court the disclosure of any such information. The Owner may, but shall not be obligated to, contest any request for the disclosure of such information.

f. On a separate sheet, identify, in numbers and experience, the Bidder's work force. Differentiate between hourly and salaried staff. Describe Bidder's workforce, focusing on worker experience and continuity.

g. Bidder for a skilled trade contract or fire safety contract shall certify and upon request, provide evidence that Bidder is a state licensed heating, ventilating, and air conditioning contractor, refrigeration contractor, electrical contractor, plumbing contractor, or hydronics contractor or licensed by the State Fire Marshall and uses skilled, trained personnel.

h. Identify the number of man hours and associated wages for each trade classification included in the Contractor's and Subtiers' Base Bid. Separately list the subtier's information. Provide additional sheet if more room is needed. DO NOT include payroll taxes, assessments or fringe benefits of any kind in the Wage amounts.

Trade	Man Hours	Wages (No fringes or OH&P)

The Undersigned certifies under oath that the information provided herein and on all supplemental pages of explanation is true, complete and correct.

_____
Company

By _____

Title _____
(Signature must be notarized)

Sworn to and subscribed in my presence this_____ day of _____,
_____

By _____ , the _____ of

_____ , a_____on

behalf of the _____ .

_____
Notary Public

My Commission Expires: _____

Franklin County Convention Facilities Authority
Bid Evaluation Process:

In determining the lowest and best bid for construction contracts, the Franklin County Convention Facilities Authority will take the following steps and consider the following items in making this determination. The Authority reserves its discretion to evaluate the price and quality of bids to ensure that the lowest and best bid is selected. The Authority reserves its discretion to modify this process at any time and for any reason without notice.

1. Select which alternates will be accepted.

2. Identify the apparent low bidder based on the accepted alternates.

    2.1 Is the apparent low bid responsive? Are all required bid submissions included?

    2.2 Has the bidder qualified their bid in a way that would disqualify the bid?

3. Meet with the bidder to determine that all project scope is clearly understood and included. Discuss project schedule, safety and all project requirements. Identify key project staff. Identify subcontractors. Identify long lead time equipment. Discuss submission, review and approval process. Identify and discuss other items pertinent to the job.

4. Is the bidder well qualified?

    4.1 Background Check:
        Check Dun and Bradstreet.
        Run Lexus/Nexus check.
        Check for prevailing wage and workers compensation compliance.

    4.2 Is the bidder qualified for a job of this scope? (Questions 4, 6, 15, 23.a, b,c,d,e)

    4.3 Has the bidder demonstrated that they will provide qualified, well trained staff? (Questions 3, 23.f, g)

    4.4 Does the bidder provide a minimum healthcare medical plan for those employees working on the project? (Question 16)

    Does the bidder contribute to an employee pension or retirement plan for those employees working on the project? (Question 17)

    4.5 Does the bidder have a history of providing quality construction services? (Questions 6, 9, 10, 11, 13, 14)

    4.6 Does the bidder maintain a safe workplace? (Questions 5, 18, 19)

    4.7 Does the bidder follow all applicable laws? (Question 7)

    4.8 Is the bidder financially stable? (Questions 7.j.3, 8, 12, 23.e)

5. If it is determined that the apparent low bid is responsive, valid and the bidder is well qualified:

5.1 Assemble all necessary documentation and paperwork required in the bid documents.

5.2 Submit a resolution for board approval to enter into the contract.

5.3 Issue a notice to proceed.

5.4 Sign a contract with the successful bidder.

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SECTION 23 0500

GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work under this Section includes, but is not limited to, providing all labor, material, equipment, and services necessary for completion of all mechanical systems in a serviceable fully operational manner.

B. All items of Work and systems shall be furnished and installed ready for satisfactory operation and all required apparatus and service shall be provided even though not specifically mentioned herein.

C. The Contract Specifications and Contract Drawing Equipment Schedules list the equipment manufacturers selected for the basis of the Specifications and for the various individual equipment layouts on the Contract Drawings. Substitutions shall be made in accordance with General Conditions and as otherwise provided in the Contract Documents.

D. The Drawings showing the layout, arrangements, sizes and principal connections to the equipment and apparatus are based on one particular type of equipment of an acceptable manufacturer. If equipment other than the particular type shown on the layout Drawings is used, it is the Contractor's sole responsibility to make all necessary modifications to related piping, ductwork, electrical and utility connections, apparatus and miscellaneous items to complete the Mechanical Work, ready for satisfactory operation required under these Specifications. The cost of making all the modifications shall be borne by this Contractor without extra cost to the Owner, Architect or Engineer. In using such equipment, it is imperative that the equipment must fit the space and the access allotted, with the final layout to be approved by the Architect/Engineer (A/E). Follow the Drawings as closely as actual building construction permits.

E. The Drawings show the principal engineering design elements of the mechanical installation. They are not intended as detailed construction installation drawings for the Mechanical Work but as a complement to the Specifications to clarify the principal features of the mechanical systems. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installation complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Contract Specifications or shown on the Contract Drawings.

F. Check the layout of the Work of this Division, as indicated on the Drawings. Determine exact locations by the dimensions of the equipment approved. Obtain written approval from the Engineer for any revised layout before equipment or material involved is installed. Consult the Architectural and Structural Drawings for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, swings of door, and other detail information required for a correct installation of this Work.

G. Examine all other Divisions of the Contract Documents for Work related to the Work of this Division. Cooperate to provide continuity of Work, to eliminate duplications, and to provide Mechanical Work in support of such related Work. Furnish to other trades and on schedule all information required for the execution of Mechanical Work.

H. Any additional Work such as cutting, drilling, patching, excavating, moving of another trade's work because of delay in Mechanical Work or lack of information is a part of this Division and shall be performed without increase in Contract Price.

I. Install and connect devices and equipment in accordance with the best engineering practice and the manufacturer's instructions and recommendations. Provide all incidental ductwork, piping, valves, connections, and all similar material recommended by the manufacturer, or required for proper operation and maintenance, complete without additional costs.

J. Provide all necessary rigging, scaffolding, tools, tackle, labor and other materials or equipment which may be necessary for the completion of the Work.

K. Furnish and install motor on proper frame designed by the equipment manufacturer.

L. All control wiring associated with the mechanical systems shall be provided under Division 23. All wiring shall comply with Division 26 Standards.

1.2 SPECIFIED ELSEWHERE

A. The following will be provided under other sections of the Specifications:
1. Openings: Walls, floor, ceiling and roof opening specifically shown and identified on the Architectural/Structural Drawings will be provided under other Divisions. Openings not so identified that are required for Mechanical Work, or changes to such openings are part of the Work of this Mechanical Division.
2. Curbs, Drains and Sleeves: Drains and roof sleeves provided under this Division shall be incorporated into the finished roofing and made watertight under another Division.
3. Equipment Bases: Concrete equipment bases, mounting slabs, and housekeeping pads specifically shown and identified on the Mechanical Drawings shall be provided under this Division. Supervise their installation. Those bases, not so identified and indicated on the Architectural and Structural Drawings, shall be provided under other Divisions. Cooperate and furnish dimensions, sleeves, inserts, hold-down bolts, and templates for their installation.
4. Painting: Painting of all exposed-to-view pipes, ducts, hangers, supports, and equipment, shall be performed under another Division. Under this Division, all manufactured equipment shall be furnished with factory-finished baked enamel, unless otherwise specified.
5. All power wiring associated with equipment provided under this Division shall be furnished, installed, and wired in accordance with Division 26. Under Division 23, provide installation instructions, locating dimensions, and wiring diagrams for the other trades. Supervise the installation and start-up and test the equipment.

1.3 RELATED WORK

A. The Drawings, General Provisions of the Contract, General Conditions, General Requirements, Supplemental General Conditions and Division 01 through 26 all apply to the work in this Section.

1.4 DEFINITIONS

A. Provide: Furnish, install and connect up complete and ready for operation of particular work referred to, unless specifically otherwise noted.

B. Furnish: To purchase, procure, acquire and deliver complete with related accessories.

C. Install: To erect, mount and connect for use complete with related accessories.

D. Work: Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

E. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

F. Exposed: Not installed underground or concealed as defined above.

G. Accessible: Capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, ductwork or going through doors or false ceilings.

H. Words: Words used in the singular number shall include the plural sense and vice versa.

I. Wiring: Wire or cable installed in conduit, with all required boxes, fittings, supports, connections, etc.

J. Power Wiring: That wiring between the source of power and the current consuming device such as motors, equipment, heaters, etc. It includes the installation of such control devices in the power circuit such as pushbuttons, thermostats, key switches, timers, etc., which control loads for which no magnetic starter or contactor is provided for controls.

K. Control Wiring: That wiring between control devices that does not provide the power circuit, regardless of voltage, when a magnetic starter or contactor is provided for control.

1.5 INTENT

A. Furnish, erect, install, connect, clean, adjust, test and place in service all materials, equipment and systems in accordance with applicable codes, manufacturer’s directions and recommendations for all work shown on the drawings and called for in the Specifications.

B. Carefully examine the contract documents, visit the site, and thoroughly become familiar with the local conditions relating to the work. Failure to do so will not relieve the contractor from any obligations of the Contract.

C. Should there be any discrepancies of a question of intent, refer the matter to the Architect/Engineer for a final decision before ordering any equipment/materials or before starting any related work.

D. In case of conflict between project specifications and drawings, drawings govern unless the Architect/Engineer rules otherwise.

E. Apparatus, devices, materials of work not specifically shown on drawings, but mentioned in the project specifications, or vice versa, or any incidental accessories and appurtenances necessary to make the work complete and ready for operation, even though not specified or shown on the drawings, shall be furnished and installed without additional expense to the Owner.

F. It is the contractor's responsibility prior to bids to review all project documents.

G. Project documents include architectural, structural, mechanical, control, plumbing, fire protection and electrical disciplines.

1.6 CODES AND STANDARDS

A. Applicable Publications: Reference made herein to standards, Specifications, or codes, refer to the latest edition including all addenda, errata, or other revisions thereto, existing on the date of execution of the Contract.

B. Local Codes and Ordinances: Install all Work in conformance with all applicable local Codes and state ordinances and statues. Nothing in the Specifications or Drawings shall be construed to permit deviation from the governing codes. In case of conflict with local ordinances and statues, the more stringent shall apply.

C. Abbreviations: Refer to Division 01, Abbreviations and Symbols under Mechanical Sections make use of the following abbreviations in adopting applicable standards and codes as a part of Division 23:

1. ADC - Air Diffusion Council - Test Code
2. AGA - American Gas Association
3. AIA – American Institute of Architects
4. AMCA - Air Moving and Conditioning Association
5. ANSI - American National Standards Institute
6. API - American Petroleum Institute
7. ARI - Air Conditioning and Refrigeration Institute
8. AGA - American Gas Association
9. ASHRAE–American Society of Heating, Refrigeration and Air Conditioning Engineers
10. ASME - American Society of Mechanical Engineers
11. ASTM - American Society for Testing and Materials
12. AWS - American Welding Society
13. AWWA - American Water Works Association
14. EPA - Environmental Protection Agency
15. FM - Factory Mutual System
16. IMC – International Mechanical Code
17. IPC – International Plumbing Code
18. IRI - Industrial Risk Insurers
19. MSS - Manufacturers Standardization Society
20. NACE – National Association of Corrosion Engineers
21. NEC - National Electric Code
22. NEMA - National Electrical Manufacturers Association
23. NFC - National Fire Code
24. NFPA - National Fire Protection Association
25. NPC - National Plumbing Code
26. NSF – National Sanitation Foundation
27. OSHA - Occupational Safety and Health Standards

28. PDI – Plumbing and Drainage Institute
29. SMACNA - Sheet Metal and Air Conditioning Contractor's National Association
30. UL - Underwriters Laboratories, Inc.
31. State and Local Fire Marshall
32. State and Local Inspection Authorities
33. Owner District's Fire Insurance Agency requirements
34. The Division 01 Sections "Regulatory Requirements" and Reference Standards of the Project Specifications

D. Permits and Inspections
1. Obtain and pay for all permits, bonds, licenses, etc. required by the Local, State or other authority having jurisdiction over the work.
2. Arrange and pay for inspections required by the above when they become due as a part of the work of the Sections affected. Conceal no work until approved by these governing authorities. Present the Owner with properly signed certificates of final inspection before the Owner's acceptance of the Work.
3. Obtain and pay for all meters, gauges, instruments, and devices required by the governing authorities except as otherwise noted as part of the Work of the Sections affected.

1.7 QUALITY ASSURANCE

A. All materials furnished shall be new and shall comply with all applicable standards listed below.

B. All materials or work found to be defective or not in strict conformity with the Contract Documents, or defaced or injured through any cause, shall be rejected, and shall be removed by Contractor and satisfactory material and Work substituted without delay.

C. Contractor shall protect his/her Work by keeping all piping, equipment, etc., capped or plugged, drained, or otherwise protected from injury by freezing, water damage, or stoppage from material, concrete, sand, or dirt and shall repair any such injury without additional charge to the User. Injury shall be interpreted to include scratches, discoloring and denting.

D. Contractor will be held responsible for any damage caused by him/her to other Contractors' Work.

E. Submit shop drawings and product data for all equipment as specified or scheduled. Update all drawings to "as-built" status and submit to Architect/Engineer digitally or on flash drive.

1.8 SUBMITTALS

A. Submit under provisions of Division 01 and as specified herein. The most stringent requirements shall apply.

B. General: Within 15 calendar days after date of Contract Agreement, submit to the Engineer a typewritten list of all items of equipment and material proposed for installation on this project. Provide the specification page number, manufacturer's name, model number, size non-standard accessories specified or required, and any other information required to identify each item.
1. Within 30 days after the Contractor has been given notice of approval of manufacturers, submit shop drawings of equipment and material proposed for this installation.
2. If substitutions have been offered in lieu of specified materials and/or equipment they shall be in accordance with AIA Document A201.

C. Shop Drawings: Submit shop drawings for all Work to be done under each of the Mechanical Sections and for all items and assemblies which are to be specifically fabricated for this Contract.

D. The Engineer's review of Manufacturer's Drawings or Schedules shall not relieve the Contractor from responsibility for errors or omissions in Manufacturer's Drawing and deviations from the Contract Drawings or Specifications.

E. Coordination and Fabrication Drawings: Prepare layout drawings of all system assemblies of this Contract including plumbing, heating, sprinkler piping, electrical and technology, mechanical and electrical room layouts with equipment and piping, ductwork installations, and control systems. Include completely dimensioned plans drawn to scale. Show elevations and sections indicating locations of all equipment, piping, ductwork, drains, controls, and other items with reference to columns, walls, slabs, beams, and to components of other systems and work of other trades. Floor plans shall be drawn at not less than 1/4-inch scale with a sign-off block including all disciplines and date. Tracing or reproduction of Construction Documents is not acceptable. Provide a minimum of one reproducible drawing and five prints of each drawing.

F. Electronic files containing AutoCAD Floor Plans or Revit models are available through the Engineer. Cad drawing format shall be AutoCAD 2017 unless requested otherwise. Revit models shall be in the version in which they are created. The Contractor shall complete, sign, and submit a "Model Sharing Agreement" form which is available from the Architect/Engineer by request. Fees may apply for these electronic files.

G. Catalog Cuts: Submit manufacturer's data sheets and pictures of all standard manufactured items proposed for installation in this project. Clearly identify each item proposed, together with all required accessories and fittings, with tag numbers and specification page and line numbers. Include graphs, curves, or charts, as applicable, with the specified operating point clearly marked.

H. Installation and Bolt Setting Diagrams: Submit complete installation instructions and bolt setting information for items of equipment furnished under Division 23 such as pumps, fans, compressors, tanks, filters, pressure vessels, etc.

I. Wiring Diagrams: Provide specific wiring diagrams and instructions for all equipment, controls or devices which are furnished under Division 23 and are to be wired and connected by other trades. The diagrams and instructions shall not be of a general or typical nature, but shall be applicable and specific to this Contract.

J. Samples: Where a Contractor proposes a manufacturer, material, or method differing from that specified, the Engineer may require samples illustrative of the manufacturer, material or method. Submit such samples as part of the shop drawing requirements, and shall include samples of insulation, special finishes, etc.

K. Submittals shall be made in accordance with the General Conditions of the Contract and as otherwise required in the Contract Documents. In submitting shop drawings, illustrations and descriptive material for approval of the Engineer, the Contractor must clearly mark each shop drawing, catalog cut, pamphlet or specification sheet as follows, for purposes of identification and record:

1. Date: (as submitted)

2. Project Title:
3. Location of Project:
4. Branch of Work: (HVAC, Plumbing, Fire Protection, etc.)
5. Specification Paragraph & Page:
6. Submitted by: (Contractor Name)
7. Contract No.:

1.9 SUBSTITUTIONS

A. Product substitutions shall be in accordance with the General Conditions, Supplemental General Conditions, Division 01 and as specified.

B. The products, equipment, etc. scheduled on the Drawings or specified are the basis of design. Where more than one manufacturer is listed, the Contractor may use any of the acceptable manufacturers as the basis of their bids unless otherwise specified. However, the Contractor assumes all responsibility for changes to the design, installation, etc. as a result of the change, i.e.: power characteristics, physical size, etc.

C. Any request for substitution to other than the specified acceptable manufacturers must be submitted to the Engineer in writing and shall include an adequate description of proposed change, reason(s) for requesting change and cost adjustment information. Substitutions not submitted in this manner will be rejected automatically. Substitution requests will only be considered for the following reasons:
   1. Specified manufacturer(s) is no longer in business.
   2. Specified product(s) cannot be delivered within the required project schedule.
   3. Alternate product(s) is of equal quality, but better value with savings offered to the Owner.

1.10 PROJECT RECORD DOCUMENTS

A. Maintain Project Record Drawings during construction in accordance with General Conditions and as specified.

B. Provide Project Record Drawings at completion of project. Shop drawings are not acceptable as record drawings unless they have been revised to reflect all field changes. Tracing or reproduction of the Contract Documents shall not be acceptable.

C. Show the following information on the Project Record Drawings:
   1. All significant changes in plan, sections, elevations, and details, such as all relocation, or changes in ductwork and piping.
   2. All final locations of controls and final arrangement of electric circuits and any significant changes made in design as a result of change order or job conditions.
   3. Final location and arrangement of all mechanical equipment.

D. Provide AutoCAD Version 2017 or later files, or Revit models digitally or on flash drive of all Project Record Drawings.

1.11 OPERATING AND MAINTENANCE MANUALS

A. Submittals of operation and maintenance manuals shall be in accordance with General Conditions and as herein specified.

B. Prepare and deliver to the Engineer, 3 complete sets of operating and maintenance manuals for all equipment listed in the Equipment Schedules and when specified by the Section in which the equipment is furnished. Provide all information pertinent to the equipment for preventive maintenance and for replacement of all expendable components. Manuals shall refer only to the actual equipment provided. All reference to alternative equipment shall be deleted. All such literature shall be bound in 3 new standard 3-ring binders and shall be submitted to the Engineer, along with an electronic (PDF) version.

C. Include the items listed below and features as may be recommended by the manufacturers.
1. Catalog information of the unit installed.
2. Capacity and installation details.
3. Wiring diagrams of electrical components.
4. Special valves and control devices.
5. Complete list of parts with reordering numbers.
6. All points requiring lubrication, lubrication frequency and type of lubricant.
7. Operating pressure and temperatures.
8. Design pressures and temperatures.
9. Relief devices and settings.
10. Electrical characteristics of all motors.
11. Operating curves of pumps and fans.
12. Recommended spare parts list.
13. Warranty Information.

D. Prepare operating instructions, complete and explicit, including instructions for start-up, operating, and stopping. Underscore and emphasize critical points of operations and hazardous limit.

E. Items which also must be included are make-up air units, coils, filters, unit heaters, heating and HVAC components, fans, motors, pumps, temperature control systems with a description of the sequence control, vibration isolation, etc.

F. Include flow charts and wiring programs in the manuals indicating valve locations and control devices. Also include parts lists to be used for ordering replacement and repair parts.

G. Arrange information in an orderly manner in accordance with the numbering system used for the project specification. Include a table of contents for each manual.

H. Manual covers shall include the name of the project.

1.12 DELIVERY, STORAGE AND HANDLING

A. Refer to the General Conditions, Standard Specifications and as specified in each individual section.

1.13 WARRANTY

A. Except where otherwise specifically included in individual Sections, all mechanical systems shall be provided with the guarantees as follows.

B. Guarantee all mechanical systems, equipment, materials, and workmanship to be free from defect for a period of 1 year from the date of final acceptance of the Work. Replace or repair in

an approved manner any Work which may prove defective or not in compliance with the Contract Documents without additional cost to the Owner and without interference with the Owner's operation. There shall be a mandatory walk thru at 10 months to ensure all equipment/materials are performing as required.

C. Deliver to the Architect/Engineer 3 copies of all manufacturer's or equipment suppliers' warranties as part of the O&M manuals.

D. Make all adjustments required to ensure operation of the various systems in accordance with the intent of the Drawings and Specifications.

E. It is specifically understood that all adjustments to ensure the proper operation of the systems shall cover a period of 12 months following acceptance of the Work, and the Contractors and/or their suppliers shall make all such adjustments required during this period without delay and without additional cost to the Owner.

1.14 TESTING, ADJUSTING AND BALANCING

A. This contractor shall employ services of an independent firm to perform testing, adjusting and balancing.

B. The independent firm will perform services specified in related section.

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

D. Test Pressures: Lines shall be tested according to the following schedule:

Line	**Test Medium**	**Minimum Pressure**	**Minimum Time**	**Remarks**
Heating Water	Water	125 lb.	24 Hours	No Drop
Condensate	Water	125 lb.	24 Hours	No Drop
Chilled Water	Water	125 lb.	24 Hours	No Drop

1.15 OPERATING INSTRUCTIONS TO OWNER

A. Contractor shall furnish Architect/Engineer with a written statement from the Owner certifying acceptance of all the equipment, data and instructions of operation. Architect/Engineer will not approve the request for final payment until this certificate has been submitted.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPLIED BY CONTRACTOR

A. Contractor furnishing an item of equipment is responsible for the proper handling, setting, installation, start-up and initial operation.

B. If Contractor is unfamiliar with the proper start-up and adjustment procedure of any equipment or system furnished by him/her, he/she shall include the services of a qualified representative of the manufacturer or vendor to provide start-up assistance and for instruction of the Owner's personnel.

C. Contractor shall include all necessary allowances to ensure that all equipment and systems furnished will be serviced as required during the guarantee period.

D. When a manufacturer offers an extended warranty at additional cost, such extended warranty shall be included as alternate.

2.2 NOISE AND VIBRATION CONTROL

A. Contractor shall make provisions in the installation of the Work that noises or vibrations will not be transmitted through foundations, floors, walls, columns, ducts and piping, so as to be objectionable in any manner. All equipment provided shall be selected and installed with this in view. If any equipment exceeds reasonable requirements as to quietness of operation and freedom from vibration when operating under continuous maximum demands, it shall be altered or replaced.

B. Furnish and install vibration eliminators and isolation equipment for equipment, motors, and pumps, as indicated on the Drawings, and as specified in related section.

C. The isolation and vibration eliminator manufacturer and Contractor shall be responsible for the selection of the proper units for their loadings, quantities, and each shall guarantee that each and every installation and their application shall have a vibration efficiency of 95% or greater. As a minimum, provide types of vibration eliminators as indicated on the Drawings and specified in related section.

D. Submit shop drawings to the Architect/Engineer for review of all isolation equipment with dimensions and other data as recommended and prepared by the isolation equipment manufacturer.

2.3 GUARDS

A. All belts, pulleys, chains, gears, couplings, projecting set screws, key and other rotating parts shall be fully enclosed and properly guarded.

B. Guards shall be constructed of not less than 1-inch x 1-inch x 1/8-inch structural steel angles and 1/2-inch diamond mesh enclosure or equally suitable enclosure, all of hot-dipped galvanized fabrication.

C. Guards shall be secured to the driven machines or to foundations of floors by heavy galvanized structural angle supports and anchor bolts. Braces or supports secured to motors will not be permitted and braces and/or supports must not "bridge" the sound and vibration isolators.

D. Guards shall be designed with adequate provision for movement of motor required to adjust belt tension. Means shall also be provided to permit lubrication, use of speed counters and other maintenance and testing operation with guard in place.

2.4 MAINTENANCE MATERIALS, SERVICE AND SPARE PARTS

A. This contractor shall be responsible for continued maintenance of all equipment furnished under this contract. This contractor shall, at the time of Owner acceptance, provide the Facilities planning Office with a report detailing the following information:
   1. Dates equipment arrived at the job site.

2. Installation date.
3. Dates of maintenance at start-up and at periodic maintenance.
4. Dates of lubrication changes as applicable and specific name, manufacturer and type of lubrication.

B. Refer to the General Conditions and to the individual Sections for additional requirements.

PART 3 - EXECUTION

3.1 SAFETY PRECAUTIONS DURING INSTALLATION

A. Contractor shall take all measures to ensure safe installation of all Work and to prevent injury to persons or damage to property in compliance with OSHA and all applicable regulations.

B. Contractor shall erect whatever scaffolds, platforms, supports, or other required construction to safely protect his/her own workers and other persons at the site.

C. Such scaffolds, platforms, etc., shall be designed and constructed by Contractor who shall be solely responsible for their adequacy and safety. Engineer, Architect, the Owner, or User is not responsible for ascertaining the adequacy of any temporary structures used or erected by the Contractor.

3.2 INTERRUPTIONS AND TIE-INS

A. Any interruptions and tie-ins to existing systems that are necessary for installation of the new Work shall be performed and completed in coordination with the Owner's representatives. Provide 2 days written notice prior to any tie-in or connection to existing active systems. Any work requiring shut down of systems serving occupied areas shall occur during off hours, unless otherwise scheduled by mutual agreement.

3.3 MODIFICATIONS AND INTERFERENCES

A. Contractor shall carefully check and become familiar with the Architectural, Structural, Electrical and all Mechanical Drawings and Details and make note of all locations where walls, partitions, ceilings, and structural members are called for to be furred or closed-in.

B. Modifications to the arrangement of the piping and ductwork systems may be required to suit structural conditions, or to avoid interference with the Work of other trades. Contractor shall furnish all offsets, additional fittings, etc., as required to meet installation conditions whether detailed on the Drawings or not.

C. Any conflicting information in the Specifications or on the Drawings shall be called to the attention of the Architect/Engineer for clarification before proceeding with fabrication or erection of the parts affected.

3.4 COOPERATION OF CONTRACTORS

A. Each Contractor, in the event of separate contracts in laying out his/her work, shall cooperate with other Contractors on the work so as to avoid any interference with their work. If this is not done, the Architect/Engineer reserves the right to make such changes in the work as are

necessary to avoid interferences and such changes will not be considered as cause for additional compensation or extension of time for the Contractor.

3.5 WORK PRIORITY OVER OTHER TRADES

A. Work in cooperation with one another to fit piping and ductwork into structure as job conditions may demand. All final decisions as to right of way and run of pipe, ducts, to be made by the Architect/Engineer. In general, priority is to be arranged as follows:
   1. Recessed lighting fixtures.
   2. Sheet metal ductwork.
   3. Sprinkler heads and sprinkler water lines.
   4. Plumbing waste lines, downspouts and vents.
   5. Refrigeration lines.
   6. Plumbing water lines.
   7. Electrical conduit.

3.6 EQUIPMENT PADS

A. Provide four-inch minimum concrete housekeeping pads for all floor mounted equipment.

3.7 ARRANGEMENT AND ALIGNMENT

A. All equipment, ductwork, piping, etc. shall be arranged and aligned in accordance with the Drawings. Elevations, where given, must be held. Floor elevations, where given, are to high points of floor. Dimensions must be held as closely as possible. All dimensions are to be field-checked for accuracy before fabrication.

B. Install all equipment, ductwork, piping, etc. straight and direct as possible, generally forming right angles with, or running parallel with, walls or adjacent ductwork, piping, etc. All ductwork, piping, etc. shall be neatly spaced with risers and drops running plumb and true.

C. Run ductwork, piping, etc. in wall chases, shafts, hung ceilings, recesses, etc., where same are provided. Do not run in floor slab fill unless specifically so noted on Drawings. Ductwork, piping, etc. shall not be covered or closed until testing is completed.

D. Drawings, in general, are made to scale. All dimensions shall be checked in the field by the Contractor before final connections are fabricated.

E. Drawings are, in general, diagrammatic and the exact locations shall be determined by the Contractor from field measurements. The actual arrangement, when erected, shall follow the general locations shown on the Drawings as far as practicable. The installation shall be neat in appearance and convenient to operate.

F. Installations shall be coordinated with other Work to avoid blocking building openings, light fixtures, etc. and shall not interfere with access to valves or equipment. Equipment, ductwork, piping, etc. shall be installed to provide working clearance for operation and maintenance.

3.8 ALIGNMENT OF ROTATING EQUIPMENT

A. All pumps, fans, etc. or similar equipment directly connected to motors by means of flexible couplings must be perfectly aligned after installation by the use of a dial indicator and the Work of alignment must be performed by a craftsman skilled in the Work.

B. Belted equipment shall be aligned so that the grooves of the driver pulley are truly aligned with those of the driven sheave, and the belts must be in the proper tension, free from flutter. In multi-belt drives, all belts must be operated at the same plane. Flutter in any 1 belt will be cause to reject the entire set, as the original installation of belts must be in matched sets.

C. All equipment provided with high-capacity belt drives must be conveniently tagged and so identified for future servicing and replacement of belts.

D. Before any rotating equipment is put in operation for testing purposes, it shall be properly lubricated with lubricants recommended by the manufacturer, and they shall be further lubricated before the equipment is turned over to the Owner.

3.9 CLEARANCES

A. Install ductwork, piping, etc. to provide minimum clearance of at least one (1) inch between extreme projections of piping, flanges, fittings, valves, allowing for insulation, expansion, etc.

3.10 EXPANSION

A. Special attention shall be given to the installation of ductwork, piping, etc. which have an appreciable movement so that they will not hit other ducts, pipes, structural members, etc. under actual operating conditions.

B. Provide flexible connections or expansion compensators where ducts, pipes, etc. cross building expansion joints.

3.11 LOCATION OF VALVES AND PIPING COMPONENTS

A. System components which require observation, operation, or maintenance such as valves, gages, controls, strainers, dirt pockets, cleanouts, unions and flanges, etc., shall be located, whenever possible, so as to be readily accessible. They shall not be concealed in chases or above ceilings without provision for access. Valves which require frequent operation, or which may require emergency operation, and which are 10'-0" from normal working level, should be installed with appropriate provisions such as chain wheels or extension stems.

B. Install all valves with stems in either an upright (preferred) or horizontal position. Control valves shall be installed with top works upward unless specifically shown otherwise.

C. Globe valves should be installed to seat against the direction of flow.

D. Make provisions for draining all low points of all piping systems, whether indicated on the Drawings or not, using a globe or ball valve and iron pipe thread to hose thread adapter with cap. Drains shall not be less than 3/4 inch, subject to sizes indicated on Drawings.

3.12 DRAINAGE AND VENTING

A. Where ducts, pipes, etc. are purposely pitched for drainage or venting, an accurate grade shall be maintained. Lines shall be supported in such a manner as to prevent deflection sufficient to pocket the lines.

3.13 PIPE SIZE DESIGNATIONS

A. All pipe sizes referred to in these Sections should be interpreted as IPS (iron pipe size) unless specifically designated otherwise, such as "O.D." for tubing.

3.14 CUTTING AND PATCHING

A. All cutting, repairing, fitting, and refinishing of in-place construction required for the installation of the Work of a Section, shall be included as part of the Work of that section except as specifically shown on Drawings or hereinafter specified.

B. Work shall be performed by craftsmen skilled in their respective trades.

C. Match existing conditions in color, materials, and texture.

3.15 DUCTWORK PIPE AND EQUIPMENT IDENTIFICATION

A. Piping identification shall be as specified in related section. Equipment identification consistent with the markings on the equipment schedule shall be made following finished painting with paint or stencil letters or numerals as approved by the Architect/Engineer.

3.16 CLEANING - GENERAL AREA

A. Contractor shall assist in maintaining the premises in an orderly fashion at all times, providing continuous clean-up during the construction period. Contractor shall remove all cartons, containers, and crates as soon as the contents have been removed and shall also remove all debris caused by Work as soon as possible. Deposit all discarded materials in a suitable refuse container and prevent these materials from being scattered by the elements. All cartons and debris shall be removed from the premises and site at the sole expense of Contractor.

B. Contractor shall stack all construction materials associated with his/her Work in areas so as to avoid congestion and interference.

C. At the completion of the work, the Contractor shall clean all of his/her work and equipment free from dust and other foreign matter and shall leave the work in good housekeeping condition, in a manner acceptable to the Architect/Engineer.

3.17 WIRING DIAGRAMS

A. Contractors shall provide each piece of electrically connected, controlled, or operated equipment with specific wiring diagrams and instructions. Diagrams and instructions shall not be of a general or typical nature but applicable only to the specific job. The diagrams and instructions used to install the equipment shall be identical to that included in the "Operations and Maintenance Manuals".

3.18 SYSTEM START UP

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

B. Notify the Architect/Engineer 7 working days prior to start-up of each item.

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

D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer. Check ratings of overload relays for each starter.

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

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

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

H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.19 DEMONSTRATION AND INSTRUCTIONS

A. Provide the services of a competent supervisor or technician to instruct the Owner's personnel in the operation of each piece of equipment/systems installed as specified in the individual sections. Include not less than the time listed for each of the systems. Where required by the individual section of the specifications, provide the services of factory trained specialists to instruct the Owner's personnel in the operation of the equipment/system so specified.

B. Demonstrate operation and maintenance of products to Owner's personnel, 2 weeks prior to date of completion. Provide an over/outline of the purpose and operation of all equipment installed under this contract.

C. Demonstrate Project equipment and instruct in a classroom environment for up to 10 people, located at the project site and instructed by a qualified manufacturer's representative who is knowledgeable about the Project. Provide documents for all attendees.

D. For equipment or systems requiring seasonal operation, perform demonstration for other season within 6 months.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual in detail with the Owner’s personnel in detail to explain all aspects of operation and maintenance. Training shall include review of temperature control drawings and schematics.

F. Demonstrate start-up, operation, control, adjustment, normal & unoccupied operations, system trouble-shooting, step by step procedure for determining the source of problems on the system level, component trouble-shooting description of diagnostic procedures for determining the source of the problems on the component level, servicing & maintenance instructions of required procedures for weekly, monthly, and annual preventive checks and timely repairs, sources of spare parts and special tools, and shut-down of each item of equipment at agreed time at designated location.

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

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

I. Training shall include a question and answer period.

J. Training shall include special requirements of tenants for equipment's function.

K. Training shall include any special issues to maintain warranties.

L. Training shall include relevant health and safety issues and concerns, and special safety features.

M. Training shall include Integral Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

N. Training shall include Building Automation Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

O. Training shall include interaction with other systems, and operation during power outage and fire.

P. Training shall include common trouble shooting issues and methods, control system warnings and error messages including using the control system for diagnosis.

Q. Digitally record all instructional sessions and demonstrations. Provide two flash drives, labeled with all pertinent information to identify specific equipment or systems, and include in the O & M's.

3.20 LUBRICATION

A. During the commissioning process and prior to testing, all equipment shall be properly lubricated in accordance with the manufacturer's instructions. One set of tools necessary for lubrication shall be provided by this Contractor.

B. Except for small electrical motors which, under NEMA Standards, are equipped with lifetime lubrication, all bearings on large motors and mechanical equipment shall be equipped with lubrication fittings at all service points, accessibly located. Oil fill and drain line extensions shall be provided where necessary for convenient servicing of equipment.

3.21 TESTING

A. Testing all equipment/systems installed shall be the responsibility of the trade installing the Work under the supervision of an Engineer employed by the Contractor except as specified. The Owner shall employ services of an independent firm to perform testing, adjusting and balancing:
   1. The independent firm will perform services specified in related section.

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

B. Furnish all gauges, instruments, test equipment and personnel required for the tests. Adjust all equipment to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment producing noise that is abnormal, in the opinion of the Architect/Engineer, shall be repaired or removed and replaced with satisfactory equipment at no additional expense.

C. Operate the system and make all adjustments in control and equipment and complete necessary balancing to deliver not less than the air or fluid quantities shown on the Drawings for each equipment item.

3.22 TOOLS

A. On completion of the Work, the Contractor shall furnish and deliver to the Owner any special tools and instrumentation that may be required for the proper servicing or routine testing of any equipment furnished under this Contract.

END OF SECTION 23 0500

SECTION 23 0510

MECHANICAL DEMOLITION & SALVAGE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Removal of designated construction, equipment and fixtures as indicated on Drawings.

B. Provide demolition for all areas necessary to receive new work.

C. Refer to items as scheduled at end of Section.

1.2 RELATED SECTIONS

A. Division 01.

1.3 REGULATORY REQUIREMENTS

A. Conform to applicable code for demolition work, safety of structure, and dust control.

B. Obtain any required permits from the proper authorities.

C. Do not close or obstruct egress width to exits.

D. Do not disable or disrupt building fire or life safety systems without 3 day prior written notice to the Owner.

E. Notify the Owner, architect and engineer if any hazardous or contaminated materials are discovered.

1.4 SEQUENCING

A. Sequence work so that building services to occupied areas remain in operation with only brief outages.

1.5 SCHEDULING

A. Schedule work to the mutual satisfaction of all parties involved.

1.6 PRE-DEMOLITION CONFERENCE

A. Convene one week prior to commencing work under this section.

B. Review demolition procedures and coordination required with related work.

1.7 QUALITY ASSURANCE

A. Contractor with minimum 5 years documented experience.

PART 2 - PRODUCTS

A. See Division 01.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide, erect, and maintain temporary barriers as necessary to protect work to remain in place.

B. Protect existing materials that are not to be demolished.

C. Prevent movement of structure; provide required bracing and shoring.

D. Mark location of utilities.

3.2 DEMOLITION REQUIREMENTS

A. Conduct demolition necessary to receive new Work.

B. Conduct demolition to minimize interference with adjacent occupied building areas.

C. This Contractor to furnish new Work at no extra cost if items scheduled to be re-used after demolition is ruined by the process of demolition.

D. Cease operations immediately if structure appears to be in danger. Notify A/E. Do not resume operations until directed.

E. Maintain protected egress and access to the Work.

F. Unless otherwise noted, this Contractor is responsible for and is to include in his/her proposal the cost for any and all demolition necessary to receive the intended new Work. The Owner shall not be responsible after bidding for any extra costs for demolition of existing materials that must be removed in order that the new scope of work is properly installed.

3.3 DEMOLITION

A. Demolish in an orderly and careful manner. Protect existing supporting structural members and work to remain in place.

B. Coordinate demolition with existing mechanical and electrical utilities.

C. Except where noted otherwise, remove demolished materials from site to an acceptable recycler. Do not burn or bury materials on site.

D. Remove demolished materials from site as work progresses. Upon completion of work, leave areas in clean condition.

E. Remove temporary Work.

F. Demolish existing work to receive new Work.

3.4 SALVAGE

A. Where existing equipment, controllers, control devices, monitoring instruments, specialty insulations or other existing Mechanical or Controls items are indicated to be removed that may still hold value for the Owner, coordinate Owner's salvage requirement prior to demolition.

B. Where certain existing equipment is known to be desired by the Owner ahead of construction demolition activities, an attempt has been made to indicate this on the Construction Documents. However, not all equipment or control devices may be indicated and it is the Contractor's responsibility to hold a Pre-Demolition Conference with the Owner to determine what items are to be saved and what can be disposed of.

END OF SECTION 23 0510

SECTION 23 0514

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements; and Division 23 Section "General Mechanical Requirements."

1.2 DESCRIPTION OF WORK

A. Provide variable frequency drives (VFDs) as specified herein.

B. The VFD shall consist of a pulse-width-modulating (PWM) inverter for positive speed control for standard NEMA design B induction motors used in HVAC applications. The VFDs will be manufactured by ABB, Danfoss, Yaskawa, or Square D and shall be UL-listed.

1.3 SUBMITTALS

A. Shop Drawings: Fabrication drawings indicating materials of construction, unit configurations, dimensions, field connection details, support details and installation details.

B. Product Data
1. All product items specified.
2. Manufacturer's literature and cut sheets.
3. Wiring diagrams.
4. Weights.
5. Temperature/ambient requirements.
6. Noise and sound data.

C. Samples: Not required for A/E review.

D. Contract Close-Out Information
1. Operating and maintenance data.
2. Training video.
3. Warranties.

1.4 WARRANTY

A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory-certified service technician. Start-up services shall include checking for verification of proper operation and installation for the VFD, its option, its interface wiring to the building automation system, and programming of any critical frequency rejection points.

B. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts and labor.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. VFD systems shall be microprocessor-based and fully transistorized with a conservatively rated 3-phase, full-wave diode bridge input and a pwm sine-coded output waveform. The input diode bridge shall be protected against line noise by a total harmonic distortion below 35% fundamental drive current. This can be accomplished through reduced harmonic technology (RHT) or 5% line reactors. The output transistors must be of the insulated gate bipolar transistor (IGBT) type to facilitate noiseless motor operation. The VFDs shall be tested and rated for a minimum of a 20-year mean time between failure (MTBF). Provide manufacturer's typical test results or calculations with submittal to verify MTBF.

B. To minimize electrical and acoustical noise, and to eliminate low-speed cogging, a minimum switching frequency of 15 khz shall be used. The VFD shall not "cog" at frequencies above 1.5 hz. There shall be no sudden frequency shifts as the output frequency is varied between 1.5 and 60hz.

C. The VFDs input displacement power factor shall be 0.98 or better over the entire operating frequency and load range. Efficiency shall be measured at 96% minimum at rated load. Provide manufacturer's typical test results or calculations with submittal to verify efficiency and power factor.

D. All VFDs shall have, but shall not be limited to, the following protective features:
   1. Solid state output ground fault protection shall be provided.
   2. Adaptive electronics motor overload protection shall be provided which shall protect both the motor and the VFD at all frequencies. Electronic thermal overload circuits which only properly protect the motor at full speed shall not be acceptable. The VFD shall sense the load and speed and shall recalibrate the thermal trip curve to ensure low-speed motor protection. The initial trip point shall be adjustable from at least 40% of the VFD continuous rating to account for motor magnetizing current.
   3. Input surge protection shall be performed by MOVs (metal oxide varistors) in accordance with ANSI Specification C62.41.1 and C62.41.2.

E. Opto-coupled isolated control inputs shall be provided. The motor speed shall be directly proportional, or inversely proportional to 0-10 VDC, 4-20 ma, and variable resistance signals. In addition, the VFD shall have independent settings adjustable on the fly for input reference offset (positive and negative) and gain to facilitate signal setting/matching.

F. VFD operation options shall be programmable, and shall include, at a minimum, the following functions:
   1. User-definable speed upon lost reference signal. Drive to indicate fault upon lost signal.
   2. The standard protocol shall be BACnet. Each individual drive shall have the protocol in the base VFD. The use of third-party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
   3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all

analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected the ability to change the PID set point. The DDC system shall also be able to monitor if the motor is running in the VFD mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

4. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

G. The VFD shall provide the following operational features:
   1. "Speed search" transfer. The VFD shall have the ability to start from bypass or fault trip into a spinning load from 100% forward to 100% reverse rotation without stopping the motor or creating a fault condition. The VFD shall match the motor's speed and then drive the motor to its proper speed reference.
   2. Programmable current limit.
   3. Programmable, "intelligent" auto-restart function. Intelligent auto-restart precludes any attempt to restart in the event of trips typically indicative of component failure.
   4. Drive must have power loss ride-through capability, for units 5 HP and larger. In the event of a loss of three-phase power lasting 2 seconds or less, the VFD must have the ability to regain operation without nuisance trips.
   5. Critical Frequency Rejection Points: Drives shall be capable of programming up to 3 frequency rejection points to protect the driven equipment from continuous operation at harmful resonance frequencies.
   6. The following fault conditions shall cause the VFD to shut down without damage and shall be annunciated via alpha-numeric fault diagnostic (remote annunciation shall be available with a form 'c' fault contact):
      a. Overload (blow fuse any or all legs/loss of phase)
      b. Instantaneous over current trip (short circuit)
      c. DC bus overvoltage
      d. DC bus under voltage, phase loss protection
      e. Excessive ambient, VFD heat sink over temperature
      f. Ground fault input
      g. Internally diagnosed, control failure
      h. Motor thermal overload
      i. VFD thermal overload
      j. Programmable "shear pin" current trip

2.2 PROGRAMMING/OPERATOR STATION

A. Include alpha-numeric display of frequency reference, output frequency, output current (accurate +/-3%, regardless of output frequency), output voltage, DC bus voltage, output power (kW), input terminal status, output thermal status, LED lamp check, and EEPROM number.

B. Alpha-numeric display of faults. Up to 4 sequential faults shall be retained in non-volatile memory (maintained even after removal of input power). All system information (voltage

levels, current levels, etc.) shall be stored for the previous 3 seconds before the last fault in 160 nsec intervals to aid in diagnostics.

C. VFD systems located outdoors shall be mounted in a NEMA or UL Type 3R enclosure. VFD systems located in indoor wet/damp rooms or indoor rooms with water systems such as chiller or boiler rooms shall be mounted in a NEMA or UL Type 12 enclosure. VFD systems mounted in indoor dry rooms without water systems shall be mounted in a NEMA 1 enclosure. All enclosures shall be provided with the following additional equipment requirements:
   1. Door-mounted digital operator control station.
   2. Door-interlocked input circuit breaker with flange-mounted pad-lockable operating handle.
   3. Three (3) contactor bypass to fully isolate the VFD. The VFD must be able to be removed for testing purposes while the motor is operating in the bypass mode. Bypass systems shall included electronic bypass board with Bacnet integration, manual bypass systems are not acceptable.
   4. Output 3-phase current sensing overload relay to provide motor protection in either the VFD or bypass mode.

D. VFD systems shall be full load tested prior to shipment.

E. DV/DT – All VFDs operating a single motor with a wire distance of more than 300 feet are required to have a DV/DT filter. The DV/DT filter will limit the rated voltage rise over time to prevent the breakdown of motor winding insulation and reduce the motor operating temperature. The DV/DT filter can be mounted internally to the VFD enclosure or supplied externally in close proximity to the VFD. If supplied externally, the DV/DT filter shall be mounted in a NEMA enclosure matching the VFD NEMA enclosure type. The DV/DT filter shall be UL listed.

F. VFDs operating multiple motors shall be sized based on NEC values for connected FLA of all motors, not based on nominal VFD/motor horsepower.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed per manufacturer’s recommendations.

B. Label all control components to match the control and wiring diagrams.

C. All motors controlled with VFDs shall be provided with a shaft grounding system to electrically insulate bearings to prevent damage due to stay shaft currents.

END OF SECTION 23 0514

SECTION 23 0523

VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section includes valves for the following systems:
   1. Chilled Water.
   2. Condenser Water.
   3. Makeup Water

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data
   1. Manufacturer's cut sheets and/or literature.
   2. Performance Data

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
   2. Operating and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.
   4. ASME Boiler Code Specifications for Boiler Room Valves.

C. ASTM Compliance
   1. ASTM B62 for 125 psi and 150 psi saturated steam rated valve pressure containing parts.
   2. ASTM B61 for 200 psi and 300 psi valves with metallic seats.

D. Factory test all Valve Bodies, Shells and Seats per MSS requirements as a minimum.

E. Iron Body Valves
   1. Pressure-Containing Parts: ASTM A126, Grade B.
   2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
   3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71, 85.

F. Butterfly Valves
   1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

G. Valve Stems: ATM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

H. Valve-End Connections
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B 16.18.
   3. Threaded: With threads according to ASME B1.20.1.
   4. Grooved: With grooves according to Victaulic published dimensions.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Pressure Casting shall be free of impregnating materials, no welding of iron allowed.

K. Manufacturer's name or trademark and working pressure stamped or cast into body.

L. Valves shall be rated at least 20% over the maximum system working pressure and not less than required for system temperatures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Sizes shall be the same as upstream piping unless otherwise indicated.

B. Valve Bypass and Drain Connections: MSS SP-45.

C. Combination Balancing and Shutoff Valves.
   1. Install where shown on Drawings. Valves shall be designed and used only for balancing.
   2. Provide a means for connecting to a portable differential pressure meter for readout. A portable pressure gauge, hoses and flow curves shall be provided in a portable test kit.
   3. On sizes 2-1/2 inches and larger, valve size, capacity and operating pressure must comply with ASME boiler and pressure vessel code: section IV.
   4. Refer to manufacturer's recommendations for upstream and downstream straight piping lengths.

2.2 HVAC SYSTEMS (heating water, chilled water, condenser water, make-up water and cooling coil condensate drain) WITH OPERATING TEMPERATURES UP TO 200 DEG F.

A. Start/Stop Flow; 2 Inches and Smaller
   1. Type: 2-piece full port ball. Basis of Design NIBCO T/S-585-66-LF and or T/S-585HP-66_LF
   2. SWP Rating: 150 psig (1035 kPa).
   3. CWP Rating: 600 psig (4140 kPa).

4. Body Material: Bronze ASTM B 584 Alloy C844.
5. Seal Material: Reinforced PTFE.
6. Ends: Threaded or soldered for copper piping.
7. Ball Material: 316 stainless steel.
8. Stem Material: 316 stainless steel.
9. Operator: Hand lever.

B. Start/Stop Flow; 2-1/2 Inches and Larger
1. Type: Butterfly. Basis of Design NIBCO LD-2000-3/5
2. Minimum ANSI Class: 150 WOG.
3. Body Material: Ductile iron.
4. Seat Material: EPDM.
5. Ends: Full lug flange.
6. Disc Material: Aluminum bronze.
7. Stem Material: 416 stainless steel.
8. Operator: 10-position hand lever for less than 6 inches, gear actuator for 6 inches and larger.
9. Other: Valves and Seats shall be rated for 150 psi shutoff during dead-end service, without downstream piping or flange.
10. Option for grooved piping systems: 300 psi CWP suitable for bi-directional and dead-end service at full rated pressure. Body shall be grooved end ductile iron conforming to ASTM A536. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat.
    a. 2-1/2" through 12": Victaulic Style 300 MasterSeal™ or NIBCO GD-4765-N
    b. 14" through 24": Victaulic AGS Style W761 300 MasterSeal™.

C. Prevent Back Flow; 2 Inches and Smaller
1. Type: Check – Horizontal swing or vertical lift.
2. Minimum ANSI Class: 125 SWP (200 WOG). Basis of Design NIBCO T/S-413Y-LF or T/S-480-Y-LF
3. Body Material: Bronze (ASTM B 62).
4. Disc Material: Reinforced PTFE.
5. Ends: Threaded or Soldered for copper piping.
6. Cap: Threaded.

D. Prevent Back Flow; 2-1/2 Inches and Larger
1. Type: Swing check.
2. Minimum ANSI Class: 125 SWP (200 WOG).
3. Body Material: Cast iron (ASTM A 126).
4. Disc Material: Cast iron (ASTM A 126).
5. Seat Ring Material: Bronze (ASTM B 62).
6. Ends: Flanged.
7. Cap: Bolted.
8. Option for grooved piping systems: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi.
    a. 2-1/2" through 12": Victaulic Series 716 (Or Series 779 with Venturi taps).
    b. 14" through 24": Victaulic AGS Style W715.

E. Prevent Back Flow; 2-1/2 Inches and Larger

1. Type: Globe body silent check valve.
2. Minimum ANSI Class: 125 SWP.
3. Body Material: Cast iron (ASTM A 48, Class 35).
4. Disc Material: Cast iron with bronze face rings.
5. Ends: Flanged or wafer.
6. Seat Material: Bronze (ASTM B584).
7. Plug Material: Bronze (ASTM B584).
8. Spring Material: Stainless steel T304 (ASTM A 276).

F. Acceptable Manufacturers: Milwaukee, Hammond, Crane, NIBCO, DeZurik, Watts, Tyco, Victaulic or Mueller.

G. Regulate/Balance Flow; 2 Inches and Smaller
1. Type: Combination balancing and shutoff valve (calibrated Y-Pattern globe) Basis of Design NIBCO T/S-1810-LF.
2. Minimum Pressure: 240 psig.
3. Body Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
4. Ends: Flanged, threaded or soldered for copper piping.
5. Seat Seal Material: EPDM.
6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: 4-Turn hand wheel with hidden memory stop.
8. NOTE: Ball type valves not acceptable as balancing device.

H. Regulate/Balance Flow; 2-1/2 Inches and Larger
1. Type: Combination balancing and shutoff valve (venturi globe type). Basis of Design NIBCO F-721-A.
2. Minimum Pressure: 300 psi.
3. Body Material: Ductile iron.
4. Ends: Flanged, grooved or threaded.
5. Seat Seal Material: EPDM.
6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: Multi-turn handwheel with hidden memory stop.
8. NOTE: Butterfly type valves not acceptable as balancing device.

I. Acceptable Combination Balancing and Shutoff Valves are: Victaulic/Tour Andersson, Armstrong, ITT Bell & Gossett, Griswold, Taco or Flow Design.

PART 3 - EXECUTION

3.1 STORAGE, HANDLING, AND EXAMINATION

A. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

B. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

C. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

D. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

E. Examine threads on valve and mating pipe for form and cleanliness.

F. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

G. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves at locations shown on the Drawings, per the Specifications and in accordance with manufacturer's written instructions.

B. Locate valves for easy access and provide separate support where necessary.

C. Service/isolation valve shall be provided at every piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown and minimal disruption to the piping service.

D. Install Combination Balancing and Shutoff Valves at each branch connection to return main.

E. Install Start/Stop flow valve for isolation at each branch connection to supply main.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. All check valves should be installed in a location that has smooth and laminar flow conditions.

H. For swing type check valves, locate valve a minimum of 10 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 5 pipe diameters downstream of valve.

I. For silent type check valves, locate valve a minimum of 4 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 3 pipe diameters downstream of valve.

J. Install valves in horizontal piping with the hand wheel and stem at or above center of pipe.

K. Install valves in position to allow full stem movement.

L. Valves installed in copper lines shall be provided with screwed or flanged adapters with a union installed downstream and within 12 inches of the valve.

M. Install chainwheels on operators for all valves located with the lowest portion of its handwheel or lever at 10 feet or more above finished floor. Extend chains to 5 feet above finished floor.

N. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

O. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 23 0523

SECTION 23 0529

HANGERS, SLEEVES, AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to: Pipe hanger and supports, Pipe and equipment anchors and Pipe sleeves.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.4 SUBMITTALS

A. Shop Drawings: Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members, Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Operating and maintenance data, Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers: Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Concrete Anchors: Phillips, Hilti, and Powers.

C. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

D. Pipe and Equipment Anchors: Shop-fabricated, Field-fabricated.

E. Sleeves: Shamrock Industries, "Crete-sleeve" plastic hole forms, Proset Systems Inc., "Proset" fire-safe pipe penetrations, Shop for field fabricated.

F. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc.

2.2 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Cadmium plated carbon steel, adjustable swivel split ring. Use PVC coated or copper plated for copper piping.

B. Hangers for Pipe Sizes 2 to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Carbon steel, adjustable, clevis type. Use copper plated for copper piping.

C. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.

D. Hangers for piping that gets insulated shall be sized to allow insulation to be continuous through hangers.

E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for hot pipe sizes 6 inches and over.

F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

G. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 6 inches and over.

H. Vertical Support: Steel riser clamp.

I. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

J. Shield for Insulation Piping 16 gage galvanized steel shield over minimum 12 inches long at pipe support. 360-degree insulated saddle system consisting of a factory assembled 2.5 PCF density 25/50 Flame/Smoke rated phenolic foam pipe insulation with .02 perm rated vapor retender film with self-sealing lap. Buckaroos model 255OFS or equal.

2.3 HANGER RODS AND ATTACHMENTS

A. Steel Hanger Rods: Threaded both ends, threaded one end, and continuous threaded. Use cadmium plated rods where unconcealed or exposed to the elements.

B. Minimum pipe hanger rod sizes are as follows:

Pipe Size	Rod Diameter
Up to 2 Inches	3/8 Inch
2-1/2 Inches & 3 Inches	1/2 Inch
4 Inches	5/8 Inch
6 Inches	3/4 Inch
8 Inches to 12 Inches	7/8 Inch
14 Inches to 18 Inches	1 Inch
20 Inches to 30 Inches	1-1/4 Inch

C. Beam Clamps (up to 8-inch diameter pipe): Top beam clamp, steel jaw, hook rod with nut and spring washer steel eye-bolt. C-clamps by themselves are expressly prohibited unless otherwise approved by Structural Engineer

2.4 INSERTS

A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 PIPE SLEEVES AND SEALANTS

A. Sleeves – General: Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:
1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping
1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.
4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
   a. Insulated chilled water and DX lines: Type CS-CW.
   b. Other insulated pipes: Type CS.
3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes
1. Length: Ends flush with finished surfaces.
2. Diameter
   a. Minimum 3 inch.
   b. Minimum 1 inch larger than pipe and pipe insulation.
   c. In concrete, 1-1/2 inch larger than pipe.
   d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.
1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity. Provide proper material for each typical application as described by manufacturer.
2. Acceptable Manufacturers: Dow Corning "Fire Stop", Nelson "Flameseal", 3M "Fire Barrier", Pipe Shields Inc., Model WFB, DFB, or QDFB Series, Proset Systems.
3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations
1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E. Permission from A/E will only be provided when required due to construction schedule timing issues. If permission from A/E is provided, Powers BANG-IT concrete insert or approved equal shall be used.
5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser

drops, heavy equipment, specialties, and each piping change of direction. At first elbow of equipment run out piping risers and horizontal piping within 10 feet of all circulating base mounted pumps having 4-inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Steel Liquid	Steel Vapor	Copper Liquid	Copper Vapor
1/2 - 1 inch	7 ft.	8 ft.	5 ft.	6 ft.
1-1/4 - 2 inch	7 ft.	9 ft.	7 ft.	9 ft.
2-1/2 - 3 inch	11 ft.	12 ft.	9 ft.	12 ft.
3-1/2 - 4 inch	12 ft.	12 ft.	11 ft.	12 ft.
5 - 6 inch	12 ft.	12 ft.	12 ft.	12 ft.
8 - 30 inch	12 ft.	12 ft.	12 ft.	12 ft.

B. For Schedule 40 or Schedule 80 PVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

Schedule 40 or 80 PVC		
Pipe Diameter	Liquid	Vapor
1/2 - 1 inch	3 Ft.	3 Ft.
1-1/4 - 2 inch	3 Ft.	3 Ft.

Schedule 40 or 80 PVC		
Pipe Diameter	Liquid	Vapor
2-1/2 - 3 inch	6 Ft.	6 Ft.
3-1/2 - 4 inch	7 Ft.	7 Ft.
5 - 6 inch	8 Ft.	8 Ft.
8 - 14 inch	12 Ft.	12 Ft.

C. Provide a hanger within 1 foot or less of each horizontal elbow and valves that are above 3 inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than 6 feet, provide only 1 hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For piping of other materials, space hangers according to manufacturer's recommendations.

E. Pipe Hanger Loading
1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

F. Trapeze Hangers: Suspend trapeze hangers from concrete inserts of approved structural clips. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

G. Vertical Pipe Supports: Support all vertical pipe runs in pipe chases at base of riser. Support pipes for lateral movement with clamps or brackets.

H. Concrete Inserts: Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required. Provide concrete inserts in time for installation in concrete.

3.3 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors: Provide as indicated and required to permit complete installation of system. Do not anchor piping to plaster or gypsum wallboard partition walls. Provide anchoring devices at locations indicated. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.4 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.5 MISCELLANEOUS STEEL

A. Piping Contractor (or Heating Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel. Repair galvanized steel at field cuts and connections.

END OF SECTION 23 0529

SECTION 23 0548

VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 23 Section “Hangers, Sleeves, and Supports” for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems
1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

1.4 SUBMITTALS

A. Shop Drawings
1. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
2. Special details necessary to convey complete understanding of the work to be performed.

B. Product Data
1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
   a. The equipment identification mark.
   b. The isolator type.
   c. The actual load.
   d. The static deflection expected under the actual load.
   e. Specified minimum static deflection.

f. The additional deflection to solid under actual load.
g. The ratio of spring height under actual load to spring diameter.

3. Spring Isolators
   a. Spring diameter.
   b. Deflection.
   c. Compressed spring height.
   d. Solid spring height.
   e. Point location of each isolator.
   f. Load at each point.
   g. Field static deflection.
   h. Horizontal loading and bolt requirements.
   i. Indicate all bases and rail clearances.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Fans and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	**Vibration Displacement (MILS Peak-to-Peak)**
Under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
Over 2000 rpm	1

C. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices
1. Amber/Booth Co.
2. Mason Industries, Inc.

3. Kinetics Noise Control.
4. The VMC Group.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.
1. Acoustical sealant D.A.P.
2. BR-96 Pecora.
3. Acoustical sealant Tremco.
4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.
1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, and welded concrete pouring forms from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:
1. All steel parts to be hot-dip galvanized.
2. All bolts to be cadmium-plated.
3. All springs to be cadmium-plated and neoprene-coated.

D. Coordinate the requirements of this Section with those of Division 23 Section “Seismic Restraint”.

E. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

F. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

G. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

H. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators
1. Type 1 Isolators: Double-deflection neoprene mountings.
a. Minimum static deflection: 0.35 inch.
b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
c. Friction pads both top and bottom to eliminate the need for bolting.
d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.
e. Mason Industries, Type ND; or Vibration Mountings & Controls, Type RD.

2. Type 2 Isolators: Spring-type.
   a. Free-standing and laterally stable, without any housings, snubbers, or guides.
   b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.
   c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
   d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
   e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
   f. Mason Industries, Type SLF.
3. Type 3 Isolators: Spring-type with vertical limit stop.
   a. Equal to Type 2 isolator, except mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.
   b. Installed and operating heights to be the same.
   c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.
   d. Limit stops to be out of contact during normal operations.
   e. Mason Industries, Type SLR.
4. Type 4 Isolators: Neoprene wafer pads.
   a. Durometer or hardness to suit application.
   b. Square waffle pattern on 1/2-inch centers.
   c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
   d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
   e. Provide type "W" adhesive, both sides, for all non-bolted applications.
   f. Mason Industries, Type "W", "WMW", "WML", or "WM".

B. Vibration Hangers
1. Type 5 Isolators: Steel spring-type hanger.
   a. Steel spring and 0.3-inch deflection neoprene element in series.
   b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
   c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
   d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
   e. Mason Industries, Type 30N.
2. Type 6 Isolators: Precompressed steel spring-type hanger.
   a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.
   b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
   c. Mason Industries, Type PC30N.
3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.
   a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
   b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
   c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.

d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.
f. Mason Industries, Type W30.

4. Type 8 Isolators: Double-deflection neoprene-type hanger.
   a. Minimum static deflection: 0.40 inch
   b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
   c. Provide hanger for direct attachment to flat iron duct straps.
   d. Mason Industries, Type WHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.
1. Rectangular, except for equipment which may require "T" or "L"-shaped.
2. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.
3. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.
4. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.
5. Mason Industries, Type WF.

B. Type B: Steel rail.
1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
2. Members must be sufficiently rigid to prevent strains in the equipment.
3. Mason Industries, Type ICS.

C. Type C: Structural steel and concrete base.
1. Rectangular structural beam or channel concrete forms for floating foundations.
2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.
5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2 inch above bottom, or additional steel as is required by structural conditions.
6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.
8. Mason Industries, Type K (Type BMK).

D. Type D: Curb-mounted base.
1. Factory-assembled isolation base that fits over roof curb and under the isolated equipment.
2. Provide extruded aluminum top member to overlap bottom member to provide water run-off independent of the seal.

3. Provide cadmium-plated springs with a 1-inch minimum deflection with 50% additional travel to solid.
4. Spring Diameter: Not less than 0.8 of spring height at rated load.
5. Provide resilient snubbers in corners with minimum clearance of 1/4-inch for wind resistance.
6. Provide a weather seal of continuous closed-cell sponge material both above and below base and a waterproof flexible ductlike EPDM connection.
7. Foam or other contact seals are not acceptable at spring cavity closure.
8. Mason Industries, Type CMAB.

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.
   1. Construction: 4 inch thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
   2. Glass Fiber Pads
      a. Inorganic inert material with loading capacity up to 500 psig.
      b. Covered with an elastomeric coating to increase vibration dampening and to protect media.
   3. Concrete Caps
      a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.
      b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12-inch o.c. each way.
   4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.
   1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.
   2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.
   3. Make isolation bases 1 foot larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.
   4. Make isolation bases minimum 1’-2” thick with top of pad 4 inches above finished floor slab.
   5. Reinforce isolation bases as indicated in specifications and drawings.
   6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4-inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:
1. Mason Industries, Type ADA.
2. Peabody Noise Control, Type RGN.
3. Vibration Mounting & Controls, Type MDPA.
4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector
1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.
5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
7. If control rods are used, they must have 1/2-inch-thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.
1. Stainless steel braid and carbon steel fittings.
2. Sizes 3-Inch and Larger: Flanged.
3. Sizes 2-1/2-Inch and Less: Male nipples.

4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

2.9 FLEXIBLE DUCT CONNECTIONS

A. Flexible duct connections shall be UL/FM-approved, fabricated from coated fabric (or loaded vinyl as called for on the drawings). The clear space between connected parts shall be a minimum of 3 inch and the connection shall have 1.5 inch minimum of slack material. Connections shall be suitable for not less than 10-inch w.c. operating static pressure.

PART 3 - EXECUTION

3.1 APPLICATION

A. General
1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.
   a. Minimum static deflections may be revised subject to prior approval.
   b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.
      1) Provide revised vibration control equipment to match revised or substituted equipment.
3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
   a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.
   b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
   c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
   d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
   e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
   f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
   g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.
   h. No pipes or equipment are to be supported from other pipes or equipment.
   i. Resiliently isolated pipes are not to contact the building construction or other equipment.

j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

B. Major Equipment
1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.
2. Flexible duct connections are to be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the Drawing.
3. Flexible pipe connections are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Resilient Pipe Hangers and Supports
1. Isolation hangers shall be used for all piping in equipment rooms and up to 50 feet from vibrating equipment. To avoid reducing the effectiveness of equipment isolators, at least the first three hangers from the equipment shall provide the same deflection as the equipment isolators, with a maximum limitation of 2-inch deflection; the remaining hangers shall be spring or combination spring and rubber with 0.75-inch deflection. The first two hangers adjacent to the equipment shall be the precompressed type, to prevent load transfer to the equipment flanges when the piping system is filled.
2. Floor-supported piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators. The first two adjacent floor supports shall be the restrained spring type, with a blocking feature that prevents load transfer to equipment flanges as the piping is filled or drained. Where pipe is subjected to large thermal movement, a slide plate (PTFE, graphite, or steel) shall be installed on top of the isolator, and a thermal barrier shall be used when rubber producers are installed directly beneath steam or hot water lines.
3. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral guides.
4. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
5. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently isolated.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Utility fans, 5 hp or less.
2. Air compressors, 3 hp or less.
3. Minimum static deflections, 0.35 inch.

B. Use Type 2 isolators for equipment mounted on all floors.
1. Utility fans, 7-1/2 hp and larger.
2. All SWSI and DWDI blowers.
3. All vane axial type fans.
4. All packaged air handling units.
5. Minimum static deflections, 0.75 inch.

C. Use Type 2 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 15 hp and larger.

2. All pumps, 30 hp and larger.
3. Reciprocating chillers, 25 tons and less.
4. Screw-type chillers, 50 tons and less.
5. Minimum static deflections, 1.5 inch.

D. Use Type 3 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Reciprocating chillers, 30 tons and larger.
2. Screw-type chillers, 60 tons and larger.
3. All centrifugal chillers.
4. All absorption chillers.
5. All indoor mounted fluid coolers or condensers (closed circuit cooling towers).
6. All boilers.
7. Minimum static deflections, 1.5 inch.

E. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.
1. Air compressors.
2. Chillers.
3. Fluid coolers.
4. Boilers.
5. Utility fans, 5 hp or less.
6. Minimum static deflections, 0.3 inch.

F. Use Type 5 vibration hangers for suspended equipment.
1. Individual runs of piping, 3-inch and smaller.
2. In-line fans, 3 hp and smaller.
3. In-line pumps, 2 hp and smaller.
4. Fan coil units, 1 hp and smaller.
5. Minimum static deflections, 0.3 inch.

G. Use Type 6 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs of piping, 4 inch through 6 inch.
3. Inline fans, 5 hp through 7-1/2 hp.
4. Inline pumps, 3 hp through 5 hp.
5. Fan coil units, 1-1/2 hp and larger.
6. Minimum static deflection, 1.5 inch.

H. Use Type 6 or Type 7 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs or piping, 8 inch and larger.
3. In-line fans, 10 hp and larger.
4. In-line pumps, 7-1/2 hp and larger.
5. Package air handling units.
6. Minimum static deflection, 2.5 inch.

I. Use Type 8 vibration hangers for suspended equipment.
1. In-line fans 1/2 hp or smaller.
2. Fan coil units 1/2 hp or smaller.
3. Utility fans 1/2 hp or smaller.
4. Minimum static deflection, 0.40 inch.

3.3 BASES AND RAILS

A. Use Type A integral structural steel bases for equipment mounted on floors other than grade-supported floor slabs.
   1. Package air handling unit fan cabinets, 15 hp and larger.
   2. SWSI and DWDI blowers, 5 hp through 15 hp.
   3. Utility fans, 7-1/2 hp through 10 hp.

B. Use Type B structural rails for equipment mounted on floors other than grade supported floor slabs.
   1. Package air handling unit fan cabinets, 10 hp and smaller.
   2. Indoor mounted fluid coolers.
   3. Reciprocating chillers, 25 tons and smaller.
   4. Screw-type chillers, 50 tons and smaller.

C. Use Type C concrete platforms for equipment mounted on floors other than grade supported floor slabs.
   1. Air compressors, 15 hp and larger.
   2. All base-mounted pumps, 30 hp and larger.

D. Use Type C concrete platforms for equipment mounted on all floors.
   1. SWSI and DWDI blowers, 20 hp and larger.
   2. Utility fans, 15 hp and larger.

E. Use Type D curb mounted isolation system for equipment mounted on roofs.
   1. Rooftop units, 50 tons and larger.
   2. Roof-mounted air handling units, 50 tons and larger.
   3. Cooling towers, 100 tons and larger.
   4. Condensing units, 25 tons and larger.
   5. Fluid coolers, 100 tons and larger.
   6. Utility fans, 7-1/2 hp and larger.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on floors other than grade-supported floor slabs.
   1. Air compressors, 5 hp through 10 hp.
   2. All base-mounted pumps, 25 hp and less.

B. Use Type IP2 isolation pads for equipment mounted on grade.
   1. Boilers.
   2. Chillers.
   3. Deareators.
   4. Indoor mounted fluid coolers.
   5. Incinerators.
   6. Pump groups where one pad serves two or more pumps.
   7. Flue gas economizers supported from the floor.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.

1. Pump Suction and Discharge
   a. Exception: When three or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.
2. Chiller Inlet and Outlet
   a. Exception: When three or more mechanical grooved pipe (Victaulic type) couplings are used at each chiller evaporator and condenser outlet and inlet.
3. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.
1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.
1. Indicate specific applications on shop drawings.

3.6 FLEXIBLE DUCT CONNECTIONS

A. Sheet metal ducts or plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. The fan unit or adjacent duct section shall be able to move 1 inch in any direction without causing metal-to-metal contact or stretching taut the flexible connection.

3.7 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be vibration isolation hanger.

B. First three floor-mounted pipe supports shall rest on Type 3 isolators.

C. If piping is connected to equipment located in basements and hangs from structure under occupied spaces, the first three hangers shall have 0.75-inch deflection for pipe sizes up to and including 3 inch; 1.5-inch deflection for pipe sizes up to and including 6 inch; and 2.5-inch deflection thereafter.

D. Locate hanger as close to overhead supports as is practical.

END OF SECTION 23 0548

SECTION 23 0593

MECHANICAL SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
1. Chilled water system.
2. Instrumentation and control system.

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF HEATING CONTRACTOR’S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

C. Maintain accessibility to test locations and devices requiring adjustment.

D. Add dampers required for correct air balance as recommended by the Air Balance Agency.

E. Provide additional sets of pulleys and belts as recommended by the Air Balance Agency.

F. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Mechanical Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Construction Manager (CM)/ Owner
   1. If balancing is not preformed during peak cooling season, demonstrate satisfactory balancing during next peak cooling season.
   2. If balancing is not preformed during peak heating season, demonstrate satisfactory balancing during next peak heating season.

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the CM/Owner may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data.
         2) All equipment nameplate information.
         3) All traverse readings.
         4) Line sketch/diagram indicating location of traverses.
         5) Static pressure profiles.
         6) AABC equipment data sheets.
         7) Fan and pump curves.
         8) Temperature readings (all air and water streams)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.

1. If requested, conduct tests of instruments in presence of CM/Owner.

B. If requested, conduct balancing tests in presence of CM/Owner.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 WATER BALANCE PROCEDURE - PHASE ONE

A. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.

B. Check operation of all relief valves.

C. Examine water in system and determine if water has been treated and cleaned.

D. Checks pump rotation.

E. Check expansion tanks to determine they are not air-bound.

F. Check for installation and proper operation of air valves.

G. Set temperature controls for all coils at maximum cooling. Check for full closure of all automatic bypass valves at coil and chiller.

H. Check operation of any automatic bypass valves.

3.3 WATER BALANCE PROCEDURE - PHASE TWO

A. Ensure start-up strainers have been removed.

B. Set pumps to specified gallons per minute delivery.

C. Adjust water flow of chilled water to supply main.

D. Check chilled water entering temperatures and return water temperatures at mains. Reset to correct design temperatures.

3.4 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours' duration each for heating and cooling systems to demonstrate to satisfaction of the CM/Owner that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 23 0593

SECTION 23 0700

HVAC INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. Section Includes
1. Pipe Insulation.
2. Equipment Insulation.
3. Insulation Adhesive.
4. Insulation Sealant.
5. Insulation Mastic.
6. Insulation Jacketing.

1.3 QUALITY ASSURANCE

A. All testing and ratings shall meet the standards set in ASTM E-84, NFPA 255, and UL 723.

B. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50. Outdoor insulation shall have a flame-spread rating not exceeding 75 and a smoke developed rating not exceeding 150.

C. Insulation accessories shall have the same or better ratings as the insulation product they serve.

D. Insulation values shall be in accordance with the State Energy Codes.

E. Maximum insulation temperature limits must exceed maximum fluid working temperatures.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with flame and smoke ratings, and maximum use temperature.

B. Protection: Leave insulation boxed and stored until time for use. Elevate and cover material to avoid moisture, dust, and physical abuse.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields with ductwork and piping installer.

B. Coordinate clearance requirements with piping installer for piping insulation application and ductwork installer for duct insulation application, and equipment installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and

maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fiberglass Insulation: Owens-Corning, Knauf, CertainTeed, Johns Manville, and Manson.

B. Closed-cell Insulation: Aeroflex, Armacell, and K-flex.

C. Adhesive: Foster, Johns Manville, and 3M.

D. Sealant: Foster, Boss Products, and Dow Chemical.

E. Mastic: Foster.

F. Aluminum Jacketing: Ideal Products, Pabco, and RPR Inc.

G. PVC Jacketing: Proto, and Johns Manville.

2.2 GENERAL

A. Products shall not contain asbestos, lead, mercury, or mercury compounds and be HCFC free.

B. Use of water-soluble treatments is prohibited.

2.3 TYPES OF INSULATION

A. Type 1: Fiberglass heavy-density insulation with all service jacket and pressure sealing lap adhesive on longitudinal and butt strips. Jacket vapor membrane shall have an installed vapor permeance of not more than 0.09 perms. Staple and seal with pressure-sealing lap adhesive on longitudinal and butt strips. Thermal conductivity (k-value) not greater than 0.23 at mean temperature of 75 deg F.

B. Type 2: Flexible closed cell elastomeric thermal pipe insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

C. Type 3: NOT USED.

D. Type 4: Semirigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 3.0 pcf density with thermal conductivity (k-value) not greater than 0.23 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

E. Type 5: Rigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 6.0 pcf density with thermal conductivity (k-value) not greater than 0.22 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

F. Type 6: Flexible closed cell elastomeric thermal sheet insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

G. TYPES OF JACKETING

H. Type 1: PVC jacket. 0.030-inch-thick ultraviolet-resistant PVC jacket. Jacket is to be self-extinguishing and have zero fuel contribution.

I. Type 2: Aluminum jacket. 0.016-inch-thick aluminum jacket with "Pittsburgh Seam." Seal between metal jacket and sleeve.

J. Type 3: Rubberized bitumen membrane. 0.060 inch thick. Designed with a cross laminated high strength polyethylene laminated to raw aluminum. This film is then laminated to rubberized bitumen compound with a release liner. Self-healing if punctured, UV stable, and will expand and contract with the mechanical system. "Alumaguard" / "Alumaguard Lite" as manufactured by Polyguard. Install a layer of "Alumaguard" on the top & sides of duct and "Alumaguard Lite" on the bottom. For cold weather installations the "Alumaguard LT" as manufactured by Polyguard, can be used. Install per manufacturer's instructions.

2.4 FITTINGS AND VALVES

A. Premolded PVC covers over molded insulation. Insulation same thickness as on adjoining pipe. Insulation shall have a flame-spread rating not exceeding 25 and a smoke-developed rating not exceeding 50.

2.5 SCHEDULE OF INSULATION

System Type	Fluid Temperature Range (F)	Insulation Type	Insulation Thickness					
			1" and smaller	1" to 1-1/4"	1-1/2" to 3"	4" to 6"	8" and larger	Duct or Equip.
Hydronic Piping								
Condenser Water (*A)	60 – 100	1	0.5	0.5	1.0	1.0	1.0	N/A
Chilled Water	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Make-up Water	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Refrigerant	Below 40	1 or 2	0.5	1.0	1.0	1.5	1.5	N/A
Equipment								
Chilled Water Pumps	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Chilled Water Tanks	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Chilled Water Heat Exchangers	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Chilled Water Air Separators	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Note: For piping exposed to outdoor temperatures, increase thickness by 0.5 inches.								
*A: Only piping in non-air-conditioned areas (Including: Shafts, Ceiling space with roof above, and Attics) or ductwork/Piping exposed to outdoor temperatures.								

2.6 EXPOSED INDOOR PIPING LESS THAN 10 FEET ABOVE NEAREST WALKING SURFACE

A. Cover piping insulation with Type 1 or Type 2 Jacketing.

2.7 OUTDOOR PIPING

A. Cover piping insulation with Type 2 Jacketing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Verify that systems and equipment to be insulated have been tested and are free of defects.

C. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in schedule of insulation.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Apply insulation with duct and pipe surfaces at room temperature.

M. Make insulation continuous except through fire-rated walls/floors. Do not leave gaps in insulation at sleeves, hangers, anchors, supports, etc.

N. Insulate all fittings, valve bodies, flanges, and other pipe accessories.

O. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 3 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

S. For insulation at hangers and bracing, see Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”

3.4 EQUIPMENT INSULATION INSTALLATION

A. Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
   d. Do not overcompress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt

each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe

insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 PIPING CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.7 PIPING FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

END OF SECTION 23 0700

SECTION 23 2113

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, and joining methods, for the following systems:
   1. Chilled Water piping.
   2. Condenser Water piping.
   3. Makeup Water piping.

1.2 SUBMITTALS

A. Provide coordination drawings per Division 23 Section “General Mechanical Requirements”.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops. In addition indicate the following:
   1. Indicate pipe sizes, elevations, clearances, etc.
   2. Indicate all equipment, transitions, and fittings to scale.
   3. Provide equipment connection details and piping support details.
   4. Drawings shall be fully coordinated with the work of all other Trades.
   5. Contractor shall not fabricate or install piping or equipment without approved Shop Drawings.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

D. Grooved mechanical piping systems shall be installed according to grooved manufacturer’s installation instructions. All grooved piping products shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as grooved components.

PART 2 - PRODUCTS

2.1 PIPING

A. For piping 4 inches and smaller: Schedule 40 black steel pipe, furnace-butt welded, continuous welded (ASTM A53, Type F) or Drawn-Temper Copper Tubing (ASTM B 88, Type L).

B. For piping 5 inches and larger: Schedule 40 black steel pipe, electric-resistance welded (ASTM A53, Type E, Grade B).

2.2 PIPE FITTINGS

A. For Piping 2 Inches and Smaller
   1. Steel Pipe:
      a. Welded Wrought-Steel Fittings (ASTM A234).
      b. Cast-Iron Threaded Fittings, Class 125 (ASME B16.4).
      c. Malleable-Iron Threaded Fittings, Class 150 (ASME B16.3).

   2. Copper:
      a. Welded or Soldered Wrought-Copper (ASME B16.22)

B. For Piping Larger Than 2 Inches
   1. Steel Pipe:
      a. Welded Wrought-Steel Fittings (ASTM A234)
      b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings, minimum Class 150 rating (ASME B16.5)
      c. Elbows shall be long radius having a centerline radius of 1.5 pipe diameters.

   2. Copper:
      a. Soldered Wrought-Copper (ASME B16.22)
      b. Elbows shall be long radius having a centerline radius of 1.5 pipe diameters.

C. Grooved Mechanical-Joint Fittings and Couplings
   1. Contractors with minimum of 5 installed grooved mechanical-joint systems may use grooved mechanical joint fittings and couplings on roll grooved standard weight Schedule 40 piping 2 inches to 60 inches.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic grooved mechanical-joint fittings and couplings. If another manufacturer is used with a manufacturer's torque requirement, the contractor shall create a log of the measured torque at every mechanical joint.
   3. Grooved End Fittings: Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall, or fabricated from Std Wt Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633. (Fittings 14" and larger shall be supplied with Victaulic factory AGS grooved ends). For piping larger than 2 inches, elbows shall be long radius having a centerline radius of 1.5 pipe diameters.

4. Couplings 2” through 12”: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000.
    a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9 and NFPA 13.
        1) Victaulic Style 107N QuickVic®. Installation ready rigid coupling for direct stab installation, without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.
    b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
        1) Victaulic Style 177 QuickVic®. Installation ready flexible coupling for direct stab installation, without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.
5. Couplings 14” through 60”: Couplings shall consist of two ASTM A-536 ductile iron housing segments with wedge shaped AGS key profile and lead in chamfer.
    a. Rigid Type: Victaulic Style AGS W07. Coupling key designed to fill wedge shaped AGS groove. Gasket shall be Grade “E” EPDM with green color code designed for operating temperatures from -30 Deg F to +230 Deg F.
    b. Flexible Type: Victaulic Style AGS W77. Coupling key designed to fill wedge shaped AGS groove and allow for linear and angular movement, vibration attenuation, and stress relief. Gasket shall be Grade “E” EPDM with green color code designed for operating temperatures from -30 Deg F to +230 Deg F.
6. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness.
7. Victaulic prefabricated pump drop assemblies, which include check valves, butterfly valves, strainers, suction diffusers, flexible couplings (style 177 or W77), and grooved pipe, may be used in lieu of individual components. Victaulic Series 380, 381, 382.
8. Vic-Headers: Victaulic prefabricated factory-fabricated grooved end header [manifold] all-in-one assembly for fluid distribution. Header shall consist of an ASTM A53, Grade B, standard weight pipe spool with required outlet connections. Grooved ends roll grooved to Victaulic [OGS] [AGS] dimensions, with enamel coating or galvanized to project requirements.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
    1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
        a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
        b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals (Pipes 2 inches and less): ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals (Pipes greater than 2 inches): AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated without major deviations. Major deviations shall be approved by the A/E on Coordination Drawings prior to installation.

B. Coordinate the exact location of this work, with the work of other trades prior to fabrication or installation and verify all dimensions and elevations. Provide additional offsets and sections of piping as may be required to meet the applicable job conditions. Coordinate with and review all related drawings of all trades prior to start of work.

C. Main piping shall be run horizontal with no slope. Branch piping shall pitch down back to main piping, uniformly a minimum of one inch in 60 feet.

D. Provide trapped cooling coil condensation piping from outlets of drain pans of all cooling coils. Pitch all cooling coil condensation piping down a minimum of 1 inch in 30 feet in the direction of flow. Install insect screen at outdoor terminations.

E. Minimum pipe size shall be 3/4 inch unless noted otherwise.

F. Provide eccentric fittings and/or eccentric reducing couplings in all cases where air or water pockets would otherwise occur in the main due to reduction in pipe size. Eccentric fittings shall keep the pipes flush on top for water piping and flush on the bottom for condensate or drain piping.

G. Do not run piping over or within 3 feet of electrical switchgear, panels, or similar equipment.

H. No piping shall pass through walls at an angle of other than 90 degrees.

I. No pipe, piping fittings, or coverings shall in any way extend partly into any plastered wall or ceiling.

J. Install piping concealed in walls, ceilings, webs of columns, or furring where possible, unless otherwise approved by the A/E and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

M. No piping shall be installed in a manner that will interfere with doorways, door and window operation, ventilation equipment, ductwork, lighting and outlets or other equipment, nor prevent proper vibration isolation or service of equipment or components.

N. Install all piping in locations and elevations such that coils, tubes, and filters can be removed and replaced without major piping removal.

O. Install piping to permit valve servicing.

P. Install piping to allow application of insulation.

Q. Install groups of pipes parallel to each other (where applicable).

R. If a hole is required after the structure is cast, its location and size shall be approved by the A/E and structural engineer. Core-drill the hole. Maintain the fire integrity of the structure.

S. All fittings shall be far enough away from plastered surfaces to allow space for installation of escutcheons. Escutcheons must not extend over any irregular parts of the walls, with all voids between piping materials and construction being properly filled in an approved manner. Provide nickel-plated steel escutcheons on all exposed pipes passing through walls, ceiling, floors, and partitions.

T. Provide unions or flanges of suitable temperature and pressure rating between all dissimilar metals including where copper tubing or components are connected to steel or cast iron piping or components. Unions on copper tubing shall be solder-type, copper-to-copper, up to and including 2-inch pipe size, and flanged 150-pound brass companion flanges for 2-1/2-inch pipe size and above.

U. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

V. Install flange or grooved coupling in piping, 2-1/2 inch and larger, at final connections to valves, apparatus, and equipment and elsewhere as indicated.

W. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration producing equipment. Option: Three flexible grooved couplings in lieu of each connector.

X. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. The use of nipples welded directly into piping for branch take-offs will not be permitted.

Y. Install expansion loops, expansion joints, anchors, and pipe alignment guides as indicated on drawings.

Z. Install drains, consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

AA. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

3.2 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook".

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Align threads at point of assembly.
2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
3. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
4. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Align flanges surfaces parallel with gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

I. Grooved Joints: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Install piping in accordance with latest installation instructions. Verify gasket is suitable for intended service. Factory trained representative (direct employee of grooved manufacturer) shall provide on-site training for contractor’s field personnel.

3.3 SLEEVES

A. Provide sleeves wherever pipes pass through building construction. Anchor all sleeves to building construction. Size sleeves to permit passage of insulation where insulation is required. Maintain the fire integrity of walls, floors, ceilings, and partitions.

B. Where pipes pass through foundation walls or footings, provide cast iron sleeve and caulk the space between sleeve and pipe with lead wool, watertight.

C. Install sleeves in floors perfectly plumb and sleeves in walls level. Center the pipe in the sleeve. Pack sleeves with fire rated materials, per shop drawings, approved submittals, and caulk in tight.

D. Set sleeves in walls, floor, and foundations during the construction.

E. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings and floors, maintain the fire-rated integrity.

3.4 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 125 psi for a length of 6 hours. No pressure drop shall occur over this duration. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the hydronic system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   5. Set temperature controls so all coils are calling for full flow.
   6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   7. Verify lubrication of motors and bearings.

3.5 CLEANING

A. At completion of project, thoroughly flush each of the various HVAC hydronic circulating systems with a cleaning solution as recommended by the chemical supplier so as to remove any oil, rust, dirt, scale, or grease that may be present.

B. Utilize water treatment provider's instructions to clean system. Drain and rinse systems completely with clean water, and clean all screens and strainers.

C. After cleaning is complete, drain system and rinse with fresh water. The chemical supplier shall test and check drain water for pH level and condition.

D. Submit report to the Engineer on condition and finalized method of chemical treatment recommended by the chemical supplier and utilized for this project.

E. If drain water indicates an acid level, neutralize the system with an alkaline-type material as recommended by the chemical supplier and reflush entire system.

END OF SECTION 23 2113

SECTION 23 2116

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
1. Thermometer wells and test gage connections.
2. Thermometers and pressure gages.
3. Combination pressure and temperature test stations.
4. Flexible Connectors
5. Air vents.
6. Strainers.
7. Unions.
8. Drains.

1.3 QUALITY ASSURANCE

A. All specialties to be ASME-labeled for ratings specified

B. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

C. Grooved end specialties shall be of the same manufacturer as the adjoining couplings.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data
1. Manufacturer's cut sheets and/or literature.
2. Performance data.

C. Grooved joint specialties shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Close-Out Information
1. Operating and maintenance data.
2. Warranty.

1.5 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position specialties for equipment clearance and accessibility and operational conditions.

B. Specialty manufacturer shall verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data shall take precedence over indicated figure or model number.

PART 2 - PRODUCTS

2.1 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Temperature Sensing Walls
1. Brass or stainless steel.
2. Provide extension necks for insulated piping.
3. Provide test thermometer well adjacent to each point where a temperature-sensing device is required by control specifications and where piping schematics indicate thermometers.

2.2 THERMOMETERS

A. Weiss Model DVU35 digital self-powered, glass passivated thermistor, internal potentiometer with 6-inch stem. Thermometer wells to be brass or stainless steel, 2-inch extension in insulated piping. Provided threaded cap nut and cap. Or approved equal by Ashcroft or Trerice.

B. Thermometers Range Schedule

	Range (deg F)
Chilled Water	0-100

2.3 PRESSURE GAGES

A. General
1. 4-1/2-inch dial, surface or flush-type, white face, black numerals, black pointers, bronze bourbon tubes and shatterproof glass.
2. Pressure Gage Range Schedule

	Range PSIG	Fig Interval PSIG	Inter Gradations PSIG
Chilled Water	0 - 100	5	1

3. Waterlines: Ashcroft 1010 with 1092 gage cock and 1106 pulsation dampeners.

B. Pump Suction and Discharge Gages: Liquid filled, indicating range 0-100 psig.
1. Provide pressure snubbers for all pump and chiller pressure gauges.

2.4 COMBINATION PRESSURE AND TEMPERATURE TEST STATIONS

A. Pressure/Temperature Test Station, Combination
1. "Pete's Plug," to receive either a temperature or pressure probe 1/8-inch o.d.

2. Fitting: Solid brass, 1/4-inch MPT, with two valve cores of neoprene (maximum 200 deg F at 500 psi) or Nordel (maximum 275 deg F at 500 psi).
3. Provide long length (XL) at all locations with pipe insulation.
4. Provide with color-coded and marked cap with gasket, rated at 1000 psi at 140 deg F.
5. Provide at locations shown on equipment and piping schematic drawings.

B. Pressure Gage Adapter
1. 1/8-inch o.d. probe and 5-inch stem pocket testing thermometers each.
2. Provide two 25-125 deg F for chilled water.
3. Provide two 0-220 deg F for hot water.

C. Pressure and Temperature Test Kit
1. 0-100 psi, 0-230 ft. w.g. gage with a No. 500 gage adapter thermometer.
2. 0-200 deg F pocket testing thermometer.
3. No. 500 gage adapter.
4. Protective carrying case.

2.5 FLEXIBLE CONNECTORS

A. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

B. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

C. Option: Flexible couplings may be used in lieu of flex connectors. Three couplings for each connector shall be placed in close proximity to the source of vibration. Victaulic S/177 flexible couplings. See Section 23 21 13.

2.6 AIR VENTS

A. Air Vents - Manual
1. Vent Valves: 1/4-inch 125 psi globe angle valve with XH nipple connecting to pipe.

B. Air Vents - Automatic
1. 150 psi rated, minimum.
2. Maximum working Pressure: 100 psig
3. Maximum Temperature: 220 deg F
4. Cast iron body with renewable valve and seat.
5. Synthetic rubber disc.
6. Armstrong AAE-750.

2.7 STRAINERS

A. General: Provide full line size strainers ahead of all water control valves, pressure regulating valves, suction side of pumps, and as indicated.

B. Hydronic Strainers

1. Y, T or basket-type, screwed, grooved or flanged.
2. 2 inches and smaller, brass body, screwed ends.
3. 2-1/2 inches and larger:
   a. Cast iron body, flanged ends.
   b. Ductile iron body, grooved ends.
4. Work Pressure, Non-Shock: 300 psig cwp.
5. Screens: Bronze, monel or stainless steel.
6. 2 inches and less: 3/64-inch perforations.
7. 2-1/2 inches and 3 inches: 1/16-inch perforations.
8. 4 inches and larger: 8-inch perforations.

2.8 UNIONS

A. Unions: Of same type, pressure rating and material as piping.

B. Flanges: Raised face type of same type, pressure rating and material as piping.

C. Unions in Copper Pipe
1. 2 Inches and Smaller: Use wrought copper solder joint copper to copper unions.
2. 2-1/2 Inches and Larger: Use brass flange unions.

D. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

E. Dielectric Unions or Waterway Fittings: Standard products for prevention of galvanic corrosion.

2.9 DRAINS

A. Drains: 3/4-inch ball valve or as indicated on the Drawings.

B. Drains from Safety Valve
1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap except where valve drains are required.

D. Drains Pipe to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

2.10 ACCEPTABLE MANUFACTURERS

A. Thermometers
1. Marsh Instrument Co.
2. Ashcroft.
3. Dwyer.
4. Marshalltown Instrument Inc.
5. Palmer Instruments.

6. Taylor Scientific Instruments.
7. Miljoco.
8. Weiss Instruments.
9. Weksler Instruments Corp.
10. Weston and Ernst.
11. Trerice.

B. Pressure Gages
1. Ashcroft.
2. Dwyer.
3. Marsh Instrument Co.
4. Miljoco.
5. US Gauge/Ametek.
6. Weiss Instruments.
7. Weksler Instruments Corp.
8. Weston and Ernst.
9. Trerice.

C. Pressure/Temperature Test Station (Pete's Plug)
1. Peterson Equipment Company, Inc.
2. Flow Design.
3. Sisco.

D. Flexible Connectors
1. Minnesota Flexible Corp.
2. Mason Industries.
3. Twin City Hose.
4. Pipe Solutions LTD.
5. Metraflex.
6. Flexicraft Industries.
7. Southeastern Hose Co.
8. Victaulic

E. Manual Air Vents
1. Crane.
2. Jenkins.
3. Johnston Corp.
4. OIC.
5. Powell.
6. Stockham.
7. Walworth.

F. Automatic Air Vents
1. Armstrong.
2. Spirax Sarco Inc.
3. Hoffman.
4. Bell & Gossett.
5. Thrush.
6. Taco.
7. Fisher.
8. Johnston Corp.

G. Hydronic Water Strainers
   1. O.C. Keckley Co.
   2. Armstrong.
   3. Mueller Steam Specialty.
   4. Tate Temco, Inc.
   5. Victaulic.

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties according to manufacturer's instructions and as specified.

3.2 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Provide test thermometer well adjacent to each point where a temperature sensing device is required by control specifications and where piping schematics indicate thermometers.

3.3 THERMOMETERS

A. Where temperature control requires a temperature transmitter, a thermometer will not be required in same location unless specifically required in equipment specifications.

B. Where two or more pumps are headered, provide one thermometer in suction header and one in discharge header.

3.4 PRESSURE GAGES

A. Install filter-type pressure snubbers at pumps and chillers.

B. Install brass tee-handle cock and 1/4-inch hard tempered tubing from gage to pipe connection.

C. Install additional brass tee-handle cock at gage for panel mounted gage.

D. Calibrate and zero all gages at job site.

3.5 AIR VENTS

A. Air Vents - Manual
   1. Vents shall prevent any part of system from being air-bound.
   2. Pipe discharge of vent to a location where air and water may be collected in a bucket.
   3. Provide at all trapped high points of cooling and heating piping systems, whether or not indicated.

B. Air Vents - Automatic
   1. Provide shut-off valve ahead of vent.
   2. Provide copper relief line from valve to drain or drip pan.
   3. Provide at each high point in closed water systems and coil headers in air handling units.

3.6 STRAINERS

A. Y-Type Strainers: Same size as piping served. Connections to suit piping.

B. Strainers 6 Inches and Larger: Provide 1-1/2-inch blow-down valve and pipe to floor drain.

C. Strainers 5 Inches and Less: Provide 3/4-inch blow-down valve with hose end connection.

D. Install strainers ahead of all automatic valves, regulating valves and pumps.

3.7 UNIONS

A. Install unions as directed by Fluid Controls Institute, Inc. (FCI).
   1. Make connections between couplings and flanged equipment with slip-on flanges.

B. Flanged Connections
   1. Where flanged valves are used at equipment connections, flange unions will not be required.
   2. Make connections to flanged valves and equipment using ANSI welding neck or slip on type welding flanges.
   3. Flanged cast iron ells may be used for connections between pumps, strainers, check valves, and other flanged equipment.

C. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

D. Install dielectric unions or Waterway fittings at each piping joint and equipment connection between ferrous and non-ferrous materials

3.8 DRAINS

A. Provide drain valves to drain all piping systems and drain safety valves.
   1. For Draining Low Points of Piping: Minimum 6-inch nipple, with ball valve.
   2. On Piping 2-1/2 Inches and Larger: Ball valve with hose adapter.
   3. On Piping 2 Inches and Smaller: Ball valve.

B. Drains from Safety Valves
   1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
   2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap, except where valve drains are required.

D. Drains Piped to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

END OF SECTION 23 2116

SECTION 23 2123

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Work Includes
1. Furnish all labor, materials, tools, equipment, and services for HVAC pumps, as indicated, in accordance with provisions of Contract Documents.
2. Completely coordinate with work of all other trades.
3. Although such work is not specifically indicated, provide all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Description of Systems
1. Double-suction pumps.

1.3 QUALITY ASSURANCE

A. Standards
1. Hydraulic Institute Standards
2. Hydraulic Institute Engineering Data Handbook.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment item specified.

B. Product Data
1. Pump curves.
2. Performance data.
3. Manufacturer's cut sheets and literature.
4. Materials of construction.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Parts list.
3. Guarantee.

PART 2 - PRODUCTS

2.1 GENERAL

A. Acceptable Manufacturers
   1. Double-Suction Pumps
      a. Grundfos.
      b. Armstrong.
      c. Bell & Gossett.
      d. Peerless
      e. Taco, Inc.
   2. Flexible Pump Couplings
      a. Dodge "Para-Flex".
      b. Wood's "Sure-Flex".

B. Pumps and drives shall be made by same manufacturer.

2.2 DOUBLE-SUCTION PUMPS

A. Pumps, Cooling and Condenser Water: Centrifugal, single-stage, double-suction, horizontal-mounted, split-case, with electric motor drive.
   1. Capacity: As scheduled.
   2. Deliver required head and gpm at 1,750 rpm, with shut-off head not more than 25% over rated head.
   3. Motor Coupling: Flexible-type.
   4. Mount motor and pump on common base. Motor to be premium efficiency with shaft grounding rings.

B. Casing: Horizontal split-type.
   1. Design casing of cast or ductile iron for 150 psi static pressure.
   2. Casting faces accurately machined and dowelled for bolting together.
   3. Provide 125 psi flanges on suction and discharge openings.
   4. Rotating element removable without disturbing pipe connections by removing half casing and bearing caps.

C. Pump Impeller: Bronze or brass, enclosed double-suction-type, radial flow design balanced both mechanically and hydraulically.
   1. Press impeller upon shaft over key to lock shaft sleeves in place.
   2. Provide axial adjustment by means of shaft sleeve locking nuts.
   3. Pump Impeller Diameter: Less than 85% of the "cut water" diameter.

D. Pump Wearing Rings
   1. Casing: Cast iron with streamlined water guiding surfaces.
   2. Impeller: Bronze.
   3. Provide clearances on wearing rings sufficient to prevent mating parts from touching under static deflection of impeller and shaft.

E. Pump Shaft: High-grade carbon steel, machined and accurately ground to size to ensure low working stresses under all normal conditions imposed by driver.
   1. Protect against corrosion and abrasive action of liquid by means of stainless steel shaft sleeves held in place by lock nuts.
   2. Make shaft long enough to permit flexible couplings to be disconnected.
   3. Design shaft so that, in starting and stopping, it will not pass through critical speed range.

4. Make it rigid enough to meet requirements of wearing rings.

F. Pump Bearings: Ball or roller bearings of deep groove or tapered type, sized to withstand all axial and radial loads imposed upon pump shaft.
1. Bearing Housings: Cartridge-type, designed so that entire rotating element may be removed from pump without disturbing alignment or exposing bearings to contaminants.
2. Position housings by means of dowel pins in pump casing and securely clamp in place by covers fit on horizontal plans.

G. Pump Seals: Mechanical, ceramic on carbon or hardened metal alloys on carbon.
1. Working Pressure: 150 psi
2. Provide one extra seal per pump, with gaskets for replacement.

H. Pump Base: Cast iron or steel, all-welded construction with intermediate ribs, closure plates and other reinforcing to provide rigid frame.
1. Provide with raised lip for water drainage and threaded drain tapping.
2. Provide holes for grouting.
3. Provide drain pipe to floor drain.

I. Pump Couplings, Flexible: Dodge Para-Flex.
1. Taper-lock bushings keyed to shaft.
2. 18 ga. sheet metal coupling guard.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all pumps according to manufacturer's recommendations and as specified.

END OF SECTION 23 2123

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DIVISION 26 – ELECTRICAL

SECTION 260501 - GENERAL PROVISIONS - ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special, and Supplementary Conditions, and Divisions 00 and 01 Specification Sections, apply to this Section.

B. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

C. Each Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect his part of the work.

1.2 SUMMARY

A. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating Electrical Systems indicated on the drawings and/or specified herein.

B. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

C. It is not the intent of this Section of the Specifications to make any Contractor, other than the General Contractor, Prime Contractor, Construction Manager responsible to the Owner. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Construction Manager to the to the Engineer. Also, this Section of the Specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

D. This section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the Prime Contract.

E. It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.

F. In general, and to the extent possible, all work shall be accomplished without interruption of the existing facilities' operations. Each Contractor shall advise the Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will occur. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule

of interruptions can be developed. Contractor will not be entitled to additional compensation due to work stoppage mandated by unscheduled interruption.

G. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work. The Contractor shall abide by the requirements of the Special Conditions and the Owner's outage request program.

H. Required Notices: Ten days prior to the submission of a proposal, each proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system.

I. Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

J. In each of the specifications and drawings referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.3 DEFINITIONS AND ABBREVIATIONS

A. Prime Contractor - The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.

B. Contractor - Any Contractor whether bidding, proposing or working independently or under the supervision of a General Contractor, Prime Contractor, Construction Manager and who installs any type of Electrical Work as specified in the Contract Documents.

C. Electrical Contractor - Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

D. Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.

E. Engineer - The Consulting Mechanical-Electrical Engineer either consulting to the Owner, or Other, etc. In this case: CMTA, Inc., Consulting Engineers.

F. Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Manager's Assignments, Construction Contract with Owner, etc.

G. Bidder/Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

H. The Project - All of the work required under this Contract.

I. Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

J. Provide - Furnish and install complete, tested and ready for operation.

K. Install - Install equipment furnished by others in complete working order.

L. Indicated - Listed in the Specifications, shown on the Plans or Addenda thereto.

M. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.

N. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.

O. Start-up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to functional testing.

P. Vendor: Supplier of equipment.

Q. Typical or Typ- Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

R. Abbreviations:

1. ADA - Americans with Disabilities Act.
2. AFF – Above Finished Floor
3. AFG – Above Finished Grade
4. AIC – Amps Interrupting Capacity
5. ANSI - American National Standards Institute.
6. ASA – American Standards Association.
7. ASTM – American Society for Testing Materials.
8. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.
9. BAS – Building Automation System.
10. BICSI – Building Industry Consulting Services International
11. CM – Construction Manager
12. EC – Electrical Contractor
13. EM - Emergency
14. FCC – United States Federal Communications Commission
15. FLA – Full Load Amps
16. GC – General Contractor
17. IECC – International Energy Conservation Code
18. IEEE – Institute of Electrical and Electronics Engineers.
19. IESNA – Illuminating Engineering Society of North America
20. ISO – International Standards Organization.
21. LRA – Locked Rotor Amps
22. MC – Mechanical Contractor
23. MCA – Minimum Circuit Ampacity
24. MOCP – Maximum Overcurrent Protection
25. NEC – National Electrical Code (NFPA 70).
26. NECA – Standards for Installation.
27. NEMA - National Electrical Manufacturers Association.
28. NESC – National Electrical Safety Code.
29. NFPA - National Fire Protection Association.
30. NRTL: Nationally Recognized Testing Laboratory
31. N/A – Not Applicable
32. OBC – Ohio Building Code
33. OSHA - Office of Safety and Health Administration.
34. PC – Plumbing Contractor
35. SPD: Surge Protection Device
36. TIA – Telecommunications Industry Association
37. RFI – Request for Information
38. RIO – Rough-in Only
39. UL - Underwriters Laboratories, Inc.
40. UON – Unless otherwise noted.

1.4 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

1.5 INTENT AND INTERPRETATION

A. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete, tested and ready for operation."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

C. It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc. as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.

D. All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer’s installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer’s installation requirements whether specifically detailed or not within the Plans and Specifications.

E. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

F. The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.

G. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten (10) days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.6 ELECTRICAL DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Contractor, bidder, proposer or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all

instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. This Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.

F. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such an event, neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Electrical drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

I. The Electrical Contractor and his Sub-Contractors shall review all drawings in detail as they may relate to his work (structural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten (10) days prior to bids, for issuance of clarification by written addendum.

J. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

K. Special Note: Always check ceiling heights indicated on Drawings and Schedules and insure that these heights may be maintained after all mechanical and electrical equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions.

1.7 EXAMINATION OF SITE AND CONDITIONS

A. Each Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.

B. Each Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten (10) days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

C. The Electrical Contractor is required to provide coordination drawings, data and collaboration for all aspects of his work in accordance with the general and special conditions – Divisions 20, 21, 22, 23, 25, 26, 27 and 28 and the Construction Manager's procedures.

1.8 EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility.

B. References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of Paragraph 5.1 immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten (10) days prior to bid date for approval to bid in written form through addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the engineers.

D. Each Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

1.9 SINGLE SOURCE RESPONSIBILITY AND OBSOLETE EQUIPMENT

A. Except where specifically noted otherwise, all equipment supplied by the Contractor shall be the standard products of a single manufacturer of known reputation and experience in the industry. Only equipment, components and accessories in current production for at least five (5) years beyond the completion date of this system shall be used and installed. Any equipment found to be obsolete or not in future production will be removed and replaced at Contractor's expense. This includes all equipment, materials and labor.

1.10 CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

C. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.

D. All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.

E. All material and equipment for the electrical systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.

F. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.

G. The Contractor shall insure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

1.11 SUPERVISION OF WORK

A. Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act for him in matters related to the project.

1.12 COST BREAKDOWNS AND PAY APPLICATION

A. Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted. Refer to Division 0 and 1 specification sections for additional requirements.

B. In addition to cost breakdowns by specification section, the following shall also be provided: Material and labor shall be listed separately. These items are in addition to items listed in front-end specifications. Pay special attention to required withholding percentages for startup, testing, documentation, acceptance, owner training, etc. The breakdown shall be minimally as follows:

1. Permitting
2. Mobilization
3. Electrical Shop Drawings/Submittals
4. Electrical Coordination Drawings
5. Temporary Power
6. Interior Lighting Materials & Labor
7. Lighting Controls Materials & Labor
8. Electrical Distribution (Switchgear) Materials & Labor
9. Feeders Materials & Labor
10. Branch Circuiting Materials & Labor
11. Electrical Devices Materials & Labor
12. Low-Voltage Data/Voice Cabling Materials & Labor
13. Low-voltage Data/Voice Equipment Materials & Labor
14. Spare lamps and ballasts
15. Electrical Distribution Equipment Startup, Testing, & Verification (shall equal 2.5% of Equipment Value)
16. Lighting and Lighting Controls Startup, Testing, & Verification (shall equal 2.5% of Equipment Value)
17. Low Voltage Systems Startup, Testing, & Verification (shall equal 5% of Equipment Value)
18. Owner Training & Acceptance
19. Punchlist

20. As-Built/Record Drawings & Acceptance
21. O&M Manuals & Acceptance
22. Warranty
23. Demobilization

1.13 GUARANTEES AND WARRANTIES

A. Each Contractor shall unconditionally guarantee all equipment, apparatus, materials, and workmanship entering into this Contract to be the best of its respective kind and shall replace all parts at his own expense, which fail or are deemed defective within one year from final acceptance of the work by the Engineer. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Engineer and Owner's Statement of Substantial Completion.

B. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

C. The Warranties specified in this and other Articles shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. All light fixtures shall have a five (5) year unconditional warranty (Parts, Labor and Travel)

E. All generators shall have a five (5) year unconditional warranty (Parts, Labor and Travel)

F. Provide all warranty certificates to Owner. All warranties begin starting at the substantial completion date, submit warranty certificates accordingly.

1.14 INSPECTION, APPROVALS AND TESTS

A. Before requesting a final review of the installation from the Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Engineers for unnecessary and undue work on their part.

B. Owner's and Engineer's inspections: Two (2) inspections will be held to generate and then review punchlist items. All site inspections and visits thereafter shall be billed to the Contractor at the Engineer's standard hourly rates.

C. The Contractor shall provide as a part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.

D. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

E. Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Engineer and the Contractor within three days of the inspection.

F. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Engineer, whose decision is binding.

G. Before final acceptance, the Contractor shall furnish three (3) copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one (1) copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

H. The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

1.15 CHANGES IN ELECTRICAL WORK

A. REFER TO GENERAL AND SPECIAL CONDITIONS.

1.16 CLAIMS FOR EXTRA COST

A. REFER TO GENERAL AND SPECIAL CONDITIONS.

1.17 COORDINATION DRAWINGS

A. Detailed electronic coordination drawings shall be required for this project. A specific line-item shall be included on the schedule of values by each Trade for "preparation of coordination drawings". This line-item value shall be approved by the Engineer. The Engineer and the Engineer's Field Inspector shall closely monitor progress and quality of the preparation of the electronic coordination drawings and may withhold pay requests as deemed appropriate.

B. Coordination Drawings shall be provided on this project by each Trade (Mechanical, Fire Protection, Electrical). Drawings shall be 30x42 sheet size and shall be at ¼" scale. Drawings shall be prepared in electronic format utilizing AutoCad software. The Engineer will supply electronic drawings files of the Contract Documents upon the Contractor's request and release.

C. The basis for the Coordination Drawings shall be the sheet metal ductwork fabrication shop drawings, all electrical feeder conduits and other conduits 2" and larger, and pneumatic tube system piping and components in ceiling spaces. The Coordination Drawings shall be prepared by the Mechanical Contractor. The Coordination Drawings shall indicate (1) systems above ceilings in finished areas, (2) systems supported from the structure in finished areas without ceilings, (3) systems in the mechanical rooms, and (4) all wall, roof, floor penetrations. These drawings shall indicate all ductwork as double lined with bottom elevations noted.

D. The sheet metal fabrication shop drawings shall be completed in a timely manner so as not to conflict with construction schedule and phasing plan. At the Construction Manager's discretion, these drawings shall be completed in phases to correspond with the project construction work sequencing. The Mechanical Contractor shall furnish an electronic copy of these ductwork shop drawings to all other Trades, specifically the Fire Protection and Electrical and other Contractors as requested by the Construction Manager for the purpose of including other trades work on the Coordination Drawings.

E. Pre-Coordination Meetings with all necessary trades shall occur. During these meetings, the Contractors shall discuss locations/elevations where piping, conduits, cable path, etc. will be installed with respect to the sheet metal fabrication drawings and other trades. The sheet metal ductwork and gravity piping systems shall be given the first priority. Within 30 days of the meeting, each Trade shall provide the Mechanical Contractor electronic drawings of all of their systems (with elevation noted), coordinated with the ductwork and other trades for them to incorporate into the Coordination Drawings. Coordination Meetings shall then occur so that all conflicts can be resolved between Trades. All conflicts shall be resolved between all Trades at these Coordination Meetings and the Mechanical Contractor shall then amend the Drawings to include the Final Coordinated Work.

F. It is realized that not all systems can be completely detailed. The coordination drawings shall include the following at a minimum:

1. All supply/return/exhaust ductwork.
2. All above slab sanitary and roof drainage piping.

3. HVAC, fire protection and domestic water piping which are 2” in size and greater, excluding insulation.
4. Medical gas mains.
5. Electrical conduits which are 1.5” in size and greater.
6. J-hook and cable tray cabling paths
7. Multiple smaller piping/conduits hung on a common hanger.
8. All wall, roof, floor penetrations.
9. Light fixtures.

G. After completion of the Final Coordination Drawings, a Final Review with the all Trades shall occur to provide any final comments and approval by all Trades. Other interim coordination meeting will be required to ensure successful coordination drawings. Any additional coordination items will be updated by the Mechanical Contractor. The Final Approved Coordination Drawings shall be distributed electronically (on CD) to each Trade by the Mechanical Contractor. The Mechanical Contractor shall also furnish a complete 30x42 paper set of drawings to the jobsite main office and shall utilize them for updates of field conditions/deviations that occur during construction. Final Approved Coordination Drawings shall also be distributed to the Construction Manager, Owner, and Engineer for their Records. This process shall be completed prior to starting any work.

H. Each Contractor shall ensure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on record drawings kept at the jobsite. Upon completion of a particular phase, the Mechanical Contractor shall incorporate all field deviations into the Coordination Drawings to be utilized as Record Drawings. The Engineer shall review the Record Documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. The Record Drawings shall be distributed electronically (on CD) to the Construction Manager, Owner, and Engineer for their Records.

I. The Mechanical Contractor is responsible to the General Contractor for the shop drawing layout of the following rooms and details:

1. Concrete pads and foundations
2. Equipment room layouts with actual equipment
3. Roof layouts
4. Trench locations and sizes
5. Dimensioned floor drain locations
6. Congested areas above ceilings adjacent to mechanical and electrical rooms
7. Dimensioned ductwork shop drawings
8. Refer to Part 43 for additional requirements.

J. The Electrical Contractor is responsible to the General Contractor for the shop drawing layout of the following rooms and details:

1. Concrete pads and foundations
2. Equipment room layouts with actual equipment
3. Routes of feeder conduits and all other conduits 1.5” and larger
4. J-hook and cable tray cabling paths
5. Trench locations and sizes
6. Congested areas above ceilings adjacent to mechanical and electrical rooms
7. Refer to Part 41 for additional requirements.
8. Light fixture locations
9. Exact layouts of all work in open ceiling areas

1.18 SURVEYS, MEASUREMENTS AND GRADES

A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

1.19 TEMPORARY SERVICES

A. The Contractor shall arrange for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

B. All temporary services shall be removed by Contractor prior to acceptance of work.

1.20 TEMPORARY USE OF EQUIPMENT

A. The permanent electrical equipment, (except lighting), when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.

B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

1.21 MATERIALS AND WORKMANSHIP

A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

B. All conduit and/or conductors shall be concealed in or below walls, below floors or above ceilings, unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein. Raceways shall not be placed within foundation walls and footings.

C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer approved testing agency, where such a standard has been established.

D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the maker’s mark or name.

E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

G. Comply with National Electrical Contractors Association (NECA) performance standards that are published as National Electrical Installation Standards (NEIS).

H. All applicable equipment and devices provided shall meet all FCC requirements and restrictions.

1.22 QUALIFICATIONS OF WORKMEN

A. All Electrical Contractors bidding this project must have been a licensed company for a minimum of three (3) years to qualify to bid this project. Individual employee experience does not supersede this requirement.

B. All subcontractors bidding the electrical work must have completed one project of 70% this subcontract cost size and two projects of 50% this subcontract cost size.

C. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the contract document provisions.

D. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

E. Special electrical systems, such as Fire Detection and Alarm Systems, Telecommunications or Data Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades.

1.23 CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

1.24 COOPERATION AND COORDINATION BETWEEN TRADES

A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be effected.

B. Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements. The Contractor is responsible for the correct location of all rough-in and connections at every piece of equipment. Work not correctly located shall be relocated at the Contractor's expense.

C. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than ¼" = 1'-0", clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. He shall make the necessary changes in his work to correct the condition without extra charge.

D. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.25 PROTECTION OF EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor. Electrical equipment exposed to the weather shall be replaced by the Contractor at his expense.

1.26 SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

1.27 CONCRETE WORK

A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.

B. All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than l8" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish.

C. Special Note: All pads and concrete lighting standard bases shall be crowned slightly so as to avoid water ponding beneath equipment.

D. In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads l8" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.

E. Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, troweled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

1.28 SMOKE AND FIRE PROOFING

A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

B. Contractor to provide heat detectors in the area of construction with complete fire detection until fire alarm system is operational and construction is complete.

C. Fire-stopping materials and installation shall be by a single source through-out the project, by all trades.

D. All fire-stopping assemblies must be UL listed. Provide shop drawings indicating penetration detail for each type of wall and floor construction. Shop drawings must be specific for each individual type (i.e., one-hour fire rated gypsum wall board with insulated metal pipe penetration.) and must indicate a UL listing for the complete fire-stopping assembly.

E. 3M fire protection products are listed below. Equivalent products may be submitted if they are UL listed.

F. All of the fire-stopping shall be applied by a Contractor who is certified by the manufacturer of the fire-stopping product for installation of the product.

G. Fire-stopping materials to include but not limited to the following:

1. 3M fire barrier FS-195 wrap/strip.
2. 3M fire barrier CP 25 caulk.

3. 3M fire barrier MP moldable putty.
4. 3M fire barrier RC-1 restricting collar with steel hose clamp.
5. 3M fire barrier damming materials.
6. 3M fire barrier CS-195 composite sheet.
7. 3M fire barrier fire dam 150 caulk.
8. Steel sleeves.
9. Hilti Speed Sleeves.

1.29 QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Engineer.

1.30 WELDING

A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained.

1.31 ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Engineer's standards for such work. In the absence of such specifications, at a minimum such work shall comply with the specifications below.

D. Access Doors; in Ceilings or Walls:

1. In mechanical, electrical and service spaces: 14-gauge aluminum brushed satin finish, 1" border.

2. In finished areas: 14-gauge primed steel with 1" border to accept the architectural finishes specified for the space.
3. In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

1.32 MANUFACTURER'S NAMEPLATE

A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.33 ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also, refer to Division 20, 21, 22, 23, 24, 25, 26, 27, and 28 of Specifications, shop drawings and equipment schedules for additional information and requirements.

B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26, 27 and 28 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.

C. Each Contractor or Sub-Contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

1.34 FINAL CONNECTIONS TO EQUIPMENT

A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturer’s representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

1.35 ENERGIZED EQUIPMENT

A. At no time shall the contractor work on energized electrical equipment. Contractor shall comply with NFPA 70E requirements at all times throughout construction.

1.36 MOTORS

A. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box and NEC required disconnecting means as indicated or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.

B. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. Refer to Division 20, 21, 22, 23 and 25 of the Specifications for further requirements and scheduled sizes.

C. All three-phase motors shall be tested for proper rotation. Correct wiring if needed and retest. Document testing and corrective action in operations and maintenance manual.

1.37 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer.

B. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

1.38 SLEEVES AND PLATES

A. Each Contractor shall provide and locate all sleeves and inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Engineer and shall carefully coordinate setting of inserts, etc., with the Structural Engineer.

B. Sleeves shall be provided for all electrical conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction. Sleeves shall not be provided for piping running embedded in concrete or insulating concrete slabs on grade, unless otherwise noted.

C. Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be packed with oakum and lead, mechanical water stop or other approved material and made completely water tight by a method approved by the Engineer.

D. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

1. Terminate sleeves flush with walls, partitions and ceiling.
2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
3. In all areas where pipes are exposed, extend sleeves 1/2 inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

E. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

F. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

1.39 ANCHORS

A. Each Contractor shall provide and locate all inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Engineer and shall carefully coordinate setting of inserts, etc., with the Structural Engineer..

1.40 CONDUIT MOUNTING HEIGHTS

A. All exposed or concealed conduit, raceways, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed conduit shall, insofar as possible, run perpendicular or parallel to the building structure.

1.41 PAINTING

A. Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime

painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint.

1.42 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

1.43 EQUIPMENT/CONTROLS STARTUP & VERIFICATION

A. A pre-start-up conference shall be held with the Engineer, Owner, Construction Manager, General Contractor, Mechanical Contractor, Electrical Contractor, Controls Contractor, Test and Balance Contractor, and any manufacturer's providing startup services. The purpose of this meeting will be to discuss the goals, procedures, etc. for start-up

B. Equipment and controls startup and verification shall be required for this project. A specific line-item shall be included on the schedule of values by each Trade for "equipment and controls startup". This line-item value shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspectors shall closely monitor progress and quality of the equipment and controls startup and may withhold pay requests as deemed appropriate.

C. The Contractor shall include in the bid to provide equipment and controls startup and verification for ALL Electrical systems specified for this project. Specific startup/verification specifications are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (not third party contractors) and shall complete and submit start-up reports/checklists. Submit factory start-up reports to the Engineer. The contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner.

D. Many pieces of equipment and systems are specified with "manufacturer" startup. In general, the manufacturer's recommended startup procedures and checklists will be acceptable for use in the project. Where "manufacturer" startup is not specified, then this Contractor shall perform startup services in strict accordance with manufacturer's instructions. All startup/verification process shall be thoroughly documented by the Contractor and shall include the time and date when performed.

E. The Contractor shall be responsible for completion of their own System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

1.44 OPERATING INSTRUCTIONS

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. Unless specified otherwise in Division 1, each Contractor shall furnish three (3) complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.

C. Unless specified otherwise in Division 1, each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

1.45 CLEANING

A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

1.46 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

1.47 HAZARDOUS MATERIALS

A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work, insure that their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

C. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

D. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

E. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

1.48 ABOVE-CEILING AND FINAL PUNCH LISTS

A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project.

1. For review of in-wall work that will be concealed by drywall or other materials well before substantial completion.
2. For review of the above-ceiling work that will be concealed by tile or other materials well before substantial completion.
3. For review of all other work as the project nears substantial completion.

B. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing two weeks prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list and all work prior to the ceilings being installed and at the final punch list review.

C. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.

D. At the engineer's option, the contractor shall supply digital photographs via email or file-share of any installed work.

E. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due 10 days from date of each additional visit) at a rate of $125.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.

F. All panelboard fronts shall be omitted until final punch list inspection is made. Directories for each panelboard shall be completed and available for review by the Engineer at that time.

1.49 POSTED OPERATING INSTRUCTIONS

A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
3. Safety precautions.
4. The procedure in the event of equipment failure.
5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.50 TRAINING AND RELATED SUBMITTALS

A. Upon completion of all work and all tests, Contractor shall provide classroom and in the field training for each type and/or model of equipment installed. Training shall be led by qualified factory certified technician. Contractor shall submit a request to schedule training sessions a minimum of two weeks in advance. Submission shall include qualifications of instructor as well as a syllabus that the Owner will add/deduct to as they see fit. Each individual listed as an "Attendee" on the roster submitted by the Owner shall receive a copy of the maintenance manual to review during training. All training sessions shall be recorded and a DVD with proper labels identifying the date, equipment, and project shall be delivered prior to Completion of the project. If the audio from the recording is unclear, narration shall be added. The

Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. The training phase shall be accompanied by complete as-built documentation and the technical systems operation manual.

C. These training sessions shall be videotaped by the Installer and copies provided to the Owner within one (1) week of training

D. Brochures: Furnish Owner a complete set of operating instructions and diagrams.

E. Instruction Program: Submit outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

F. At completion of training, submit two complete training manual(s) for Owner's use.

G. Qualification Data: For facilitator, instructor and photographer.

H. Attendance Record: For each training module, submit list of participants and length of instruction time.

I. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

J. Demonstration and Training DVDs: Submit two copies within seven days of end of each training module.

K. Identification: On each copy, provide an applied label with the following information:

1. Name of Project.
2. Name and address of photographer.
3. Name of Construction Manager.
4. Name of Contractor.
5. Date video was recorded.
6. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

L. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video. Include name of Project and date of video on each page.

1.51 EQUIPMENT/SYSTEMS TESTING, VERIFICATION & START-UP

A. The Contractor (and Sub-Contractors) shall be responsible for commissioning, starting-up, testing, checking, examining, inspecting, etc. their own systems.

B. The Electrical Contractor shall designate an individual under his employment to lead the start-up, testing and verification process. This person should not be the project manager or job site superintendent, but a person dedicated to making this critical task successful and completed in a timely manner.

C. This individual shall also be responsible for the following items:

1. All identification and labeling requirements per plans and specifications.
2. Submission of switchgear coordination study, fault current study, and arc flash hazard analysis.

D. A pre-start-up conference shall be held with the Owner, Construction Manager, Electrical Contractor, and the Manufacturers providing startup services. The purpose of this meeting will be discuss the goals, procedures, etc. for start-up.

E. A specific line-item shall be included on the schedule of values for testing and verification of all systems indicated in this section. This line-item value shall be approved by the Engineer. The Engineer, Owner and the Engineer’s Field Inspector(s) shall closely monitor progress and quality of the testing, verification, and startup and may withhold pay requests as deemed appropriate.

F. The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation

resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

G. Systems Requiring Testing & Verification:

1. Electrical Distribution Equipment
2. Lighting and Lighting Controls
3. All Low Voltage Systems
4. Grounding Systems
5. Wiring and Terminations

H. The Contractor shall include in the bid to provide systems startup and verification for ALL electrical systems specified for this project. Specific startup, testing, and verification specifications are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (not third party Contractors) and shall complete and submit start-up reports/checklists. Submit start-up reports to the Engineer. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner. Where factory start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up.

I. The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

J. The completed reports shall be organized and bound together in a tabbed binder and submitted for review and approval.

1.52 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two (2) of any such special wrench, keys, etc. shall be turned over to the Engineer prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.53 CLOSEOUT DOCUMENTS

A. All items listed in this section shall be provided to the engineer upon substantial completion. Provide three bound copies with complete index and tabs to locate each item.

B. As-Built Record Drawings:

1. The Contractor shall insure that any deviations from the design are being recorded daily, as necessary, on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Deliver these record drawings to the Engineer as a system is completed, within ten days of the mark-up and/or while the accuracy of the mark-ups can be verified visually. Monthly payment may be withheld if the requirement is not complied with.
2. All underground utilities/piping installed as part of this project shall be surveyed by a land surveyor licensed in the State of Ohio. This shall include underground electrical primary, communications, vaults. The survey shall include actual duct bank depths to top of conduit every 100 feet in length. The survey shall also include benchmarks dimensions relative to above grade, fixed structures. The survey shall be furnished on a compact disc in AutoCad ".dwg" format and ".pdf" format. Provide a GPS coordinate of each geothermal well and indicate on the as-built drawing. The survey information shall be included in the closeout documentation.

3. Refer to additional record drawing requirements within the general conditions and other sections of these specifications.

C. Start-up and System Testing Certifications and Reports:

1. Provide reports from all required testing to indicate procedures followed and complete results of all tests. Provide reports on manufacturer's standard forms for all equipment and system tests. Testing shall be per applicable NEC, NFPA, UL, NETA, and/or ANSI standards.

D. Operation and Maintenance Manuals

1. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three (3) complete bound hard copies and a digital copy of operation and maintenance instructions and parts lists for all equipment provided in this contract. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:
2. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
3. Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.
4. The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
5. The operation and maintenance manuals shall contain the following information:

    a. Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
    b. Provide contacts (company name, address, phone number, email) where parts may be purchased for all equipment.
    c. Provide detailed maintenance instructions, including recommended preventative maintenance schedules for all equipment requiring maintenance. For lighting and lighting controls, provide recommended re-lamping program, provide a schedule for inspecting and recalibrating lighting controls, and provide a recommended settings list for all components with adjustable settings.
    d. General Information. Provide the following:

        1) Building function
        2) Building description
        3) Operating standards and logs

    e. Technical Information. Provide the following:

        1) System description
        2) Operating routines and procedures
        3) Seasonal start-up and shutdown
        4) Special procedures
        5) Basic troubleshooting

    f. The maintenance manual should contain the following information:

        1) Equipment data sheets. Provide the following:
            a) Vendor and local representative's contact information
            b) Operating and nameplate data
            c) Warranty
            d) Detailed operating instructions.
            e) Tools required
            f) Types of cleaners to use

        2) Maintenance program information. Provide the following:
            a) Manufacturer's installation, operation, and maintenance instructions
            b) Spare parts information

c) Preventive maintenance actions
d) Schedule of actions
e) Action description
f) History

g. Test reports document observed performance during start-up and commissioning.
h. Reference Division 1 specifications for additional requirements.

E. Shop drawings will not be accepted as satisfying the requirement for Operation and Maintenance Manuals.

F. Shop Drawings: Provide complete copies of all approved shop drawings. Where shop drawings were returned "Furnish as Corrected", the contractor shall make the corrections noted by the engineer and submit final corrected shop drawings with close-out documentation.

G. Parts Lists: Provide an inventory of all spare parts, special tools, attic stock, etc. that have been provided to the owner.

H. Warranties: Contractor's one-year warranty and all other specific warranties indicated in the construction documents.

I. Training Verification: Provide certification that all specified training has been completed. List training session dates, times, and types.

J. Inspection Certificates: Provide certificates of inspection from electrical inspector, fire marshal, and any other required special inspections.

K. Panel Schedules: Provide hard copies and digital copies of Excel files for all panel-board schedules.

L. Final Power System Study Reports.

M. Power Riser Diagram: Provide a framed full-size copy of the overall power riser diagram (under glass) to the Owner. Also, provide three (3) vinyl-coated copies of same. Where an existing power riser diagram is present, the Contractor shall obtain the document from the Owner, and update in digital format with the scope of this project. Edits shall be in digital format and this work shall be closely coordinated with the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION (260501)

DIVISION 26 - ELECTRICAL

SECTION 260502 - SCOPE OF THE ELECTRICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SCOPE OF THE ELECTRICAL WORK

The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, verify place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

1. All raceways, conduits, cable management systems, cable trays, J-hooks, conductors, outlet boxes, fittings, pull boxes, manholes, etc.
2. All low-voltage distribution equipment, switchboards, panelboards, disconnect switches, fuses, , contactors, starters, service pedestals, etc.
3. Electrical Studies including Fault Current, Arc Flash, and Coordination Studies. All studies to be performed by manufacturer of electrical distribution equipment.
4. Electrical Contractor shall install, mount and wire VFD’s which shall be furnished by the Mechanical Contractor, unless otherwise noted.
5. All wiring devices and device plates.
6. Cable splicing, terminations, supports, etc.
7. All light fixtures, drivers, ballasts and lamps.
8. Grounding, per NEC and specified requirements.
9. Identification of electrical systems and equipment labeling.
10. All low-voltage systems as listed in System Responsibilities Matrix on Electrical Legend.
11. Cabling, testing and devices for data/voice network.
12. All necessary coordination with the Owner ensure that work, connections, etc., that they are to provide is accomplished and that service to this facility is delivered complete prior to occupancy.
13. Paying all necessary fees and costs for inspections of all Division 26 systems by a Licensed Electrical Inspector.
14. Paying all necessary fees and cost for permits, electrical inspections, work by utility companies (power, telephone, cable television company, etc.). The Contractor shall contact the utility companies prior to submitting a bid to determine exactly these charges will be.
15. Prior to submitting a bid, the Contractor shall contact all serving utility companies and municipal services to determine exactly what each utility company will provide and exactly what is required of the Contractor and the Contractor shall include all such requirements in his base bid. This shall include relocation fees and construction cost recovery due to Power Utility Company and Cable Company or their successors.
16. All general and special conditions required to accomplish the work.

1.3 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

END OF SECTION

DIVISION 26 - ELECTRICAL

SECTION 260503 - SHOP DRAWINGS, SUBMITTALS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Each Contractor shall submit to the Engineer, within thirty days after the date of the Contract, one (1) electronic set of shop drawings and/or manufacturer’s descriptive literature on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer’s descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer’s attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term “as specified” will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. Shop Drawings: Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

G. Product Data: Submittal shall include performance and characteristic curves.

1.3 SUBMITTALS AND SHOP DRAWING

A. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

1. Power Equipment

   a. Fault Current, Arc Flash and Coordination studies (submit along with switchgear & panelboards).
   b. Switchgear, switchboards, distribution panelboards and panelboards.
   c. Circuit breakers and fusible switches, per each type.
   d. Disconnect switches.
   e. Fuses, per each type required.
   f. Control components (relays, timers, selector switches, pilots, etc.)
   g. Motor starters, if not submitted with unit equipment by supplier.

2. Raceways

   a. Conduits and each type of conduit fittings.
   b. Cable trays and each type of cable tray fitting.
   c. Ladder trays and each type of ladder tray fitting.
   d. Surface-mounted metal or plastic raceways, with each type of fitting.
   e. Wireways and each type of wireway fitting.
   f. J-hook assembly.
   g. Floor trough and each type of floor trough fitting.
   h. Composite pullboxes.

3. Conductors

   a. Conductors, splicing devices, and connectors, each by type.
   b. Splice or tap blocks.
   c. Primary cable (over 600 volts) and each style of termination fitting for primary cable.

4. Devices

   a. Each type of wiring device and their coverplates.
   b. Floor boxes and poke-thrus, each by type, with required accessories.
   c. Data/voice/video wallplates, each by type.
   d. Any special items not listed above.

5. Lighting

   a. Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Engineer to indicate color selection.
   b. Lamps, each by type.
   c. Ballast and drivers, each by type.
   d. Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

6. Grounding

a. Electrodes, bonding devices, terminals, etc.
b. Building service grounding electrode components.

7. Electronic 3D Coordination Drawings per Electrical General Provisions

8. Dimensioned electrical room plans/equipment layouts

9. Fire-stopping materials including wrap, caulk, putty, sleeves, etc.

10. Seismic Restraints

11. Miscellaneous

a. Control panel assemblies.
b. Non-standard junction/pullboxes.

12. Special wrenches, tools and keys

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260504 - SLEEVING, CUTTING, PATCHING AND REPAIRING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 SUMMARY

A. The Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the Construction Manager, General Contractor and all other trades. He shall determine and coordinate any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

C. The Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

D. The Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

E. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

F. Where any cutting, coring, etc. of reinforced concrete is required, such structures shall be x-rayed to avoid damaging existing reinforcing steel.

G. Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be made completely water tight. Provide Crouse-Hinds Link-Seal Environmental Conduit Seal with stainless steel hardware. Alternative methods shall be approved by the Engineer during shop drawing review.

H. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

I. All roof penetrations shall be made inside mechanical equipment curbs, UON.

J. Sleeves passing through roof or exterior wall or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed.

K. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

L. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Structural Engineer.

M. The Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Engineer.

N. All work improperly done or not done at all as required by the Electrical trades in this section will be performed by the Contractor at the direction of the trade whose work is affected. The cost of this work shall be paid for by the Contractor who is in non-compliance with the Contract.

O. All penetrations shall be patched with materials matching that which has been disturbed.

PART 2 - PRODUCTS

2.1 SLEEVES

2.2 SLEEVES

A. Sleeves for Raceways:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, hot-dipped galvanized, plain ends.

a. Sleeves for exterior walls: Anchor flange welded to perimeter.

B. Sleeves for Raceways Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel of length to suit application.
2. Minimum Metal Thickness: Shall be 0.138 inch (10 gauge).

D. Coordinate sleeve selection and application with selection and application of firestopping.

2.3 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annual space between sleeve and conduit.

1. Sealing elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure plates: Stainless steel. Include two for each sealing element.
3. Connecting bolts and nuts: Stainless-steel of length required to secure plates to sealing elements. Include one for each sealing element.

2.4 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for conduits where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the conduit and the sleeves shall be made completely and permanently water tight.

D. Conduits that penetrate fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

E. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

F. Sleeves in floors shall extend 4" above finished floor level.

G. Escutcheon plates shall be provided for all conduits passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the conduit. Where plates are provided for conduits passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the conduit sleeves.

H. In all areas where busducts are exposed and pass thru floors, the opening shall be surrounded by a 4-inch-high by 3-inch-wide concrete curb.

I. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.2 CUTTING

A. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

B. Conduit openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

C. X-ray concrete slabs and walls prior to core drilling. Do not core drill through rebar, steel or or reinforcing material without written permission from the Structural Engineer.

D. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

3.3 PATCHING AND REPAIRING

A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.

B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.

C. Where the installation of conduit, raceways, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, raceways, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

D. Conduits passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the conduit around which it is installed.

E. Stainless steel collars shall be provided around all conduits, raceways, etc., at all wall penetrations; both sides where exposed.

F. Where conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to insure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260508 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 COORDINATION

A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other Contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

C. The Contractor shall be responsible for coordination with all trades to ensure that they have made provision for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc. that are required for equipment operation shall be provided as a part of this contract.

D. Review and coordinate connections to electrically operated equipment furnished by other trades with project contract documents, shop drawings, submittals, and installation instructions. Notify Engineer in writing of discrepancies prior to proceeding with work. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

E. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Engineer far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

F. In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s), the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Engineer where in doubt about the potential acceptability of an installation.

G. Refer to equipment schedules and details on all contract documents for additional information for mechanical and plumbing connections. Provide labor and materials for a complete and operable system.

H. Provide equipment overcurrent protection and feeder sizes for equipment furnished by this or other trades or by Owner per actual equipment nameplates and installation instructions.

I. Provide weather-proof/weather-resistant maintenance receptacles within 25 feet of all mechanical and plumbing units/equipment. Coordinate installation locations with final equipment layout provided by Mechanical Contractor. Provide GFI branch circuit for each maintenance receptacle to nearest panelboard unless circuit is otherwise noted on drawings.

J. Verify exact mounting locations and connection requirements of all mechanical equipment with the Mechanical Contractor prior to rough-in.

K. Verify exact mounting locations and connection requirements of all plumbing equipment with the Plumbing Contractor prior to rough-in.

L. Verify elevator mounting locations and connection requirements with manufacture prior to rough-in. Provide overcurrent protection as required per the final vendor shop drawings.

1.3 INTERFACING

A. Each Electrical Trade, Specialty Controls Trade, Mechanical Trade, Plumbing Trade, Fire Protection Trade and the General Trades, etc., shall insure that coordination is affected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

1. Connection of all controls to equipment.
2. Electrical power connections to electrically operated (or controlled) equipment.
3. Electrical provisions for all equipment provided by other trades or suppliers within this contract.
4. Contractor is to provide conduit whips and back boxes, as needed, to power systems furniture.
5. Coordination of connection of Telecommunications (voice, data, video) lines to Owner’s existing or new service.
6. Connection of utility electrical service to Owner's existing or new services.

1.4 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

G. Sides of cable, basket and ladder trays shall not be obstructed with special attention to pipes, ductwork, raceways, equipment, cables, etc.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide power wiring from the motor starters to each motor and its manual controlling device.

1. Make flexible or liquid tight connections as specified in Section 260533, Raceways

B. Except where provided with equipment, furnish and install manual pushbutton stations and pilot lights, with wiring. Where stations and pilot lights are grouped at central locations, mount them under a common faceplate.

C. Certain equipment, as indicated, will be furnished with control panels and auxiliary control components. Mount the panels, furnish and install source wiring and disconnects, and completely connect controls and motors.

D. Where a specification sections require installation of equipment under supervision of equipment manufacturer's representative, coordinate electrical installation to cooperate with representative's requirements.

E. Provide power sources for Owner-furnished equipment.

F. Provide power and control wiring for emergency generator, controllers, and remote-control panels.

END OF SECTION 260508

DIVISION 26 – ELECTRICAL

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER, CONDUCTORS, CABLES, SPLICING DEVICES AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. This section of the Specifications covers all of the electrical power, lighting, and control power (line voltage) conductors, but does not include communications, data or signal system conductors, which are specified separately in these specifications.

C. All conduits installed without conductors shall have a 200 lb. test nylon string installed for future use, tied off securely at each end.

D. No more than 40% conduit fill permitted for any conduit system, including video, intercom, data, voice, power or other signal circuits unless specifically indicated otherwise on the plans.

E. No more than seven conductors (six current-carrying and one ground) shall be installed in a conduit except for switch legs and travelers in multi-point switching arrangements. Multi-wire branch circuits with a shared neutral are not allowed.

F. If multiple circuits are pulled in a single homerun, a dedicated neutral shall be provided for each phase conductor. In these cases, a maximum of seven conductors (six current carrying and one ground) are permitted in a single conduit. Conductors shall be derated per NEC.

G. Intentional or unintentional painting of exposed low-voltage and/or line-voltage cabling is prohibited. The contractor shall ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. The contractor shall review the painting requirements for all disciplines and shall provide cabling protection as required. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, the contractor shall provide alternate options for cable colors and shall provide submittals for such cabling to engineer for approval.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Coordinate paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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. Alpha Wire Company.
3. American Insulated Wire Corp.; a Leviton Company.
4. Belden Inc.
5. Cerro Wire LLC.
6. Encore Wire Corporation.
7. General Cable Technologies Corporation.
8. General Cable Corporation.
9. Senator Wire & Cable Company.
10. Southwire Company.

B. All conductors shall be 98% conductive annealed copper unless otherwise noted, UL listed and labeled. Comply with ANSI/NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation:

1. Comply with ANSI/NEMA WC 70/ICEA S-95-658.
2. Lighting and receptacle branch circuits shall be Type THW, THHN or THWN insulation.
3. All feeders shall be Type THW or THWN of the size as shown on the Contract Drawings.
4. THHN wiring shall only be installed in overhead, dry or damp locations.
5. THWN OR THW wiring shall be used for all circuits pulled in underground or other wet locations.

D. Conductor sizes indicated on drawings are based upon 75 degree C rating.

E. Minimum branch circuit or feeder size shall be not less than #12 AWG copper wire or of the sizes shown on the drawings.

F. Conductors #10 AWG and smaller shall be solid. Conductors #8 AWG and larger sizes shall be stranded.

G. Conductors for fire alarm wiring shall be stranded and in full compliance with NEC 760. Exposed cabling in air plenums shall be rated for plenum installation.

H. All wire on the project shall be new, in good condition, and shall be delivered in standard coils or reels.

I. The color of the wire shall be selected to conform to Section 210-5 of the latest edition of the National Electrical Code. Power conductors of all sizes shall follow the color coding scheme listed under PART 3, IDENTIFICATION below.

J. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible.

K. Conductors for main ground from neutral bus, equipment grounding bus, building steel, grounding grid and main cold water pipe connection shall be bare copper.

L. All conductors shall be identified by color code and by means of labels placed on conductors in all junction boxes and at each terminal point with Brady, Ideal, T & B or approved equivalent labels indicating source, circuit number or terminal number.

M. All feeders and branch circuits shall be installed and sized for a maximum 2% voltage drop. As calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.

N. For 120VAC, 20AMP branch circuits:

1. #12 AWG when run is 50 feet or less;
2. #10 AWG when run is between 50 feet and 100 feet;
3. #8 AWG when run is more than 100 feet.

O. No aluminum conductors shall be used.

P. MC cable may be used for normal power branch circuits, #10 and smaller, where concealed in walls, above ceilings, etc. MC cable shall not be used for emergency power circuits, any feeders, any exposed locations, or any wiring larger than #10. Supports shall be per NEC and all runs shall be parallel or perpendicular to building lines with right angle turns. Cables shall be bundled where run in groups using listed supports. Do not route through structure or on work of other trades. Provide independent supports directly from structure.

Q. MC cable is acceptable for the following applications:

1. Feeders for lighting fixture whips and for branch circuits concealed in walls and partitions only. Locate junction box and convert to single conductors in rigid raceway within the same room as where the cable enters/exits the wall.
2. Use only for single-circuit cable (i.e. two wire plus ground). For devices in the same wall connected to different circuits, install separate single circuit cable for each circuit.
3. The MC cable length for power circuits shall be limited to 30′ from the junction box to the wiring device located in the wall. If the circuit continues outside the wall, the circuit must immediately transition to conduit.
4. The MC cable length for lighting circuits shall be limited to 30′ from the junction box to the first fixture and from that point only those fixtures above the enclosed space/room shall be served by this HCF circuit.

R. MC cable is not acceptable for the following applications:

1. Homeruns to Panelboards.
2. Branch circuits serving Essential Electrical System (Emergency & Standby) loads; including Life Safety branch, Critical branch and equipment emergency system.
3. Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
4. Within mechanical, electrical or telecommunication equipment rooms.
5. Exposed Branch Circuits within areas that do not have a ceiling (i.e. open to structure).
6. Wet locations.

2.2 SPLICING DEVICES & CONNECTORS

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. 3M; Electrical Products Division.
2. AFC Cable Systems, Inc.
3. Burndy
4. Gardner Bender.
5. Hubbell Power Systems, Inc.
6. Ideal Industries, Inc.
7. ILSCO.
8. NSi Industries LLC.
9. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
10. Reliable
11. T&B
12. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Splicing devices for use on #10 AWG and smaller conductors shall be pressure type such as T&B "Sta-Kon".

D. Wire nuts shall be spring pressure type, insulation 600V, 105°C insulation, up to #8 AWG. Greater than #6 AWG shall be a compression type connection, 600V insulation, cold shrink tubing, taped to restore full insulation value of the wire being spliced.

E. Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using #10 AWG or smaller conductors.

F. Splices, where necessary, shall be made with hydraulically-set "Hy-press" or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.

G. Large connectors (lugs) at terminals shall be mechanical type, hex-head socket or crimp-on style, installed per the manufacturer's recommendations.

H. Underground connections made between bare ground wires or to ground rods shall be exothermically welded, "Cadweld" or equivalent.

I. No aluminum splicing devices or connectors shall be used.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION MATERIAL APPLICATIONS

A. Feeders and Branch Circuits: Copper. Solid for #10 AWG and smaller; stranded for # 8 AWG and larger.

B. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible stranded.

C. Conductors used for theatrical lighting branch cables shall be extra flexible stranded.

D. Lighting and receptacle branch circuits shall be Type THW, THHN or THWN insulation.

E. All feeders shall be Type THW or THWN of the size as shown on the Contract Drawings.

F. THHN wiring shall only be installed in overhead, dry or damp locations.

G. THWN or THW wiring shall be used for all circuits pulled in underground or other wet locations.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. Motor Connections shall use connection lugs with motor stub splice insulators.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.2 INSTALLATION

A. Clean out raceway system before pulling conductors.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

E. The radius of bending of conductors shall be not less than eighteen times the outside diameter of the conductor insulation or more, if recommended by the manufacturer.

F. Conductors installed within environmental air plenums shall be per NEC. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Also provide plenum-rated tie-wraps where plastic straps or other supports, etc., are installed in plenum areas.

G. Where indicated, systems and control conductors that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the access to or operation of equipment or removal of ceiling tiles. Nylon tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans. Refer to the drawings for support requirements and details on routing exposed communications conductors.

H. Conductors for isolated power systems shall be installed in as short a run of conduit as practicable. No pulling soap shall be used on conductors in isolated power systems.

I. Where conductors are installed in industrial facilities, they shall be per JIC standards.

J. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment to ensure compliance. Use particular caution when installing twisted pair data cable or fiber optic cables -- forces permitted for pulling in are typically very low for these cable types.

K. All cables and wiring, regardless of voltage, installed in manholes or cable vaults shall be routed in such a manner to provide a minimum of 6 feet of slack cable for future splicing. Install cables along walls by utilizing the longer route from entry to exit. If both routes are symmetrical, provide a loop of cable secured to wall. All cables shall be tied to insulated cable supports on wall-mounted racks, spaced a maximum of three feet apart.

L. Where multi-wire branch circuits are allowed on the drawings, the phases and neutral shall be wire-tied together in the panelboard and in all pull boxes.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductors at each outlet with at least 12 inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Perform insulation resistance (megger) testing for all bus duct and feeders in accordance with NETA ATS. Testing may be witnessed by the Engineer and/or Commissioning agent. Schedule all tests with Engineer with ample notice.
3. 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 120-300 volt rated equipment. Minimum acceptable (temperature corrected) resistance is 25 megaohms for 120-300 volt rated equipment and 100 megaohms for 600 volt rated equipment and wiring.
4. Test instruments shall be calibrated to national standards within the last 12 months.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors #3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Test and Inspection Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

F. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

G. Submit test results to Engineer for approval.

3.5 IDENTIFICATION

A. Color coding distribution voltage conductors, 600 volts or less

B. Conductors, in all sizes of cable, shall have continuous solid insulation color(s) from the manufacturer. Taped ends shall not be acceptable.

1. Conductors shall be color coded as follows:

a. 120/208 Volt Conductors

1) Phase A: Black
2) Phase B: Red
3) Phase C: Blue

4) Neutral: White
5) Ground: Green
6) Isolated Ground: Green/Yellow

b. Isolated Power Conductors (Type XLP or XHHN)

1) Phase A - Brown
2) Phase B - Orange
3) Phase C - Yellow
4) Neutral - White with brown tracer stripe
5) Note: Provide each phase with tracer color other than white, green, or gray.

c. Note: Further identify isolated power conductors with ½" wide purple tape at all terminations and junctions.

2. Fire Alarm Wiring: Red
3. Signal voltage wiring color coding shall be consistent throughout the project and shall match existing equipment and standards where applicable. Color coding for each system shall be unique.
4. Conductors within enclosures that may be energized when enclosure disconnect is off - yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.
5. DC Wiring: Positive: Light Blue
Negative: Dark Blue

C. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems.

B. All metallic conduit, raceways, cable trays, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.

C. The size of the equipment grounding conductors, grounding electrode conductors and service grounding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings. Where ungrounded conductor sizes are increased to minimize voltage drop, grounded conductor sizes shall be increased in the proper proportion.

D. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.

E. The service entrance main ground bus shall also be connected to the main cold metallic water pipe within three feet of where it enters the building, on both the house and street sides of the main shut-off valve with a properly sized bonding jumper. A properly sized bonding jumper shall also be provided to the frame of any steel structure utilized in the construction. The steel frame of the building (if any) shall be made electrically continuous.

F. All ground electrode systems shall be installed in accordance with manufacturer's recommendations, UL listings, ANSI standards, National Electrical Code and National Electrical Safety Code.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including the following:

1. Grounding Systems
2. Ground Rods
3. Ground Wires
4. Connectors and Fasteners
5. Bonding Materials

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.

3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports. Provide the following test reports:

1. Bond resistance test
2. Ground resistance tests
3. Ground isolation test
4. Continuity isolation test

1.5 CLOSEOUT DOCUMENTS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

B. In addition to items specified in Section 260501 "CLOSEOUT DOCUMENTS," include the following:

1. Instructions for periodic testing and inspection of grounding features at building master ground bus and electrodes based on NFPA 70B.
2. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
3. Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Listing and labeling: Provide products specified in this Section that are listed and labeled.

D. Comply with NECA's "Standard of Installation."

1.7 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:

1. Erico
2. ILSCO
3. Cadweld
4. Burndy
5. Therm-O-Weld
6. T&B

7. O.A. Co.
8. Lyncole XIT Grounding
9. Superior Grounding Systems
10. LEC Inc

2.3 CONDUCTORS

A. Comply with Specification Section 260519, LOW-VOLTAGE ELECTRICAL POWER, CONDUCTORS, CABLES, SPLICING DEVICES AND CONNECTORS.

B. Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Ground wires and cables shall be of the AWG sizes shown on the Contract Drawings or shall be sized in accordance with the prevailing codes. All ground wires and cables shall be copper.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar per EIA/TIA standards.

E. All grounding fittings shall be heavy cast bronze or copper of the mechanical type except for underground installations or interconnection of grounding grid to cable, columns and ground electrodes, which shall be thermically welded type as manufactured by Cadweld, Burndy Co., Therm-O-Weld, or approved equivalent.

PART 3 - EXECUTION

3.1 GENERAL

A. All metallic conduit, raceways, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest issue of the National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.

B. The size of the equipment shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings.

C. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.

D. All outlet, junction and pull boxes shall be grounded with pigtail to the equipment grounding conductor.

3.2 APPLICATIONS

A. Conductors: Install solid conductor for #10 AWG and smaller, and stranded conductors for #8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, #3/0 AWG minimum or as indicated on drawings, whichever is larger.

1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Grounding Bus: Install in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 18 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Busway Supply Circuits
8. Computer and Rack-Mounted Electronic Equipment Circuits.

B. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

C. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide #4/0 minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-18-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. All grounding conductors shall be protected from mechanical injury and shall be rigidly supported. Where ground conductors are run through flexible conduit and through panelboard switchboard or motor control center feeders, they shall be securely bonded to such conduit thru the use of grounding bushings at the entrance and exit. All connection of equipment shall be made with an approved type of solderless connection and same shall be bolted or clamped to equipment or conduit.

C. Equipment ground connections to GFI circuit breakers shall be carried and bonded to each outlet on the circuit. Provide a separate equipment grounding conductor with green color insulation.

D. Equipment grounding conductors shall be routed to lighting fixtures, devices, receptacles, electric heaters, furnace and other equipment. Equipment grounding conductors shall be green.

E. Resistance to the grounding at the service entrance equipment shall be in accordance with the NEC for style of construction and shall not exceed five ohms as measured by the described testing method.

F. All circuits shall have a grounding conductor.

G. When grounding systems are completely installed and all grading in the area of the service grounding electrode has been completed up to finish elevations, perform a fall-of potential or other approved test to determine actual system resistance to earth. Report results to the Engineer in writing. Refer to testing provisions in this section of specifications.

H. The Contractor shall ensure that the ground return path thru building structural steel or other means is electrically continuous back to the service grounding electrode and is of adequate capacity and impedance to carry the maximum expected fault or other current. Where no electrically continuous steel building frame is available, the Contractor shall provide a properly sized ground bar and ground conductor routed back to the main facility ground bus.

I. Where a building's steel frame is made electrically discontinuous by masonry breaks (as at firewalls, etc.), the Contractor shall provide an accessible thermically welded bonding jumper of #500Kcmil copper to bond the building steel frame sections together, making the entire steel frame electrically continuous. The installation of these bonding jumpers shall be reviewed by the Engineer prior to their being covered by construction.

J. Grounding connections shall never be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans.

K. Where dielectric fittings are utilized in piping systems, the piping system shall not be utilized as a ground path. Bonding jumpers shall not be utilized to bridge over such fittings. Piping systems shall not be utilized as ground paths except where specifically required by codes in the case of water piping.

L. At all metallic outlet, junction and pull boxes, bond the equipment grounding conductor to the box.

M. Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
3. Provide well access for testing at one (1) rod.

N. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

O. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

P. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange.

Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

Q. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

R. Grounding for Steel Building Structure: Provide a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

S. Concrete-Encased Grounding Electrode (Ufer Ground): Provide and fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than #4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

T. Perform ground testing, log results, and provide reports of test points, test values, and procedure as required by engineer and/or local authority having jurisdiction. All systems shall be grounded to maintain leakage current below levels required by applicable codes and standards.

U. Grounding Busbars:

1. Install busbars horizontally, on insulated spacers 4 inches minimum from wall, 72 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by four point fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
5. Substations and Pad-Mounted Equipment shall be 5 ohms or less.
6. Manhole Grounds shall be 10 ohms or less.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

3.6 FUNCTIONAL PERFORMANCE TESTS

A. System functional performance testing is part of the Commissioning Process as specified in Section 019113. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes the following:
1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.
3. Isolation pads.

B. Related Sections include the following:

1. Division 26 Section "Vibration Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit

C. LFMC: Liquid-tight flexible metal conduit

D. GRS: Galvanized rigid steel conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.
5. Concrete Based for Equipment.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
7. Delegated-Design Submittal: For hangers and supports for electrical systems.
8. Include design calculations and details of trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which hangers and supports will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:
5. Lighting fixtures.
6. Air outlets and inlets.
7. Speakers.
8. Sprinklers.
9. Access panels.
10. Projectors.

1.7 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.9 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. 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:

a. Allied Tube & Conduit

b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. Thomas & Betts Corporation.
e. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Device Box Mounting Brackets: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.

1. 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:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

F. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.

1. 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:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

G. Roof-mounted Raceway Support Blocking: Factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper B-Line C-Port series components or a comparable product by one of the following:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

H. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.

1. 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:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

I. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

J. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, or steel with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    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) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    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) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Solid, threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.3 VIBRATION ISOLATION PADS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Korfund Maxi-Flex Pads or a comparable product by one of the following:

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except where requirements of this Section are more stringent.

B. Maximum Horizontal and Vertical Support Spacing for Raceway(s): Space supports for EMT and GRS as required by NFPA 70.

C. Minimum Hanger Rod Size for Raceway Supports: Minimum rod size shall be 1/4 inch in diameter.

D. Single Raceways:

1. For Raceways 1-1/4-inch and smaller: Install adjustable steel band hanger suspended on threaded rod.
2. For Raceways larger than 1-1/4-inch: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods. Size trapeze members, including the suspension rods, based on the support required for the size, and loaded weight of the conduits.

a. Secure raceway or cable to support with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

E. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods, where multiple raceways are run vertically or horizontally at the same elevations. Size trapeze members, including the suspension rods, based on the support required for the number, size, and loaded weight of the conduits. Space them as required for the smallest conduit to be supported. Size so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.3 SUPPORT INSTALLATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for installation requirements except where requirements of this Article are more stringent.

B. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.

C. Install Device Box Mounting Brackets supported between two studs. All device boxes shall attached to two studs, device box stabilizers shall not be acceptable.

D. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.

E. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings.

1. Install at least one independent support rod from box hanger to structure.

F. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.

1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work.

G. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.

H. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.

I. Locate raceways so as not to hinder access to mechanical equipment.

J. Do not secure conductors, raceways, or supports to suspended ceiling hanger rods or wires.

K. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

L. Mounting and Anchorage of Surface-Mounted or Recessed-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured, if possible. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. For Surface-Mounted Items on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to structure by means that meet seismic-restraint strength and anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means; slotted-channel rack solidly attached to structure or light-gauge metal framing at both ends is required.
8. For Recessed-Mounted Items in Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices to intermediate light-gauge metal framing members on each side of device or provide slotted-channel racks within hollow wall attached to structure by means that meet seismic-restraint strength and anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means.

M. Do not support any items (equipment, piping, conduit, etc.) exceeding 2 inches in diameter from the bottom of slabs. Where intermediate supports are required between structural members, use slotted steel channels support systems attached to beams or joists in order to avoid attachment to slabs.

N. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars. Verify reinforcing locations with Structural Engineer. X-Ray existing concrete structures as required.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 3 inches larger in all directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.6 PAINTING

A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260533 - RACEWAYS AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This section is intended to specify the raceways, conduit, conduit fittings, hangers, junction boxes, splice boxes, specialties and related items necessary to complete the work as shown on the drawings and specified herein.

B. This section specifies basic materials and methods and is a part of each Division 26, 27 and 28 Sections that implies or refers to electrical raceways specified therein.

C. The types of raceways specified in this section include the following:

1. Steel electrical metallic tubing (EMT)
2. Galvanized rigid steel conduit (GRS or RMC)
3. Intermediate metal conduit (IMC)
4. Rigid aluminum conduit (RAC)
5. Flexible metal conduit (FMC)
6. Liquid-tight flexible metal conduit (LFMC)
7. Rigid nonmetallic conduit (RNC)
8. Surface metal raceway (SMR)
9. Metal wireways and auxiliary gutters.
10. Wall ducts and trench ducts.
11. Cable tray or cable trough.
12. Duct banks, and their construction.

D. All raceways, as listed above and otherwise specified herein shall be provided in compliance with latest editions of all applicable UL, NEMA, NEC and ANSI standards. All conduit, raceways and fittings shall be Underwriters Laboratories listed and labeled, or bear the listing of an agency acceptable to the local authority having jurisdiction.

E. Conduit and raceways, as well as supporting inserts in contact with or enclosed in concrete shall comply with the latest edition of all ACI standards and the equipment manufacturer's recommendations for such work.

F. The decision of the Engineer shall be final and binding in any case where a question or inquiry arises regarding the suitability of a particular installation or application of raceways, supports or materials, if other than outlined herein.

G. Minimum size of conduit shall be 3/4" trade size for power and 1-1/4” trade size for voice/data/TV unless otherwise noted on the drawings. All conduit and raceways shall be sized for the number of conductors contained, in accord with the latest edition of the National Electrical Code or any other applicable standards.

H. The installer of raceway systems shall avoid the use of dissimilar metals within raceway installations that would result in galvanic-action corrosion.

I. PVC or other non-metallic conduit shall be rated for the maximum operating temperature that could be developed by the conductors it encloses, while in normal operation.

J. All empty conduit installed anywhere shall have pull-strings installed for future cabling installation. Coordinate with vendors and provide extra pull-strings as required to ensure that when cabling is pulled, conduit will still have pull-strings installed for future use.

K. ½" conduit may be used for no more than (5) #12 AWG or (3) #10 AWG wires. Light fixture whips may be 3/8" flexible metal conduit.

L. Fire Alarm Cabling (open): All wiring which is exposed, concealed in walls, concealed above inaccessible ceilings, or otherwise inaccessible shall be installed within conduit and enclosed junction boxes. Provide a completely separate conduit system from power wiring or other raceway systems. All concealed conduit shall be manufactured red – no field painting will be accepted – and exposed conduit in finished spaces shall be painted to match adjacent finishes. Concealed cabling above accessible ceilings shall be an open cabling system ran in dedicated 2'' J-hooks. Provide J-hooks above or below primary cabling paths used for other systems. Conduit stub-outs shall be run to these paths. Cabling shall be listed by the fire alarm system manufacturer for use with their system. Cabling shall be air-plenum-rated.

1.3 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.

B. Comply with NFPA 70.

1.4 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product data for raceways, conduits, outlet boxes, and wireways.

B. Shop Drawings:

1. Submit Shop Drawings of the complete metal surface raceway system.
2. Shop Drawings shall include sizes and lengths of raceways, inside corners, outside corners, end caps, raceway cover spacing, grounding, branch circuiting and wiring including locations of service entrances, receptacle types and manufacturers, receptacle spacing, and receptacle labeling with proper voltage, phase, circuit and panelboard designations as indicated on the Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.

3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. STEEL ELECTRICAL METALLIC TUBING

1. Electrical metallic tubing (EMT), of corrosion-resistant zinc coated cold rolled steel tubing shall be permitted for concealed installation in dry interior locations.
2. EMT shall not be installed underground, in concrete slabs or where exposed to physical damage. EMT shall be permitted for exposed work in mechanical and electrical rooms and other exposed structure areas where not subjected to physical damage, as determined by the Engineer. All exposed conduit and fittings located within 8'-0" of finished floor shall be rigid steel with threaded connectors.
3. Comply with ANSI C80.3 and UL 797.
4. Connectors and couplings for EMT: Concrete- or rain-tight, compression type, made of zinc- or chromium-plated steel. Connectors shall have nylon insulating throats.

D. GALVANIZED RIGID STEEL CONDUIT

1. Galvanized rigid steel conduit (GRS or RMC) shall have a zinc coating inside and outside by means of hot-dip galvanizing. Use only threaded fittings for GRS.
2. Use GRS where subject to physical damage for exposed work in mechanical spaces, within factory or other industrial work areas, for exposed fit-up work on machinery, for exposed exterior damp or wet location work, in hazardous atmospheres, in exterior underground locations where installed beneath roadways, where ells occur in underground PVC conduits, or where turning out of concrete encased duct banks, and at other locations as specifically called out on the drawings.
3. GRS shall be used for all building interior power wiring or cables of over 600 Volts.
4. GRS shall be delivered with plastic protectors on the threads.
5. GRS threads shall not have any coating which will reduce conductivity of the joint.
6. Couplings, bends, elbows and fittings shall be subject to the same requirements as for the straight lengths.
7. Comply with ANSI C80.1 and UL 6.
8. "Kwik-Couple" type fittings are not acceptable.
9. Use polyvinylchloride (PVC) coated rigid steel conduit in accordance with NEMA RN 1, Type 40 (40 mils thick) where underground and in corrosive areas.

E. INTERMEDIATE METAL CONDUIT

1. Unless otherwise indicated on the drawings, intermediate metal conduit (IMC) may be used in any location in place of rigid galvanized steel conduit, as permitted by codes, and as approved by the Engineer.
2. Manufactured in conformance with UL standards.
3. Comply with ANSI C80.6 and UL 1242.

F. RIGID ALUMINUM CONDUIT

1. Rigid aluminum conduit shall be permitted for installation indoors in dry locations only. Under no conditions shall it be cast into concrete slabs or pass thru construction where prolonged contact will degrade the aluminum.
2. All ells used in rigid aluminum conduit systems shall be rigid galvanized steel.

3. Manufactured in conformance with UL standards.
4. Comply with ANSI C80.5 and UL 6A.

G. FLEXIBLE METAL CONDUIT

1. Flexible metal conduit may be used only where required for connection to light fixtures, motors and other equipment subject to vibration. It shall be constructed of galvanized steel. It shall be installed with connectors designed for the purpose. All flexible metal conduit shall be installed as a single piece. No joints shall be installed. Flexible conduit shall not be used in wet or dusty locations or where exposed to oil, water or other damaging environments. An equipment grounding conductor or bonding jumper shall be used at all flexible conduit installations. Flexible metal conduit shall not be used in lengths over six feet for light fixture and three feet for other connections. Flexible metal conduit shall not be used in telephone, fire alarm, intercom, security, and other communication systems.
2. Comply with UL 1.

H. LIQUIDTIGHT FLEXIBLE METAL CONDUIT

1. Weatherproof flexible metal conduit shall be wound from a single strip of steel, neoprene covered, equivalent to "Liquatite" or "Sealtite" Type "UA". It shall be installed in such a manner that it will not tend to pull away from the connectors. Provide strain relief fittings equivalent to "Kellems" as required where subject to vibration. Flexible connections to motors in dusty areas shall be dust-tight, in areas exposed to the weather - weatherproof. Length shall not exceed 3' unless permitted by the Engineer.
2. Comply with UL 360.
3. Liquidtight type connectors: UL 14814A. Fittings: With nylon insulated throat.

I. RIGID NON-METALLIC CONDUIT

1. Polyvinylchloride (PVC) Conduit:
    a. PVC conduit shall be Type II, in conformance with NEMA TC2 and the following:
        1) Schedule 40 and 80, high impact.
        2) Suitable for use with 90ºC rated wire.
        3) Conform to UL Standard 65l and carry appropriate UL listing for above and below ground use.
2. Rigid non-metallic conduit shall be constructed of PVC, nominally schedule 40 weight. If installation will enclose utility company provided conductors, verify exact type required and install in accordance with their standards, where more stringent than this specification in normal building conditions.
3. Rigid non-metallic conduit may be used in exterior wet or damp locations where installed underslab or underground. It shall not be run in interior locations, except with special permission from the Engineer for use in corrosive environments, and then only if protected from physical damage. No rigid non-metallic conduit may be installed in environmental air plenums or cast into above-grade concrete slabs. No rigid nonmetallic conduit may be installed in locations where the ambient temperature might exceed the rating of the raceway.
4. Where rigid non-metallic conduit is placed underground, as for feeder circuits, secondaries or branch circuit runs and where ell is made upward thru a slab on grade, transition the turning ell and the riser to rigid steel conduit to a height of 6" above the concrete slab.
5. Flexible non-metallic conduit shall not be used, except by special permission, obtained in writing from the Engineer.
6. Provide equipment grounding conductors of copper, sized as required by codes, in all circuits installed in rigid nonmetallic raceways.
7. Manufactured in conformance with UL standards.
8. Comply with NEMA TC 2 and NEMA TC 3.

J. RACEWAY FITTINGS

1. Fixture whips shall be 1/2" flexible, with clamp-on steel fittings at each end, six foot maximum length, with insulated throat bushings at each end and bonding locknuts. Wiring thru fixture whips shall be #12 AWG, with #12 AWG ground bonded to outlet at source end.
2. Raceway fittings (or condulets) shall be of gray iron, malleable iron or heavy copper-free cast aluminum. They shall be furnished in proper configurations, avoiding excessive plugged openings. Any openings that are left shall be properly plugged. All coverplates shall be gasketed with neoprene or similar approved materials, rated for the environment. Wiring splices within are not permitted.
3. Where required, raceway fittings shall be provided in explosion-proof configurations rated for the atmosphere. Place conduit seal off fittings at each device in accord with applicable codes. Seal off fittings shall be packed with wadding, and poured with an approved non-shrink sealing compound.
4. Where conduit transitions in a run from a cold to a warm environment, (such as at a freezer, refrigerator or exterior wall) sealoff fittings shall be placed on the warm side immediately at the boundary to prevent migration of condensation within raceway systems.
5. Conduit bodies, junction boxes and fittings shall be dust tight and threaded for dusty areas, weatherproof for exterior locations and vapor tight for damp areas. Conduit fittings shall be as manufactured by Crouse Hinds, Appleton, Killark or approved equivalent. All surface mounted conduit fittings as with "FS", "FD", "GUB" Types etc., shall be provided with mounting hubs.
6. Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint and #14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs weight. Fixtures shall be installed plumb and level. Cover pendants shall be finished to match fixtures.
7. UL listed expansion/deflection fitting shall be provided at all locations where a raceway/conduit crosses a structural joint intended for expansion, contraction or deflection. Other approved means may be acceptable with permission of the Engineer. Provide copper ground bonding jumpers across expansion fittings.
8. Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.
9. Fittings for EMT conduits 2-1/2" and smaller shall be of steel, compression type. Fittings for sizes larger than 2-1/2" shall be setscrew, with two setscrews each side. Conduit stops shall be formed in center of couplings. All EMT connectors and couplings shall be of formed steel construction. All connectors shall be insulated throat type.
10. Indentation or die-cast fittings shall not be permitted in any raceway system.
11. Compression type fittings shall be utilized for EMT conduit installed in damp or dusty locations, or where otherwise indicated.
12. All conduit fittings shall be securely tightened. All threaded fittings shall engage seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.
13. Comply with NEMA FB1 and UL 514B.

2.2 SURFACE MOUNTED METAL RACEWAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wiremold
2. Istrol
3. Hubbell

B. Surface metal raceways shall only be provided where indicated on the drawings.

C. System: Provide surface raceway systems for branch circuit and data network voice, video and other low-voltage wiring. Surface raceway system shall consist of raceway bases, covers, pre-divided raceway bases, dual covers, appropriate fittings and device mounting plates necessary for a complete installation.

D. Surface metal raceways shall be constructed of code gauge corrosion-resistant galvanized steel or aluminum extrusions, and finished in an ivory, buff or grey color as selected by the Engineer. Finishes shall be suitable for field painting, prepared by the installing Contractor as necessary.

E. Surface metal raceways, where used as raceways only, shall be sized for the conductors indicated. Nominal minimum size of such raceways shall be equivalent to Wiremold Co. Series #700, or equivalent by Walkerduct, Isotrol or other approved manufacturer.

F. Surface metal raceways to be furnished with integral receptacles shall have Simplex Nema 5-20R outlets spaced on centers as indicated on plans. These shall be Wiremold Co. #2200 Series or equivalent Walkerduct, Isotrol or other approved manufacturer.

G. Surface Mounted Aluminum Raceways: ALDS4000 Dual Channel Aluminum Surface Raceway by The Wiremold Company.

1. Material: Alloy 6063-T5 extruded aluminum; minimum thickness 0.050-inches.
2. Finish: Satin, No. 204 clear anodized, 0.004-inch thick, Class R1 Mil-Spec.
3. Device Cover Plates: Suitable to mount commercially available duplex devices, single 1.40" and 1.59" diameter receptacles. GFCI, surge receptacles and other rectangular faced devices, and voice and data jacks. Cover plates shall be removable using standard screwdriver without marring the finish.

H. Surface metal raceways and all components and fittings shall be furnished by a single manufacturer, wherever practical. All trim and cover fittings, flush feed boxes, splices, outlet fittings, etc, necessary for a complete installation shall be provided by the installing contractor. These raceways shall be rigidly mounted with approved fasteners on not to exceed 24" centers in a run, or 6" from ends and on either side of a corner. Refer to plans for notations on exact types of these raceways and outlet configurations.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70. Minimum of 14 guage steel before finishes are applied.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireways of painted steel construction shall be corrosion-resistant, moisture and oil resistant where indicated or necessary. Wireways shall be furnished in nominal sizes of 2 ½ " X 2 ½ ", 4" X 4", 6"" X 6", 8" X 8" or 12" X 12", as indicated on plans. Furnish with hinged covers on all runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation. Provide knockouts on all runs, unless otherwise indicated or prohibited by codes.

E. Provide wireways with hangers of same manufacturer, installed so as to allow unobstructed access to wireway interior. Install at not to exceed 8'-0" centers, closer as needed at fittings and turns. Use ¼ " rod hangers minimum for up to 4"X 4", 3/8 " rod minimum up to 8"X 8", ½ " rod minimum for 12" X 12".

F. Wireway Covers: Furnish with continuous hinged covers on all runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation.

G. Finish: Manufacturer's standard enamel finish.

2.4 SUPPORTS AND HANGERS

A. Supports and hangers shall be installed in accord with all applicable codes and standards. They shall be corrosion - resistant, galvanized or furnished with an equivalent protective coating. All electrical

raceways shall be hung independently from the building structure with UL listed and approved materials. Hangers and supports depending from the support systems of other trades work shall not be permitted, except with specific approval in writing from the Engineer. The use of tie wire for support or fastening of any raceway system is prohibited. Perforated metal tape shall not be used for raceway support.

B. No raceway shall be installed on acoustic tile ceiling tees, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.

C. Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are not permitted for supports.

D. The installing contractor shall provide all necessary supports and braces for raceways, in a rigid and safe installation, complying with all applicable codes.

E. Individual conduits routed on building walls, ceilings or equipment shall be secured by two- hole galvanized malleable iron or stamped steel pipe strap or "minerallac" 2-piece straps. The straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.

F. Supports may not be fastened to roof decking on drive pins.

G. Individual conduits run on building steel shall be secured by means of clamp supports similar and equal to those manufactured by the C.C. Korn Company, Elcen Co., B-Line or approved equivalent. Provide korn clamps, bulb-tee, flange clamps, beam clamps, "minerallacs", etc.

H. Where feasible, vertical and/or horizontal runs of conduit shall be grouped in common hangers on "trapezes" of channel stock as manufactured by "Unistrut" or equivalent, 1-5/8" minimum depth. Utilize conduit clamps appropriate to the channel.

I. Channel strut systems for supporting electrical equipment or raceways shall be constructed of 16 gauge minimum hot dip galvanized steel with 9/16" diameter holes on 8" centers, with finish coat of paint as manufactured by Unistrut, B-Line, Kindorf, or approved equivalent.

J. The minimum diameter of round all-thread steel rods used for hangers and supports shall be 1/4", 20 threads per inch. All-thread rod shall be furnished with a corrosion-resistant finish.

K. Welding directly on conduit or fittings is not permitted.

L. Provide riser support clamps for vertical conduit runs. Riser support clamps shall be of heavy gauge steel construction. Install riser support clamps at each floor level penetration, or as otherwise required.

M. Provide conduit cable support clamps for vertical conductor runs as required or indicated on plans. Clamps to be insulating wedging plug, with malleable iron support ring. Install within properly sized and anchored junction box.

N. Spring steel clips and fittings such as those manufactured by HITT-Thomas, Caddy-Erico, or approved equivalent, with black oxide finish are permitted in any indoor dry location for concealed work, where acceptable to the local authority having jurisdiction.

O. Raceways shall be securely and rigidly fastened in place at intervals specified here-in-before with wall brackets, conduit clamps, approved conduit hangers, or beam clamps. Fastenings shall be made by wood screws or screw type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat treated or spring steel tension clamps on steel work. Bolts, screws, etc. used in securing the work shall be galvanized and of ample size for the service. Assembly bolts, nuts, washers, etc., shall be zinc or cadmium coated. Raceways shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joists shall avoid cutting the main reinforcing bars.

P. The use of perforated iron straps or wire for supporting conduits will not be permitted.

Q. Where conduits are installed in groups on a common steel channel type support, each conduit shall be secured by Korns, Unistrut, Kindorf clamps or equal.

R. Rigid conduits, where they enter panelboards, cabinets or pull boxes shall be secured in place by galvanized, double locknuts (one inside and one outside) and non-metallic bushings. All bushings shall have insulating material which has been permanently fastened to the fittings. Bushings for conduit 1-1/2 inches trade size and larger, which are used for power distribution, shall be complete with grounding lug and shall be bonded to the box by means of bare copper wire.

2.5 FIRESTOPPING MATERIALS

A. All conduits and cables penetrating fire or smoke rated floors, walls and ceilings shall be firestopped. Firestopping assembly must be UL listed. All corridor walls, storage room walls and mechanical room walls are to be considered minimum one-hour fire rated. Elevated slabs and floors shall also be considered minimum one-hour rated. Refer to Architectural drawings for additional rating requirements.

B. Provide shop drawings indicating penetration detail for each type of wall and floor construction. Shop drawings must be specific for each individual type. (i.e., one-hour fire rated gypsum wall board with insulated metal pipe penetration.)

C. 3M fire protection products are listed below. Equivalent products may be submitted if they are UL listed.

D. The manufacturer of the firestopping materials must provide on site training for the contractor. The training session shall demonstrate to the contractors the proper installation techniques for all the firestopping materials. The training session shall be four hours minimum. Contact the Engineer prior to conducting this training session.

E. Firestopping materials to include but not limed to the following:

1. 3M fire barrier FS-195 wrap/strip.
2. 3M fire barrier CP 25 caulk.
3. 3M fire barrier MP moldable putty.
4. 3M fire barrier RC-1 restricting collar with steel hose clamp.
5. 3M fire barrier damming materials.
6. 3M fire barrier CS-195 composite sheet.
7. 3M fire barrier fire dam 150 caulk.
8. Steel sleeves.

2.6 SPECIALTIES

A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the NEC and other applicable codes.

C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

D. Nylon pull strings shall be provided in all empty conduit and in all conduit installed for other trades. Pull strings shall be left securely tied off at each end.

E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

F. All outlet, junction and pull boxes shall be grounded with pigtail to the equipment grounding conductor.

G. All fire alarm raceways in concealed areas, data/mechanical/electrical rooms and above ceilings shall be red. Exposed fire alarm raceways shall match adjacent finishes.

H. All junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings shall be identified with panel and circuit designation on outside of covers. All junction, outlet and pull boxes in exposed areas shall be identified with panel and circuit designation on inside of covers.

2.7 COMMUNICATIONS OUTLETS

A. Outlet boxes shall be 5" square by 2-7/8" deep with single or double-gang with raised extension ring.

B. All communications outlets shall be fed with at least (1) 1-1/4" inch EMT conduits, with an absolute minimum number of bends from the outlet to the cable tray, wire way or homerun directly to the Telecommunications room. Pull boxes must be installed after every 270 degrees of bend (including offsets) or 100 feet of the conduit run.

C. When mounting the outlet box in a steel studded wall, use a back brace.

D. Use only compression fittings at joints. No more than one offset in a conduit run, unless additional pull boxes are provided after each offset.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Concealed in Ceilings and Interior Walls and Partitions: EMT, IMC or GRC
2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
3. Damp or Wet Locations: GRC
4. Exposed, Not Subject to Physical Damage: GRC, IMC or EMT. Raceway locations include the following:
    a. Electrical Rooms
5. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms (below 8'-0").
    d. Gymnasiums.

B. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

C. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface raceways only where indicated on Drawings.

F. PVC conduit and plastic molding are not acceptable except in caustic environments.

G. Aluminum is not acceptable in caustic environments.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. This Contractor shall lay-out and install all conduit systems so as to avoid any other service or systems, the proximity of which may prove injurious to the conduit, or conductors which it confines. All conduit systems, except those otherwise specifically shown to the contrary, shall be concealed in the building construction or run above ceilings. Size of all conduit shall conform to Annex C, of the National Electrical Code, unless otherwise shown on the Contract Drawings.

C. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

D. Support conduit within 12 inches of enclosures to which attached.

E. No conduit shall be installed in or below poured concrete slabs except with permission of the architect or engineer. Conduit shall be held at least 12" from flues, steam or hot water pipes.

F. All conduits in slab, under slab and in areas subject to abuse shall be shall be galvanized rigid steel with threaded fittings or rigid PVC Conduit encased in 3" (minimum) and steel reinforced concrete with dye identification.

G. Intermediate grade conduit will not be acceptable in place of galvanized rigid steel conduit.

H. All exposed conduit shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart. Randomly routed conduits will not be acceptable.

I. Conduit shall be installed in such a manner so as to insure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90° bends.

J. Junction boxes shall be installed so that conduit runs will not exceed 50', or as shown on the Contract Drawings. Junction boxes shall be sized per NEC, Article 370.

K. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the NEC, and NECA "Standard of Installation", complying with recognized industry practices.

L. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

M. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.

N. Complete installation of electrical raceways before starting installation of cables or wires within raceways.

O. Bushings shall be provided on conduits to protect cables transitioning from conduits to cable tray pathway.

P. Provide plastic bushings on the end of all conduit stub-ups.

Q. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the NEC, and NECA "Standard of Installation", complying with recognized industry practices.

R. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

S. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.

T. Raceways installed in exterior locations shall receive one coat of primer, two coats finish paint after preparation of galvanizing, color selected by Architect. Exposed raceways in painted interior areas shall be similarly painted.

U. Conduits, cables, raceways, and enclosures under metal-corrugated sheet roof decking shall not be located within 1-1/2" of the roof decking, measured from the lowest surface of the roof decking to the top of the conduit, cable, raceway, or box. GRS is acceptable to route tight to bottom of roof deck.

V. Conduits, cables, raceways, and enclosures are not permitted in concealed locations of metal-corrugated sheet decking type roofing.

W. All conduit, tubing, raceways, ducts and duct banks shall be installed in such manner as to insure against collection of trapped condensation and raceway runs shall be arranged so as to be devoid of traps.

X. Where conduits pass through exterior concrete walls of facilities, the entrance shall be made watertight. This shall be done by providing pipe sleeves in the concrete with l/2" minimum entrance seal.

Y. All necessary precautions to prevent the lodgment of dirt, plaster, or trash in all conduit or tubing, fittings and boxes during construction shall be taken. All conduit in floors, concrete or below grade shall be swabbed free of debris or moisture before wires are pulled.

Z. Liquid-tight flexible steel conduit shall be used for connections to all vibrating equipment, including motors and transformers, with a minimum of 18-inches of flex looped to avoid restraining equipment vibrating.

AA. Stub-ups to Above Recessed Ceilings:

1. Use EMT for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

BB. Grounding bushings and bonding jumpers shall be used on conduit terminations at all junction boxes, pull boxes and cabinets to maintain grounding integrity of conduit system.

CC. Do not install conduits or raceways on exterior facades or within wall cavities.

DD. All conduit and PVC conduits installed below grade or below slabs (where indicated) shall be concrete encased.

EE. Do not drill into bar joists to support raceways or cables.

FF. All utilities and underground conduits shall be surveyed and recorded on as-built drawings.

GG. All exterior conduits and raceways shall be painted.

HH. All floor slabs and concrete walls shall be x-rayed before cutting.

II. Contractor must maintain a minimum 12" clear space above, 6" below and a minimum 26" clear on one side of all cable trays and wireways (both new and existing).

JJ. Absolutely no "LB's" are allowed in any communications conduit installation.

KK. Conduit ends at a wireway will be mechanically fastened, have plastic bushings, and be wire bonded to the wireway.

LL. Underground electric, cable TV, telephone service or other rigid steel conduit and underfloor rigid steel conduit below the concrete floor slab shall be painted with two coats of bitumastic paint, such as "Asphaltum".

MM. All underground or underfloor conduits shall be swabbed free of all moisture and debris before conductors are pulled.

NN. At least two (2) 1" and three (3) 3/4" conduits shall be stubbed from all flush-mounted panelboards into the nearest accessible area for future use. Provide suitable closures for these stubs. Identify each stub with a suitable hang tag.

OO. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

PP. All underground conduits shall be buried to minimum depth of 24" from the top of the concrete encasement or raceway to finished grade, unless otherwise noted on plans. Observe minimum burial requirements of local utility company where their standards or regulations apply. Conduits containing primary power conductors, (higher than 600 volts to ground) shall be 48" to top below finished grade, unless otherwise noted on plans. Conduits containing secondary power conductors, (600 volts and less to ground) shall be 36" to top below finished grade, unless otherwise noted on plans.

QQ. Provide uni-strut racks where multiple conduits are supported at one location.

RR. Provide separate a completely separate raceway system of conduits, pull-boxes, etc. for each emergency power branch and for normal power for complete separation per NEC.

SS. Where existing panels are flush-mounted in walls, contractor shall cut, patch, and repair existing construction as required for concealed conduit entry for new connections to those panels.

TT. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

UU. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.4 SPECIALTIES

A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the NEC and other applicable codes.

C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

D. Pulling lines shall be left in all open conduit systems and shall be non-metallic, left securely tied off at each end cap any unused conduits.

E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

F. All metal boxes, junction boxes and pull boxes shall be grounded with pigtails to the equipment grounding conductor.

G. All empty raceways inside switchgear and open spaces shall be capped.

H. All fire alarm raceways shall be red. Painted red conduit will not be accepted. Junction and pull boxes shall be identified with panel and circuit number on covers.

I. All emergency power raceways shall be blue. Painted conduit will not be accepted. Junction and pull boxes shall be identified with panel and circuit number on covers.

J. All conduits in theaters shall be black. Painted conduit will not be accepted. Junction and pull boxes shall be black and identified with panel and circuit number on inside of covers.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260535 - CABINETS, OUTLET BOXES AND PULL BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes: Boxes, enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 CABINETS, OUTLETS AND PULL BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. Cabinets for lighting and power, telephone, pull boxes, outlet boxes, or any other purposes specified or shown on the Contract Drawings, shall be constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing. Boxes assembled with sheet metal screws will not be accepted. Pull boxes shall include all boxes used to reduce the run of conduit to the required number of feet or bends, supports, taps, troughs, and similar applications and shall also be constructed as specified above.

C. All cabinets and boxes for NEMA 1 and 1A application shall be provided with knockouts, as necessary, or shall be cut in the field by approved cutting tools which will provide a clean, symmetrically cut opening. All boxes, except panelboards, shall be provided with code gauge fronts with hex head or pan head screw fasteners. Fronts for panelboards shall be as specified for panelboards.

D. Ceiling outlet boxes shall be galvanized steel, 4" octagonal, not less than 2 1/8" deep, with lugs or ears to secure covers, and those for use with ceiling lighting fixtures shall be fitted with 3/8" fixture studs fastened to the back of the boxes, where applicable. Provide adequate support with at least a 2 x safety factor for the anticipated fixture weight.

E. Special size concealed outlet boxes for clocks, speakers, alarms, TV, etc., shall be provided by the manufacturer of the equipment.

F. The location of outlets, as shown on the drawings, shall be considered as approximate only. It shall be incumbent upon this Contractor to study the general building drawings, with relation to spaces surrounding each outlet, in order to make his work fit the work of others and in order that when the devices or fixtures are installed, they will be symmetrically located and will not interfere with any other work or equipment. Any change in fixture or layout shall be coordinated with and approved by the Engineer before this change is made. Regardless of the orientation shown on the drawings, all devices shall be easily accessible when installed.

G. All outlets, pull boxes, junction boxes, cabinets, etc., shall be sized per the current edition of the National Electrical Code.

H. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

I. Outlet boxes and junction or pull boxes shall be threaded for rigid-threaded conduit, dust-tight vapor-tight or weatherproof as required for areas other than for NEMA 1 or 1A application. These shall be as manufactured by Crouse-Hinds, Appleton, Killark, or approved as equivalent.

J. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

K. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

L. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

M. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

N. NEMA 1 or 1A outlet boxes or pull or junction boxes shall be as manufactured by Appleton, Steel City, T & B, or approved equivalent.

1. Outlet boxes for switches, receptacles, etc., concealed in walls shall be galvanized steel, 4” x 4” x 2 1/8” deep with plaster cover for the number of devices as required and to be flush with finished wall. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or other masonry which will not be covered with plaster or in walls covered by wood wainscot or paneling, deep sectional masonry boxes shall be used and they shall be completely covered with the plates or lighting fixtures. This Contractor shall cooperate with the brick layers, block layers and carpenters to insure that the outlet boxes are installed straight and snugly in the walls. Receptacles shall be set vertically in walls.
2. Outlet boxes for data/voice locations shall be as specified in Division 27.

O. Unless otherwise noted on the drawings or in the specifications, outlet boxes shall be installed at the following heights to centerline of box:

Wall Switches, Control Stations	3'-10"
Convenience Outlets	1'-6"
Above Counter, Convenience Outlets	Bottom at 2" above top of backsplash
TV Outlets	1'-6"
TV Outlets - At Wall Brackets	7'-2"
Desk Telephones	1'-6"

Wall-Mounted Telephone .....3'-10"
Weatherproof Outlets.....2'-2"
Disconnects, Branch Panelboards.....5'-0" max. to centerline and no more than 6'-6" to top
Fire Alarm Manual Stations.....3'-10"
Fire Alarm Audio and/or Visual Unit……80" AFF to bottom of device or 6" below ceiling, whichever is lower

Note: Contractor is to refer to Architectural elevations and coordinate device mounting heights, quantities, and locations.

P. Outlet boxes mounted in glazed tile, brick, concrete block or other types of masonry walls shall be mounted above or below the mortar joint. Do Not Split The Mortar Joint.

Q. Boxes for more than two (2) devices shall be for number of devices required and shall be one piece. No ganging of single switch boxes will be allowed.

R. Outlets provided shall have only the holes necessary to accommodate the conduit at the point of insulation and shall be rigidly secure in position. Boxes with knockout removed and openings not used shall be replaced or provided with a listed knockout closure.

S. Exterior outlets shall be die-cast aluminum, weather-proof with gasketed covers and baked on grey enamel finish, per ANSI 61.

T. Boxes up to 4-11/16 square size shall be fastened to their mounting surface with two fasteners of proper size. Larger sizes shall be fastened with four fasteners, minimum.

U. Openings for conduit entrance in cabinets and boxes shall be prefabricated, punched, drilled and/or reamed. The use of a cutting torch for this purpose is prohibited.

V. Aluminum is not acceptable in caustic environments.

2.2 COMMUNICATIONS OUTLETS

A. Outlet boxes shall be 5" square by 2-7/8" deep with single or double-gang with raised extension ring.

B. All communications outlets shall be fed with at least (1) 1-1/4" inch EMT conduits, with an absolute minimum number of bends from the outlet to the cable tray, wire way or homerun directly to the Telecommunications room. Pull boxes must be installed after every 270 degrees of bend (including offsets) or 100 feet of the conduit run.

C. When mounting the outlet box in a steel studded wall, use a back brace.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Install electrical boxes as required for splices, taps, wire pulling, equipment connections.

D. Do not install flush mounting boxes back-to-back in walls; install with minimum 6-inches separation. Install with 24-inches separation in acoustic rated walls.

E. Do not fasten boxes to ceiling support wires or other piping systems.

F. Support all boxes independently of conduit.

G. Grounding bushings and bonding jumpers shall be used on conduit terminations at all junction boxes, pull boxes and cabinets to maintain grounding integrity of conduit system.

3.2 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260553 - IDENTIFICATIONS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 DEFINITIONS AND ABBREVIATIONS

A. SWBD – Switchboard.

B. MCC - Motor Control Center.

C. DP - Distribution Panel. Electrical distribution panel which is an integral part of a switchboard or switchgear but has its own isolation circuit breaker.

D. P – Panel. Electrical distribution panels with manually operated circuit breakers which feed other distribution panels or directly to loads. These are generally the last distribution panel before the load.

E. N - Normal power system. Annotates that the associated component is part of the Normal Power distribution system and receives no backup power from the Emergency Power distribution system.

F. E - Emergency power system. Annotates that the associated component is part of the Normal Power and Emergency Power distribution systems. In the event of a loss of the supply from the normal power system, the component will receive power from the emergency power system.

G. BKR – Breaker. Switch which interrupts or establishes power flow to its associated load.

H. DISC - Disconnect Switch. Manually operated knife switch which interrupts or establishes power flow to its associated load.

1.4 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.2 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES”

F. Provide warning signs for the enclosures of electrical equipment including pad-mounted transformers, pad-mounted switches, and switchgear having a nominal rating exceeding 600 volts.

1. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.
2. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field. Sign shall be Panduit No. PASO710D72 or approved equal.

2.3 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.4 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

C. Retain paragraph below to specify type of label for identifying outdoor equipment if specified in "Identification Schedule" Article.

D. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 CABLE TIES

A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Clear

B. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Clear

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Cable Ties: For attaching tags.

1. Indoors: Plenum rated.
2. Outdoors: UV-stabilized nylon.

G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

H. Equipment, disconnect switches, switchgear, switchboards, panelboards, transformers, motor starters, variable frequency drives, special device plates, and similar materials shall be clearly marked as to their function and use. Markings shall be applied neatly and conspicuously to the front of each item of equipment with 1/2" black lamacoid plate (or equivalent) with white letters 1/4" high unless otherwise specified.

I. PANELBOARD DIRECTORIES

1. The Contractor shall provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc. controlled by each switch, breaker, fuse, etc. These directories are to be inserted into plastic cardholders on back door in each panel. Descriptions shall be approved by the Owner.

a. EXAMPLES:

LIGHTS, ROOM 100
RECEPTION, ROOM 200

2. Provide electronic Excel files of all directories to owner as part of Close-out Documentation.
3. Panel Schedules and circuit numbers on Record Drawings shall match.

J. All electrical distribution equipment shall be provided with a black lamacoid plastic plate with 1/2" white letters for panel designation and 1/4" white letters showing voltage and feeder information. This includes branch circuit panelboards, switchboards, switchgear, disconnect switches, transformers, motor starters, variable frequency drives and lighting control panels, Branch circuit switches shall be designated as to function. Electrical distribution equipment labels shall indicate the source they are fed from, and the circuit number at that source. Clearly indicate the exact label legend to be furnished with each panelboard and switchgear on the shop drawings for each item of equipment prior to submission of shop drawings. Refer to drawings for further details.

K. Where electrical distribution equipment, including branch circuit panelboards, switchboards and switchgear, are connected to an emergency source, the lamacoid plate shall be red, and the word "EMERGENCY" shall be incorporated into the legend. Also, provide similar plates and legends for automatic transfer switches, as appropriate. Refer to drawings for further details.

L. Lamacoid plates shall be located at center of top of trim for branch circuit panels, switch gear, and centered at side for branch circuit switches. Fasten with self-tapping stainless steel screws or other approved method.

M. All junction boxes utilized for life-safety branch emergency power circuits, connections, devices, etc. shall have the cover painted blue. Mark over paint with panel and circuit number.

N. All concealed junction boxes utilized for fire alarm circuits, connections, devices, etc. shall have the cover painted red. Mark over paint with stenciled letters “FA”.

O. All new receptacle cover plates shall be marked with their panel and circuit number(s) with clear, machine printed adhesive labels with black lettering. Circuit number shall also be hand written inside outlet box with black permanent marker.

P. All systems requiring room names and/or numbers for labeling or programming shall use the Owner's actual room name and numbering scheme, not floor plans. All reprogramming shall be included as required to accommodate construction phasing.

Q. All junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings shall be identified with panel and circuit designation on outside of covers. All junction, outlet and pull boxes in exposed areas shall be identified with panel and circuit designation on inside of covers.

R. The inside of all junction and backboxes shall be marked with panel and circuit number in permanent marker.

S. All identifications shall be consistent with the owner's standard practices, especially within existing facilities. Where the requirements here-in are in conflict with such standard practices, the contractor shall notify the engineer in writing prior to ordering any material for clarification.

T. Identification shall consist of all UPPER CASE LETTERS.

U. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

V. Apply identification devices to surfaces that require finish after completing finish work.

W. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification devices.

X. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

Y. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

Z. Fire alarm system: Install a nameplate on the fire alarm panel to indicate the panelboard and circuit number supplying the fire alarm system.

AA. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

BB. Accessible Raceways, More Than 600 V: Self-adhesive vinyl labels. Install labels at 10-foot maximum intervals.

CC. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

DD. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

EE. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

FF. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

GG. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

HH. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer and load shedding.

II. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

JJ. Labeling Instructions:

1. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
2. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
3. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
4. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260573 - ELECTRICAL STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Provide a short-circuit, component protection, arc-flash hazard analysis, and protective device coordination study for the electrical distribution system beginning with all power sources and ending with the lowest level power, lighting and receptacle panels, and motor control equipment.

B. This Section includes computer-based, fault-current, arc-flash and overcurrent protective device coordination studies. Hand calculations are not acceptable. Protective devices shall be set based on results of the protective device coordination study.

C. Electrical Studies shall be performed by the Low-Voltage Switchboard manufacturer. All Electrical Studies required by this specification shall be completed within five (5) weeks from award of project. The Electrical Contractor shall provide all required data to Low-Voltage Switchboard manufacturer within one (1) week and the manufacturer will have four (4) weeks to complete the studies.

D. A licensed professional engineer employee of the Low-Voltage Switchboard manufacturer shall provide electrical power system studies for the project using the latest version of one of the approved software packages. The software model files shall be submitted with the report. The analysis shall follow the latest IEEE 1584 guidelines. An example report will be provided by the Owner upon request.

E. Studies specified herein must be submitted and approved prior to release of any affected equipment. Revisions to equipment or devices necessary to meet study recommendations shall be at the Manufacturer’s expense.

F. All adjustments and settings recommended by these studies shall be made prior to any testing.

G. The analysis shall be submitted to the engineer of record prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

1.3 PURPOSE

A. The study shall calculate the worst case available short circuit current at each point in the electrical distribution system considering all power sources under all permissible system operating and switching modes. The study shall be performed in accordance with Part 3 of this specification. The overcurrent protective devices shall have an interrupting and/or withstand rating equal to or greater than the available short circuit current at the applicable time band (1/2, 5, or 8 cycle) at the point of application. Discrepancies shall be noted and called to the attention of the Engineer.

B. The overcurrent protective devices shall be analyzed for adequate short circuit rating. This analysis shall identify any potential insufficient equipment ratings of existing equipment based on actual available utility values.

C. The study shall also include an arc flash hazard analysis for all electrical equipment. The analysis shall determine the flash protection boundary, incident energy, and required level of Personal Protective

Equipment (PPE) for workers at the electrical equipment. The arc flash protection boundary and incident energy shall be determined based upon a working distance as defined in per IEEE 1584, based on system voltages The electrical distribution equipment shall be field marked with this information in accordance with NFPA 70E.

D. The above study shall use equipment designation (labeling) that is consistent with the electrical system diagrams. Equipment shall be readily identifiable without the use of a cross reference list.

1.4 SUBMITTALS

A. Product Data: Computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:

1. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

    a. Coordination-study input data, including completed computer program input data sheets.
    b. Study and Equipment Evaluation Reports.
    c. Coordination-Study Report.
    d. Short Circuit Study and Coordination Study including all input data.
    e. Study recommendations for device settings, fuse types/ sizes and Equipment Evaluation findings.
    f. Report shall include any identified recommendations for improvements or suggestions for correction of deficiencies for consideration by the Engineer.
    g. Arc-Flash Hazard Calculations and list of data for Labels, including any recommendations to reduce any PPE Category 4 or higher hazard level to a PPE Category 3 or lower hazard level.

2. The results of the study shall be summarized in report form, for review and approval by the Engineer.
3. The results of all studies shall include the following:

    a. Descriptions, purpose, basis, and scope of study.
    b. Fault current calculations including definition of terms and guide for interpretation of computer printout.
    c. Tabulations of protective device and equipment ratings versus maximum calculated short circuit duties, and commentary regarding same.
    d. Flash hazard analysis report for newly installed and directly impacted existing electrical equipment. Based on the worst case resulting in Greatest Personnel Hazard.
    e. Time versus current curves with tabulations of overcurrent protective device settings and selective coordination analysis and commentary regarding same.
    f. The above studies shall be submitted to the Engineer for review and comment, before any labels are printed.
    g. If power company review and/or approval of device settings or fuse types/sizes is required, appropriate data shall be submitted to the power company for review and/or approval. The results of the power company review and /or approval shall be forwarded to the Engineer and included in the study report.

E. The studies must bear the signature/seal of the Professional Electrical Engineer in the state where the project is located.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 (power system analysis) for general study procedures.

E. Comply with IEEE 1584 (guide for performing arc flash hazard calculations) for Arc Flash calculation procedures.

1.6 Commissioning

A. This section specifies a system or a component of a system being commissioned as defined in Section 019113 Commissioning. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Section 019113 Commissioning for detailed commissioning requirements.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Discrepancies shall be noted and called to the attention of Engineer.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

a. Circuit-breaker and fuse-current ratings and types.
b. Relays and associated power and current transformer ratings and ratios.

c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
d. Generator kilovolt amperes, size, voltage, and source impedance.
e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
f. Busway ampacity and impedance.
g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.
b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Data shall be obtained for the power sources (campus 12 kV system and generators), impedance components (transformers, cables and busway), overcurrent protective devices (fuses, circuit breakers and relays) and other relevant equipment such as automatic transfer switches. Cable data (length, quantity per phase, size and type) shall be provided by the electrical contractor. Assumptions should only be used when the actual data is not available and the assumptions should be clearly listed in the report. Assumptions shall be kept to a minimum.

C. A one line diagram shall be provided as part of the analysis and shall clearly identify individual equipment buses, bus numbers used in the analysis, cable information (length, quantity per phase, size and type), overcurrent device information (manufacturer, type and size), transformers, motors, transfer switches, generators, etc.

D. The one line and analysis shall use a numbering scheme where each bus begins with a three digit number followed by a description (e.g., 102 MDPA or 103 ELEV DISC) and each connected circuit breaker or fuse shall have a corresponding designation (e.g., 102-1 MAIN CB, 102-2 ELEVATOR FDR or 103-1 ELEV DISC CB). An example one line will be provided by the Owner upon request.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus
2. Medium-voltage switch and transformers
3. Distribution panelboards
4. Branch circuit panelboards
5. Variable Frequency Drives
6. Motor Control Centers
7. Company switches

8. Fused and non-fused disconnects
9. Low-voltage transformers
10. Individual circuit breakers
11. Automatic transfer switches
12. Generator
13. Combination starter/disconnects

B. Study electrical distribution system from normal and alternate emergency power sources throughout electrical distribution system for Project, using approved computer software program. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10
b. ANSI C57.12.22
c. ANSI C57.12.40
d. IEEE C57.12.00
e. IEEE C57.96

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.
4. Circuit Breakers: IEEE c37.13.

E. Study Report: Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

G. A table shall be included which lists the calculated short-circuit currents (rms symmetrical three phase), equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment at each bus.

H. Any inadequacies shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
3. Device settings shall protect transformers according to IEEE C57.12.91, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

H. A table shall be included which lists the recommended settings of each circuit breaker and relay.

I. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

J. Deficiencies in protection and/or coordination shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

K. The electrical engineer that performed the study shall be responsible to set the circuit breakers according to the analysis once the report has been approved by the engineer of record.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The analysis shall consider multiple possible utility scenarios as well as multiple system configurations where appropriate such as normal and emergency transfer switch positions and different main-tie-main configurations.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system. This includes all switchboards, switchgear, motor-control centers, panelboards, busway and splitters.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment locations. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category

8. Recommendation for arc flash energy reduction

M. The Arc Flash Hazard Analysis shall include recommendations for reducing Arc Flash Incident Energy (AFIE) levels and enhancing worker safety.

N. Results of the Arc Flash Hazard Analysis shall be submitted in tabular form and shall include the following information for each bus location: bus name, protective device name, bus voltage, bolted fault, arcing fault, trip/delay time, equipment type, working distance, arc flash boundary, incident energy and protective clothing category.

3.6 ARC FLASH WARNING LABELS

A. Arc flash labels shall be furnished and installed by the contractor of the Arc Flash Hazard Analysis.

B. The labels shall be 4 inches high by 6 inches wide and printed on a Brady THTEL-25-483-1-WA label type or similar. The arc flash label shall be formatted similarly to the examples shown below (Figure 1) and include the wording indicated in the table (Table 1) for each PPE category.

C. After labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

D. The label shall include the following information, at a minimum:

1. Arc Flash Incident Energy
2. Location designation
3. Nominal voltage
4. Arc Flash protection boundary
5. Hazard risk category
6. Incident energy
7. Working distance
8. PPE category
9. PPE clothing description
10. PPE equipment description
11. Voltage
12. Glove class
13. Shock protection boundaries according to NFPA 70E
14. Analysis date
15. Building name/number
16. Equipment name and the upstream tripping device.
17. Engineering report number, revision number and issue date.

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. Provide one arc flash label for all electrical equipment including, but not limited to, the following:

1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
2. For each 480 and applicable 208 volt distribution panelboard, one arc flash label shall be provided.
3. For each motor control center, one arc flash label shall be provided.
4. For each low-voltage switchboard, one arc flash label shall be provided.
5. For each switchgear, one flash label shall be provided.
6. For medium voltage switches and transformers, one arc flash label shall be provided.
7. For each fused or non-fused disconnect switch, one arc flash label shall be provided.
8. For each generator and automatic transfer switches, one arc flash label shall be provided.
9. For each variable frequency drives, one arc flash label shall be provided.
10. For each combination starter/disconnects, one arc flash label shall be provided.
11. For each fused or non-fused disconnect switch and individual circuit breakers, one arc flash label shall be provided.
12. For each low-voltage transformer, one arc flash label shall be provided.

13. For each company switch, one arc flash label shall be provided.

Figure 1. Example arc flash labels.

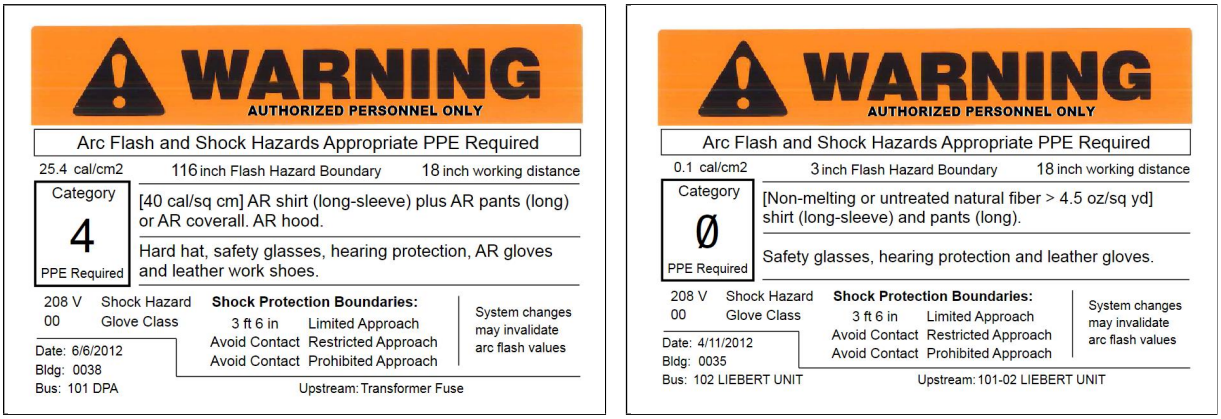

Table 1. Wording for the PPE related arc flash label fields.

Incident Energy (calories/cm^2)	PPE Category	PPE clothing	PPE equipment
0 - 1.2	0	[Non-melting or untreated natural fiber > 4.5 oz/sq yd] shirt (long-sleeve) and pants (long).	Safety glasses, hearing protection and leather gloves.
greater than 1.2 - 4	1	[4 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR faceshield.	Hard hat, safety glasses, hearing protection, leather gloves and leather work shoes.
greater than 4 - 8	2	[8 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR balaclava and AR face shield or AR hood.	Hard hat, safety glasses, hearing protection, leather gloves and leather work shoes.
greater than 8 - 25	3	[20 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR hood.	Hard hat, safety glasses, hearing protection, AR gloves and leather work shoes.
greater than 25 - 40	4	[40 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR hood.	Hard hat, safety glasses, hearing protection, AR gloves and leather work shoes.
greater than 40	X	Arc Flash Energy Exceeds the Rating of Category 4 PPE	Do not work on energized equipment

3.7 INSTALLATION/START-UP

A. The Electrical Contractor shall install equipment and protective devices in accordance with the approved short circuit and selective coordination study.

B. The Electrical Contractor shall field mark equipment with flash hazard analysis data as required in accordance with codes and standards.

C. The Manufacturer's engineer shall set all adjustable overcurrent and/or timing devices in accordance with the approved study results, and then test the devices.

D. The Manufacturer performing the study shall provide assistance to the installing Electrical Contractor during start-up of electrical system and equipment as needed.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards
2. Lighting and appliance branch-circuit panelboards

1.3 DESCRIPTION OF WORK

A. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.

B. Branch panelboards shall be as indicated on the drawings and as specified herein. The lighting panelboards shall be of the dead-front, quick-make, quick-break, bolt-on circuit breaker type, with trip indicating and trip free handles. All circuits shall be clearly and properly numbered and shall be provided with thermal magnetic protection.

C. The panelboards shall be enclosed in code gauge, galvanized steel cabinets with smooth finished hinged doors without visible external fasteners and heavy chrome locks. Provide baked-on grey enamel finish, in accord with ANSI 61. Panels shall be constructed in accord with Federal Specification W-P-115B Type 1 Class 1, UL67, UL50, NEMA P31, and NFPA 70. Locks shall all be keyed alike.

D. Each door shall have a directory card inside, covered with a plastic shield, with typewritten circuit numbers and description indicated. Room numbers shall be coordinated with final room numbers as selected by Owner, not numbers on Contract Documents.

E. Panelboard trim for surface or flush panels shall be double-hinged type, to allow exposure of dead-front breaker portion behind locked door, with screw-fastened gutter trim that is hinged to allow full access to wiring gutters.

F. Special Note: The room numbers used to fill out the panel directories shall match the actual final name and numbering scheme selected by the Owner. They shall not be filled out per the construction drawing numbering scheme, unless the Contractor is directed to do so by the Engineer.

G. Branch panelboards shall be surface or flush mounted as indicated on the Contract Drawings. Flush panels trims shall be tight to wall and interior barriers, with no gaps allowing access to live parts. Oversize trims will not be acceptable.

H. Note: Where mounted in groups, align top of trim or tub for all panels in an area. Exact mounting height of topline shall be as directed by the Engineer.

I. All main bus and connections thereto in panelboards shall be copper. All bus bars shall extend full length of panelboards.

J. All panelboards shall have full size un-insulated copper ground busses and insulated full neutral busses.

K. All panelboards shall be provided with an SPD per Specification 264313, Surge Protection for Low-Voltage Electrical Power Circuits.

1.4 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. GFCI: Ground-fault circuit interrupter

1.5 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for panelboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each panelboard cabinet lock. All keys shall match.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate space available for panelboards including clearances between panelboards and adjacent surfaces and other items. Furnish and install equipment to comply with NEC clearances.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager no fewer than 14 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.
3. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All panelboards, finishes, and all of its component parts, and controls shall have an unconditional one (1) year warranty. Warranty shall include finishes and all components to be free from defects in materials and workmanship for a period of one (1) year from date of Owner’s acceptance. Replacement of panelboards, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace surge suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.13 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.

B. Enclosures: Flush- and surface-mounted cabinets. Box width shall not exceed 20" wide. Rated for environmental conditions at installed location.

1. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Kitchen and Catering Areas: NEMA 250, Type 4X, Stainless Steel.

C. Type 1 Boxes

1. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel is not acceptable.
2. Boxes shall have removable end walls. End walls shall not be provided with concentric knockouts. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes: Panels, Back Boxes and Trim: Galvanized Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
8. All lock assemblies shall be keyed alike.

D. Incoming Mains Location: Top and bottom to match feeder conduit entry. Feeders routed through the side gutters to reach the top or bottom main breakers from the opposite end of the panel are not acceptable.

E. Phase, Neutral, and Ground Busses:

1. Material: Fully plated, hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Extend full length of panelboard and adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box. Provide where show on drawings.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Provide when supplied by K rated transformers.
5. Split Bus: Vertical buses divided into individual vertical sections.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus-Configured Terminators: Mechanical type.
3. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
5. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike. For doors more than 36 inches high, provide two latches, keyed alike.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Interior:

1. Continuous main current ratings, as indicated on associated drawings.
2. Short circuit rating as shown on the schedules.
3. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing shall be plated copper. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
5. A solidly bonded copper equipment ground bar shall be provided.
6. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.
7. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting space.
8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA/UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Circuit breakers shall be CSA and UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules.

2. Molded case branch circuit breakers shall have bolt-on type bus connectors.
3. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
4. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red indicator appearing in the clear window of the circuit breaker housing.
5. The exposed faceplates of all branch circuit breakers shall be flush with one another.
6. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors.
7. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
8. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
9. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
10. Instantaneous trip.
11. Long- and short-time pickup levels.
12. Long- and short-time time adjustments.
13. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
14. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
15. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
16. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
17. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    d. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Equipment Mounting: Install floor-mounted panels on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four (4) 1-inch and two (2) 1-1/4”-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Each door shall have a directory card inside, covered with a plastic non-yellowing shield. Directory Card to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer to create directory in Microsoft Excel; handwritten directories are not acceptable. Digital versions to be provided to Owner.

B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553.

C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553.

3.4 QUALITY CONTROL/STARTUP: Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Section 019113 Commissioning.

A. Functional Performance Tests: System functional performance testing is part of the Commissioning Process as specified in Section 019113. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

B. Demonstration and Training: Training of the owner’s operation and maintenance personnel is required in cooperation with the Commissioning Authority. The instruction shall be scheduled in coordination with the Commissioning Authority after submission and approval of formal training plans.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.
2. Spare fuse cabinet.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

a. Let-through current curves for fuses with current-limiting characteristics.
b. Time-current curves, coordination charts and tables, and related data.
c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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

C. Comply with:

1. NEMA FU 1 – Low Voltage Cartridge Fuses.
2. NFPA 70 – National Electrical Code.
3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
4. UL 198E – Class R Fuses.
5. UL 512 – Fuseholders.

1.5 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three of each size and type.

C. Fuse Pullers: Two (2) for each size and type.

1.7 WARRANTY

A. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace fuses that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Owner’s acceptance.

1.8 PROJECT CONDITIONS

A. A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.3 FUSE APPICATIONS

A. Circuits 601 to 6000 amperes shall be protected by current limiting BUSSMANN HI-CAP TIME DELAY FUSES KRP-C. Fuses shall employ "O" rings as positive seals between the end bells and the fuse barrel. Fuses shall be a time-delay type and must hold 500% of rated current for a minimum of 5 seconds, clear 20 times rated current in .01 seconds or less and be listed by Underwriter's Laboratories, Inc., with an interrupting rating of 200,000 amperes RMS symmetrical. The fuses shall be UL Class L.

B. Circuits 0 to 600 amperes shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses, LPN-RK (250 volts) or LPS-RK (600 volts). All dual element fuses shall have separate overload and short circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284NF melting point alloy and shall be independent of the short-circuit clearing chamber. The fuse shall hold 500% of rated current for a minimum of l0 seconds and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes RMS symmetrical. The fuses shall be UL Class RK1.

C. Motor Circuits - All individual motor circuits rated 480 amperes or less shall be protected by BUSSMANN LOW PEAK DUAL-ELEMENT FUSES LPN-RK (250 volts) or LPS-RK (600 volts). The fuses for 1.15 service factor motors shall be installed in rating approximately l25% of motor full load current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the Type KRP-C HI-CAP Time Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element Fuses LPN RK (250 volts) or LPS-RK (600 volts) installed in rating approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class RK1 or L.

D. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual Element fuses LPN-RK (250 volts) or LPS-RK (600 volts) as shown on the drawings. The fuses shall be UL Class RK1.

2.4 LIGHTING BALLAST/DRIVER/TRANSFORMER FUSES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussman, Inc. – GLR fuses with HLR holder.
2. Tracor, Inc.; Littelfuse, Inc. Subsidiary – LGR fuses with LHR-000 holder.
3. Ferraz Shawmut, Inc. – SLR fuses.

B. Provide each lighting ballast/driver/transformer with individual protection on the line side.

C. Provide fuse and holder mounted within or as part of the fixture.

D. Provide fuse size and type recommended by the fixture manufacturer.

2.5 SPARE-FUSE CABINET

A. Manufacturer: Bussmann #SFC-FUSE-CAB spare fuse cabinet or equal.

B. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

C. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

D. Finish: Gray, baked enamel.

E. Identification: "SPARE FUSES" in 1-1/2 inch high white letters on black lamicoid plate. Mount plate on exterior of door.

F. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Fuses shall be installed when equipment is ready to be energized, including thorough cleaning and tightening of all electrical connections.

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

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energizing at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energizing of the circuit in which it is applied.

B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to insure retention of selective coordination, as designed.

C. Provide a complete set of fuses for all fusible devices. Arrange fuses so rating information is readable without removing fuse.

D. Install spare-fuse cabinet(s). Locate in Main Electrical Room.

E. Upon completion of the building, the Contractor shall provide the Owner with spare fuses in Spare-Fuse Cabinet.

3.3 IDENTIFICATION

A. Install as part of the lamicoid identification labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 262813

DIVISION 26 – ELECTRICAL

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes Interior and Exterior Luminaires, Supports and Accessories

1.3 DESCRIPTION OF WORK

A. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all luminaires, including power wiring, control wiring and accessories, in accordance with the contract documents.

B. Contractor shall coordinate with Vendors and other trades, in advance of installation work, to define all infrastructure and installation requirements. Contractor shall coordinate all infrastructure requirements with all approved lighting equipment prior to infrastructure installation. This includes, but not limited to, appropriately sized, positioned, and located junction boxes, structural supports, feeds, power conduits and control conduits, and remote code-compliant power-supply enclosures.

C. Contractor shall provide all luminaires, as herein specified, complete with lamps, drivers, power supplies, ballasts and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

D. Contractor shall coordinate all infrastructure requirements with all approved lighting equipment prior to infrastructure installation, including, but not limited to appropriately sized, positioned and located junction boxes, structural supports, feeds, power and control conduits, and remote code-compliant power-supply enclosures.

E. All luminaires, items, equipment and parts furnished and specified herein shall bear the “UL Approved” label (or other NRTL label) to indicate compliance with UL requirements. All luminaires shall be manufactured in strict accordance with the appropriate and current requirements of the National Electrical Code as verified by Underwriters Laboratories, Inc. (UL), or tested to UL standards by other nationally recognized testing laboratory (NRTL) as acceptable to Building Officials and Code Administrators International (BOCAI); the International Conference of Building Officials (ICBO); or other relevant code authority recognized by the local jurisdiction within which the project is being constructed. Such a listing shall be provided for each luminaire type, and the appropriate label or labels shall be affixed to each luminaire in a location as required by code or law. All luminaires shall be UL/NRTL listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations, as required.

F. All available finishes and colors, for each luminaire, shall be submitted to the Engineer for selection during shop drawing review. Premium finishes, where indicated, shall be provided at no additional cost premium.

G. Specifications and drawings are intended to convey all salient features, functions and characteristics of the luminaires only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper

execution and completion of the luminaries, shall be included, the same as if they were herein specified or indicated on the drawings.

H. The Owner and Engineer shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the light fixtures. The responsibility of accurately fabricating the light fixtures to the fulfillment of the specification rests with the Contractor.

I. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

J. In accordance with the above and the criteria established herein, the Contractor is responsible for assuring the final design, fabrication and installation which fulfills the requirements of the Contract Documents.

1.4 CODES: Materials and installations shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State and local codes and regulations.

1.5 REFERENCE STANDARDS: The publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. The publications may be referred to in the text by the basic designation only.

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

C. Certified Ballast Manufacturers Association (CBM): Requirements for Ballast Certification.

D. Federal Communications Commission (FCC)

E. Entertainment Services and Technology Association: ESTA E1.3 - Entertainment Technology - Lighting Control System - 0 to 10V Analog Control Protocol

F. International Electrotechnical Commission (IEC)

G. Illuminating Engineering Society of North America (IESNA)

H. Institute of Electrical and Electronic Engineers (IEEE): C62.41-91 - Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

I. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC), National Fire Protection Association
2. NFPA 101 - Life Safety Code, National Fire Protection Association

J. National Electrical Manufacturer’s Association (NEMA)

K. OSHA 29CFR1910.7 – Luminaires shall be listed by National Recognized Testing Laboratory Approved by United States Department of Labor.

L. Underwriters Laboratories, Inc. (UL)

1.6 ACRONYMS AND DEFINITIONS

A. Light Fixture (Luminaire): Complete lighting unit consisting of a lamp(s) and driver(s)/ballast(s) (when applicable) together with the parts designed to distribute the light, to position and protect the lamp(s), and to connect the lamps to the power supply.

B. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.7 EQUAL MANUFACTURERS

A. Manufacturers listed as “Equal” to the Basis of Design on the light fixture schedule shall submit product cutsheets to the Engineer ten (10) days prior to bid for final written approval. This written approval will only be issued in addendum form. “Equal” fixtures shall be of equal or better quality and performance to the fixture(s) listed with manufacturer’s model numbers. Burden of proof shall be on the Contractor, Vendor and manufacturer.

B. Upon request by Engineer, the Contractor shall submit manufacturer's computerized horizontal illumination levels using AGI32 software in footcandles at workplane (30" above finished floor), taken every 3 feet in every interior room and area. Include average maintained footcandle levels and maximum and minimum ratio.

C. Upon request by Engineer, the Contractor shall submit manufacturer's computerized horizontal illumination levels using AGI32 software in footcandles, taken every ten (10) feet at grade for the entire exterior site. Include average maintained footcandle levels and maximum and minimum ratio.

1.8 SUBMITTALS

A. Submittal data shall be in accordance with Division 01 SUBMITTAL Specification Section, IECC and as specified herein.

B. Light fixture factory shop drawings and cuts, showing fixture dimensions, photometric data and installation data shall be submitted to the Engineer for review 15 days after project award date.

C. Product Data: For each type and model of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. All available finishes and colors for each luminaire type shall be submitted to the Engineer for selection during review.
4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for light fixtures.
5. Dimensions, effective projected area (EPA), accessories, installation details and construction details.
6. Distribution data according to IESNA classification type as defined in IESNA HB-10.
7. Amount of shielding on luminaires.
8. Control type: 0-10V, DMX, bi-level, etc.
9. Warranty.

D. Shop Drawings: Including plans, elevations, sections, details, and attachment to other work.

1. Include detailed equipment assemblies and indicate electrical ratings, dimensions, emergency section, control type, wiring, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.9 QUALITY ASSURANCE

A. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and NEMA unless more stringent requirements are specified or indicated.

B. Where groups of luminaire types exhibit the same list of acceptable Manufacturers, such as downlights, accents, and wall washers, the intent is to have a final installation with the same Manufacturer's equipment across the groupings as specified for consistency of optics, aesthetics, and similarity of maintenance procedures. Mixing/matching across groups is unacceptable. This also applies to multi-phased projects with single or multiple, but related luminaire types exhibiting the same list of acceptable Manufacturers, except where products have subsequently been discontinued or significantly redesigned in size, appearance, lamping, or gear. Lamps shall be from a single manufacturer and batch.

C. Product procurement and coordination: Contractor shall:

1. Order products according to application.
2. Confirm the proper and complete catalog number with distributor and agent.
3. Ensure wiring, driver, etc meets the specifications and proper requirements.
4. Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.

1.10 COORDINATION

A. Coordinate layout and installation of lighting fixtures with all other construction that penetrates ceilings or is supported by them, including HVAC equipment, plumbing, fire-suppression system and partition assemblies. Refer to Engineer's reflected ceiling plan (RCP) for locations of all ceiling devices.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING:

1.12 The Contractor shall provide, receive, unload, uncrate, store, protect and install lamps, luminaires and auxiliary equipment, as specified herein, in accordance with respective manufacturers' project conditions of temperature and humidity and with appropriate protection against dust and dirt. Lamps for miscellaneous equipment shall be provided and installed by the Contractor according to equipment manufacturers' guidelines. All products shall be stored in manufacturer's unopened packaging until ready for installation.

1.13 EXTRA MATERIALS

A. Furnish the following extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing content:

1. LED Drivers: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.
2. LED Lamps/Boards: One (1) for every one-hundred (100) of each type and rating installed. Furnish at least two (2) of each type.

1.14 WARRANTIES

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All luminaries, finishes, poles and all of its component parts, workmanship, and controls shall have an unconditional ten (10) year on-site replacement warranty. Warranty shall include all light fixtures, lamps, drivers, poles, finishes and all components to be free from defects in materials and workmanship for a period of ten (10) years from date of Owner's acceptance. On-site replacement includes transportation, removal, and installation of new products. Replacement of luminaries, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. LED drivers: The warranty period shall not be less than ten (10) years from the date of substantial completion. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

PART 2 - PRODUCTS:

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of Design for each light fixture type shall be the first fixture manufacturer and model number for each type listed. Refer to Specification Section 260501, paragraph EQUAL MANUFACTURERS for additional requirements.

B. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Report any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS: Comply with the requirements specified in the Articles below and the Light Fixture Schedule.

A. Complete luminaires shall be in accordance with NFPA 70, NEMA, and UL 1598 listed and labeled.

B. Ballasts, drivers, or transformers, unless otherwise specified, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

C. Luminaires shall be entirely factory wired by the luminaire manufacturer in accordance with code and UL requirements and shall be furnished fully compatible with the project electrical wiring and controls system for smooth, continuous, dimming or on/off flicker-free operation.

D. Metal parts: Free of burrs, sharp corners and sharp edges.

E. Doors, frames and other internal access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers and other components from falling accidently during maintenance and when secured during operating position.

F. Mounting Frames and Rings: If ceiling system and luminaire type requires, each recessed and semi-recessed luminaire shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed as coordinated by Contractor. The frames and rings shall be one piece and of sufficient size and strength to sustain the weight of the luminaire and maintain plumb. Luminaires shall be braced such that the force required to close and/or latch lens or door frame does not lift or shift luminaire.

G. Pendant Supports: Contractor shall be responsible for coordination with Manufacturer, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within ceilings to support pendant mounted lighting equipment for a secure, neat, square, plumb appearance. Pendants shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

H. Wall Bracket (Sconce) Supports: Contractor shall be responsible for coordination with Manufacturer, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within walls to support wall mounted lighting equipment for a secure, neat, square, plumb appearance. Wall brackets shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

I. All lenses or other light diffusing elements shall be removable for access to lamp and electrical and electronic components and luminaire cleaning, however, they must otherwise be positively and securely held in-place, unless otherwise specified.

J. All lens door or holder trim flanges shall fit plumb and flush with the ceiling or wall surface. There shall be no light leaks around the interface between lens door or holder trim flanges and the ceiling or wall.

K. Mechanical Safety: Unless otherwise specified, luminaire closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

L. Unless otherwise specified, luminaires with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and re-lamping. Vapor tight luminaires shall have stainless steel pressure clamping devices.

M. Yokes, brackets and supplementary supporting members necessary for mounting lighting equipment shall be furnished and installed by the Contractor and approved by the Engineer. All materials, accessories, and any other equipment necessary for the complete and proper installation of luminaires, lamps, ballasts/neon transformers included in the contract shall be furnished and installed by the Contractor. All yokes, brackets and supplementary supports shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with all lamps, globes, lenses, lens frames or doors etc. in place.

N. All connections shall be fixed rigid by screws, rivets and/or soldering. Screws and rivets shall not be visible except as necessary for maintenance and/or aesthetic appearance. All connections shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

O. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal and the luminaire styling. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.

P. For steel and aluminum luminaires, all screws, bolts, nuts and other fastening and latching hardware shall be a cadmium or equivalent plated. For stainless steel luminaires, all hardware shall be stainless steel. For all bronze luminaires, all hardware shall be bronze.

Q. Extruded aluminum frames and trims shall be rigid and manufactured from quality aluminum without blemishes in the installed product. Miter cuts shall be accurate; joints shall be flush and without burrs and cut alignment maintained with the luminaire located in its final position.

R. Castings shall exactly replicate the approved pattern(s) and shall be free of sand pits, blemishes, scales and rust and shall be smoothly finished, excepted as necessary for an authentic historic appearance and as agreed by Engineer. Tolerances shall be provided for any shrinkage in order that the finished castings accurately fit their locations resulting in plumb and level fit and consistently tight-seamed fittings.

S. Each light fixture shall be packaged with complete instructions and illustrations on how to install.

T. Each light fixture box, container, etc shall be labeled at the factory with the type designation as indicated on the Light Fixture Schedule.

U. Fixture whips shall be 1/2" flexible, with clamp-on steel fittings at each end, six-foot maximum length, with insulated throat bushings at each end and bonding locknuts. Wiring thru fixture whips shall be #12 AWG, with #12 AWG ground bonded to outlet at source end.

V. All luminaires that are split-wired shall be provided with a permanently affixed lamacoid warning label on the ballast channel cover indicating two hot circuits present and indicating both normal and emergency power panel and circuit numbers.

W. Provide custom, factory cut stem lengths as required.

X. Contractor shall verify ceiling types prior to ordering fixtures and provide fixtures appropriate to the actual condition. This is to include specific type of lay-in ceiling grid.

Y. Exit signs and fixtures that are hatched or where the fixture type contains the suffix "EM" for emergency operation, the fixture shall have an integral 90-minute battery inverter if not powered from an emergency generator.

Z. All battery powered fixtures shall have test switches factory installed integral to the reflector. Remote test switches will not be accepted.

2.3 LUMINAIRE REFLECTORS AND TRIMS

A. Alzak cones, reflectors, baffles and louvers shall be warranted against discoloration.

B. All trims, reflectors and canopies shall fit snugly and securely to the ceiling or wall so that no light leak occurs.

C. Trims shall be self-flanged, unless otherwise specified.

D. For trimless or flangeless luminaires, Contractor shall coordinate with other Trades to achieve a trimless/flangeless installation acceptable to the Engineer. Where ceilings are drywall or plaster, this involves Level 5 finishes or as otherwise directed by the Engineer. In drywall, plaster, wood, or stone ceilings, special luminaire collars and exacting coordination are required of Contractor.

2.4 LIGHT EMITTING DIODE (LED) ELECTRONIC DRIVERS: The electronic driver shall at a minimum meet the following characteristics:

A. LED drivers shall comply with NEMA SSL 1, NFPA 70, and UL 8750 unless otherwise specified.

B. Drivers remote from luminaires shall be housed in NEMA enclosures so rated for the driver and located in code-compliant, sound-isolated, well-ventilated and easily accessible areas. Wire shall be sized according to run length and LED Manufacturer’s size and distance-of-run requirements and all in accordance with all code requirements.

C. Driver shall comply with UL 1310 Class 2 requirements for dry and damp locations, NFPA 70 unless specified otherwise. Drives shall be designed for the wattage of the LEDs used in the indicated application. Drivers shall be designed to operate on the voltage system to which they are connected.

D. LED driver shall withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.

E. LED driver shall tolerate ±10 percent supply voltage fluctuation with no adverse effects to driver or LEDs.

F. Drivers for luminaires controlled by dimming devices shall be as specified herein and equipped for dimming and conform to the recommendations of the manufacturer of the associated dimming devices to assure satisfactory operation of the lighting system. Contractor shall coordinate all wiring infrastructure to accommodate final-selected drivers and controls systems for smooth, continuous, and flicker-free operation.

G. Flicker: The flicker shall be less than 5 percent at all frequencies below 1000 Hz and without visible flicker.

1. Drivers shall meet or exceed NEMA 410 driver inrush standard.

2.5 LIGHT EMITTING DIODE (LED): The light emitting diodes shall as a minimum meet the following characteristic:

A. LED lamps shall comply with ANSI C78.1.

B. Light emitting diodes shall be tested under IES LM-80 standards.

C. Color Rendering Index (CRI) shall be 84 (minimum).

2.6 SUSPENDED LUMINAIRES

A. Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended fixtures shall have twin-stem hangers. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Rods shall be a minimum 0.18 inch diameter.

B. All suspended luminaires with a weight in excess of 150 pounds shall be fitted with safety cable of sufficient strength and length to meet all UL safety cable load-bearing requirements. Cable shall exhibit a finish (but not painted) compatible with that of the metal finish of the stem/chain/suspension-cable assembly or alternatively finished in black as approved by Engineer. Shop drawings shall indicate luminaire weight. Contractor shall coordinate structural support/attachment requirements including independent structure for safety cable attachment with Vendor, and Structural Engineer and all respective trades. Safety cable shall exhibit sufficient length to wrap tightly and entirely around structural member at least twice before attachment subject to Vendor confirmation of UL requirements and pending Structural Engineer review. Contractor shall provide labor necessary for the stem/chain-assembly-wiring-threading and safety-cable-attachment as instructed by Vendor.

2.7 LUMINAIRE SUPPORT HANGERS AND COMPONENTS

A. Wires: ASTM A641/A641M, Class 3, soft temper, galvanized regular coating, 0.1055 inches in diameter (12 gage).

B. Straps: Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

C. Rod Hangers: Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.8 FUSING: All luminaires shall be provided with fuse(s) and in-line fuse holder(s). Fuse pole mounted luminaires at handhole.

2.9 EQUIPMENT IDENTIFICATION

A. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

B. Factory-Applied Labels: Provide labeled luminaires in accordance with UL 1598 requirements. All light fixtures shall be clearly marked for operation of specific LED's and drivers according to proper type. The following characteristics shall be noted in the format "Use Only _____":

1. LED or lamp type, and nominal wattage
2. Driver or ballast type
3. Correlated color temperature (CCT) and color rendering index (CRI)
4. All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Drivers and ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.10 FACTORY APPLIED FINISH: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Engineer's reflected ceiling plan (RCP) shows actual locations of all light fixtures, diffusers and system devices. Report to the Engineer any conflicts. Do not scale plans for exact location of lighting fixtures.

B. Install luminaires in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", and NEMA standards.

C. Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.

D. Installed luminaires shall be provided with protective covering by Contractor until such time as the space(s) is cleaned and ready for occupancy.

E. Align, mount and level the luminaires uniformly. All luminaires shall be installed plumb/true and level as viewed from all directions. Luminaires shall remain plumb and true without continual adjustment.

F. Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed.

G. Recessed, semi-recessed and surface fixtures shall be independently supported from the buildings structure. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires for lighting fixture support in this section. Lighting fixtures installed in suspended ceilings shall also comply with the requirements of Division 09 Specification Sections GYPSUM BOARD, ACOUSTICAL PANEL CEILINGS and SUSPENDED DECORATIVE WOOD GRIDS. Support lay-in ceiling light fixtures as follows:

1. Support fixtures with four (4) wires, with one (1) at each corner. Hanger wires shall be installed within 15 degrees of plumb or additional support shall be provided. Wires shall be attached to fixture body and to the building structure (not to the supports of other work or equipment).
2. Where building structure is located such that 15 degrees cannot be maintained, the Contractor shall provide "Uni-strut" or similar structure to meet this requirement.
3. Support Clips: All fixtures shall be furnished with hold down clips to meet applicable seismic codes. Provide four (4) clips per fixture minimum or the equivalent thereof in the installation trim. Fasten

to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application. Contractor shall install clips per manufacturer's requirements. If screws are required, they shall be provided.

H. Lighting Fixture Supports:

1. Shall maintain the fixture positions after cleaning and re-lamping.
2. For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system.

I. Downlights, exit signs and battery pack supported by or attached to ceiling grid or tile shall be provided with one hanger wire at each end. Provide a minimum of two, located at opposite corners. Hanger wires shall be installed within 15º of plumb, maximum or additional support shall be provided. Wires shall be attached to the fixture body and to the building structure and not to the supports of other work or equipment.

J. Luminaires installed and used for working light during construction shall be replaced prior to turnover to the Owner if more than 3 percent of their rated life has been used. Fixtures shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer.

K. Suspended fixtures shall hang plumb and shall be located with no obstructions within the 45 degree range in all directions. The stem, cable, canopy and fixture shall be capable of 45 degree swing. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown.

L. Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, a finishing ring painted to match the ceiling, shall be used to conceal the junction box.

M. Rigidly align continuous rows of light fixtures for true in-line appearance.

N. Exit Signs and Emergency Lighting Units: Wire exit signs ahead of the switch to the un-switched branch circuit located in the same room or area. Connect to emergency life safety branch circuit where applicable.

O. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an un-switched power line and wired in accordance with applicable codes and the manufacturer's recommendations.

P. Light fixture whips shall be supported from the building structure. Do not clip to lay-in ceiling support wires.

Q. Transformers (applies to all transformers including (but not limited to) low voltage, neon, remote ballast, LED power supplies, exterior locations):

1. Electrical Contractor to locate all transformers (including low voltage, neon, remote ballasts, led power supplies, etc.) near fixtures in a well-ventilated and accessible location. Transformers must be installed (per codes) in accessible areas large enough to dissipate the heat of the transformer. Temperatures should not exceed 100°F (38°C) or that required by manufacturer if more stringent.
2. Electrical Contractor to determine wire size according to load and wire length to eliminate voltage drop. If voltage drop is a problem after installation, the Electrical Contractor is responsible for reinstallation (at no additional cost) of transformer and wire to solve problem.
3. Electrical Contractor to label front of transformer/driver. Example: "Large Display Case @ Entry to Main Dining Room."

R. Light fixture locations in mechanical and electrical equipment rooms/areas are approximate. Locate light fixtures to avoid equipment, ductwork, and piping. Locate around and between equipment to maximize the available light. Coordinate mounting heights and locations of light fixtures to clear equipment. Request a meeting with the Engineer if uncertain about an installation.

S. Contractor shall be responsible for sealing all luminaires for wet and damp locations (i.e. all knock-outs, all pipe and wire entrances, etc.) to prevent water wicking.

T. Coordinate between the electrical and ceiling trades to ascertain that approved luminaires are furnished in the proper sizes, with the proper flange details, and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.

U. All reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.

V. Handle all reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements with care during installation or lamping to avoid fingerprints or dirt deposits.

3.2 IDENTIFICATION

A. Light fixtures served from multiple power sources, such as emergency fixtures fed from emergency transfer relay, shall have the following label affixed to it: "DANGER - ELECTRICAL SHOCK HAZARD - LIGHT FIXTURE HAS MULTIPLE POWER SOURCES"

3.3 CLEANING

A. At completion of each phase and the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturer.

B. All fingerprints, dirt, tar, smudges, drywall mud and dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens/louvers prior to final acceptance. Cleaned with solvent recommended by the manufacturer to a like-new condition or replaced. All reflectors shall be free of paint other than factory-applied, if any.

3.4 TESTING AND ADJUSTMENT

A. The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

B. All adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Engineer. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor. All aiming and adjusting shall be performed after the entire installation is complete for each phase or area. The Contractor shall be responsible for notifying the Engineer of appropriate time for final luminaire adjustment. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night at no premium cost.

C. All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

D. Replace defective lamps, ballasts and drivers.

3.5 FIELD QUALITY CONTROL:

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal and emergency power sources.

C. Dimming Drivers. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

D. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

E. Inspect each light fixture for damage. Replace damaged light fixtures at no cost to the Owner.

F. Fixtures showing dirt, dust or fingerprints shall be restored to like new condition or shall be replaced at no cost.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Engineer.

END OF SECTION 265000

Exhibit A – Trane Chiller Submittal

Submittal

Prepared For:
Heapy Engineering

Date: April 19, 2023

Job Name: GCCC North Chillers

Trane U.S. Inc. is pleased to provide the following submittal for your review and approval.

Product Summary

Qty	Product
3	Centrifugal Water Chiller

Andrew Walsh, Account Manager
Trane U.S. Inc.
2300 CityGate Drive, Suite 100
Columbus, OH 43219
E-mail: andrew.walsh@trane.com
Office Phone: (614) 473-3500
Cell: (614) 499-1344
Fax: (614) 473-3501

The attached information describes the equipment we propose to furnish for this project and is submitted for your approval.

Submittal acceptance and return is a critical step, so please ensure submittals are returned with approval to release to production within 14 days of submittal date.

Product performance and submittal data is valid for a period of 6 months from the date of submittal generation. If six months or more has elapsed between submittal generation and equipment release, the product performance and submittal data will need to be verified. It is the customer's responsibility to obtain such verification.

Labor for support in disassembly/reassembly is included for all 3 chillers.
Does NOT include full work from Trane.
Teardown details to be provided to installing contractor.
Rigging and support materials will need to be provided by installing contractors.

Insulation is NOT provided.
With disassembly and reassembly of chillers, insulation will get damaged during handling.
Installing contractor will need to account for pricing of material and install in field after reassembly.

Unit connection locations are NOT finalized. To be determined before release.

1600 Ton chillers require remote mounted starter or AFD. Confirmation of fit by others.

Lug Coordination noted on drive detail page for incoming power.
Drive to motor terminal wiring to be determined with design engineer.

Estimated lead times are currently 40-42 weeks.

TESTING REQUIREMENTS -

Final factory testing requirements to be clarified before release. Initial project scope did NOT include factory performance or witness testing. Additional costs are necessary to account for either.

Factory test is NOT for in person witness, but is available for additional costs.
Travel, lodgings, and general per diem would need to be considered.
All chillers do not need to be tested if requested. Final decision required before release.

Recommendation for witness test scope provided in previous communication. Shown below as EXPLANATION ONLY and not included until confirmed.

Witness testing adds 4-6 weeks to the delivery schedule.
Lodging, airfare, and per diem food provided for 3 people over 2 days/2 night (typical)

Recommendation to witness test 1 – 1600 ton chiller and 1 – 800 ton chiller for timing purposes at a maximum.

SIMULTANEOUS TESTING REQUIRES FACTORY COORDINATION WITH TEST STANDS AND MAY RESULT IN A LONGER SCHEDULE DATE.
If not testing will likely occur over multiple days.
Additional 1600 ton chiller will run through same test, just not witnessed

Testing is for full load and 3 part load points (currently 75%, 50%, and 25% capacity points)
Based on AHRI testing tolerances. No special tolerances included.

If performance test only is requested on more units, pricing will be reduced.
All chillers are not required to be run through performance tests and would go through traditional air and run testing.

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Tag Data - Centrifugal Water Chiller (Qty: 3)

Item	Tag(s)	Qty	Description	Model Number
A1	1600T 514a	2	Centrifugal Chiller (CTV)	CVHF147
A2	800T 514a	1	Centrifugal Chiller (CTV)	CVHF076

Startup Included - Trane Service must start equipment for warranty to be honored
Centrifugal liquid chiller with 2 stage compressor
Incoming line voltage: 460 volt / 60 hertz
Separable shells with compressor doweling unit disassembly kit

EVAPORATOR
- Evaporator tubes: 1.00 inch (25.4 mm) dia. micro intl enhanced cu low press tbg
- Evaporator tube wall: .025 inch (0.6 mm) thick
- Evaporator fluid type: Water
- Evaporator waterbox type: Marine
- Evaporator waterbox construction: Standard
- Evaporator water box passes: Two pass
- Evaporator waterbox pressure: 150 psig (1034 kPa)
- Evaporator waterbox connection: Victaulic
- Thermal dispersion flow switch (IFM) - Field Installed (Field Installed)

CONDENSER
- Condenser shell construction: Standard
- Condenser fluid type: Water
- Condenser waterbox type: marine
- Condenser waterbox construction: Standard
- Condenser water box passes: Two pass
- Condenser waterbox pressure: 150 psig (1034 kPa)
- Condenser waterbox connection: Victaulic
- Thermal dispersion flow switch (IFM) - Field Installed (Field Installed)

Agency listing: U.L. / CUL listed
Standard air run and vibration factory test – FINAL TEST REQUIREMENTS TO BE DETERMINED
Selection tolerance: AHRI Standard tolerance
With enhanced protection
BACnet
Enhanced flow mgt package <=365 psi
Relief device: Rupture guard factory installed
Complies with ASHRAE 90.1 - 2016
R514 Refrigerant
Trane Supplied Refrigerant

5 Year Parts Warranty Unit
5 Year Labor Warranty Whole Unit with Trane Supplied Starter

Item: A3 Qty: 1 Tag(s): 1600T AFD Alternate option

Remote mounted low voltage AFD
- Remote mounted adaptive frequency drive
- Adaptive frequency drive maximum RLA: 1380 amps
- Starter power connection: Circuit breaker high-interrupt
- Standard enclosure - Nema 1

Item: A4 Qty: 1 Tag(s): 800T AFD Alternate option

Refrigerant Cooled AFD
- Unit mounted refrigerant cooled adaptive frequency drive
- Adaptive frequency drive maximum RLA: 900 amps
- Starter power connection: Circuit breaker
- Standard enclosure - Nema 1

Performance Data - CVHE/F/G R-514A 200T-2000T (CTV)

Tags	1600T 514a- V, 1600T 514a--1	800T 514a-V
Refrigeration capacity (tons)	1600.00	800.00
Total power (kW)	911.80	476.70
Primary RLA (Incoming line) (A)	1289.50	635.40
Min circuit ampacity (A)	1610.00	793.00
Max overcurrent protection (A)	2500.00	1200.00
Compressor motor RLA (A)	1313.50	684.30
Motor LRA (A)	8773.00	4743.00
Actual motor frequency (Hz)	58.2	60.0
Refrigeration Efficiency (kW/ton)	0.5699	0.5959
NPLV.IP (kW/ton)	0.3408	0.3617
Entering fluid evap (F)	54.00	54.00
Leaving fluid evap (F)	44.00	44.00
Flow evap (gpm)	3822.00	1911.00
Evap pressure drop at Design (ft H2O)	23.24	22.24
Evap fouling factor (hr-sq ft-deg F/ Btu)	0.000100	0.000100
Entering fluid cond (F)	85.00	85.00
Leaving fluid cond (F)	99.09	99.18
Flow cond (gpm)	3200.00	1600.00
Cond pressure drop at Design (ft H2O)	13.65	13.01
Cond fouling factor (hr-sq ft-deg F/ Btu)	0.000250	0.000250
Cond fluid concentration (%)	0.00	0.00
Refrigerant charge (lb)	2400.0	1100.0
Shipping weight - No Charge (lb)	50413.0	28291.0
Operating weight (lb)	63792.0	32927.0
Unit center of gravity X (in)	58.000	29.000
Unit center of gravity Y (in)	61.000	54.000
Unit center of gravity Z (in)	95.000	84.000
Left Front isolator load (lb)	9440.0	9540.0
Left Rear isolator load (lb)	11514.0	6012.0
Right Front isolator load (lb)	15111.0	10546.0
Right Rear isolator load (lb)	17238.0	6828.0
Left Middle isolator load (lb)	10488.0	-
Chiller heat rejected to ambient (MBh)	15.56	8.14
AFD heat rejected to ambient (MBh)	99.22	16.93
Maximum flow evap (gpm)	6307.60	3109.70
Evap pressure drop max flow (ft H2O)	64.91	60.67
Min flow evap (gpm)	917.30	424.10
Evap pressure drop min flow (ft H2O)	1.00	0.79
Maximum flow cond (gpm)	6891.20	2853.40
Cond pressure drop max flow (ft H2O)	52.62	36.38
Min flow cond (gpm)	1879.40	778.20
Cond pressure drop min flow (ft H2O)	5.19	3.60
Compressor Weight (lb)	8736.0	6045.0
Motor Weight (lb)	3934.0	2803.0
Starter Weight (lb)	0.0	3000.0
Suction Elbow Weight (lb)	722.0	519.0
Economizer Weight (lb)	878.0	735.0
Evap Weight (lb)	15766.0	7122.0
Evap water box weight (lb)	2733.0	1609.0
Cond Weight (lb)	13573.0	4293.0
Cond water box weight (lb)	2736.0	1056.0
Miscellaneous Weight (lb)	1334.0	1108.0

Field Installed Options - Part/Order Number Summary

This is a report to help you locate field installed options that arrive at the jobsite. This report provides part or order numbers for each field installed option, and references it to a specific product tag. It is NOT intended as a bill of material for the job.

Product Family - Centrifugal Water Chiller

Item	Tag(s)	Qty	Description	Model Number
A1	1600T 514a- V, 1600T 514a--1	2	CVHE/F/G R-514A 200T-2000T (CTV)	CVHF147
A2	800T 514a-V	1	Centrifugal Chiller (CTV)	CVHF076

Field Installed Option Description	Part/Ordering Number
Thermal dispersion flow switch (IFM) - Field Installed	
Thermal dispersion flow switch (IFM) - Field Installed	
With RuptureGuard-relief valve-field install	RUPTURE_GUARD

Unit Features

Chiller Model	Refrigeration Capacity	Total Power	Fullload Eff	Refrigerant	Line Volt	Line Frequency	Starter Type
CVHF	1600 tons	911.8 kW	0.5699 kW/ton	R-514A	480. V	60. Hz	VFD

Unit Overview

Application type	Standard cooling
Rupture Guard	RuptureGuard-relief valve-field install
Tracer Controls	BACnet
Compressor	1470
Impeller	336
Orifice	2345
NPLV.IP	0.3408 kW/ton
Rated NPLV.IP	0.3408 kW/ton

Selection Tolerances

Selection Tolerance	AHRI Tolerance

Shell Information

	Evaporator	Condenser
	Fluid Temperature	
Entering	54.00 F	85.00 F
Leaving	44.00 F	99.09 F
	Fluid Properties	
Fluid Type	water	water
Fluid Concentration	0.00 %	0.00 %
Fouling Factor	0.000100 hr-sq ft-deg F/ Btu	0.000250 hr-sq ft-deg F/ Btu
	Flow Rate	
Design Flow	3822 gpm	3200 gpm
Min Flow	917.3 gpm	1879 gpm
Max Flow	6308 gpm	6891 gpm
	Fluid Pressure Drop	
PD at Design Flow	23.2 ft H2O	13.7 ft H2O
PD at Min Flow	1.00 ft H2O	5.19 ft H2O
PD at Max Flow	64.9 ft H2O	52.6 ft H2O

	Evaporator	Condenser
	Construction Features	
Shell Size	250E	250L
Bundle Size	2300	2300
Tube Type	IMC1	TECU
Tube Thickness	0.025"	0.028"
Connection Type	Victaulic connection evap.	Victaulic connection cond.
Water box type	marine	marine
Water box pressure	150 psig	150 psig
Wbox Arrangement	Evap in LH front - evap out LH rear	Cond in LH rear - cond out LH rear
Flow Proving	Thermal dispersion flow switch (IFM)	Thermal dispersion flow switch (IFM)
Number of Passes	Two pass evap water box	Two pass cond water box
Shell Side Volume	347.38 cu ft	133.34 cu ft

Unit Electrical

Low Voltage AFD type	RM air-cooled AFD w/o harmonic filter
Low Voltage AFD connection type	Circuit breaker high-interrupt
AFD frame size	1380 max RLA
Low Voltage AFD enclosure type	Standard enclosure - NEMA 1
Motor	964
Total Power	911.8 kW

Min Circuit Ampacity	1610.00 A
Max Overcurrent Protection	2500.00 A
Nameplate RLA	1313.50 A
Primary RLA	1289.50 A
Motor Locked Rotor Amps	8773.00 A

Physical Information

Operating Weight	63792.0 lb
Cond Shell Construction	Standard condenser construction
Agency Listing	U.L. / CUL listed

Shipping Weight - No Charge	50413.0 lb
Regional Code Requirement	No Requirement
Chiller Heat Rejected to ambient	15.56 MBh

Refrigerant charge	2400.0 lb
AFD Heat Rejected to ambient	99.22 MBh

Information for AHRI and ASHRAE Projects

AHRI 550/590 2015 classification	Certified
ASHRAE 90.1 - 2007	Complies
ASHRAE 90.1 - 2007 Add. M	Complies
ASHRAE 90.1-2010	Complies
ASHRAE 90.1-2013	Complies
ASHRAE 90.1 - 2016	Complies

Certified in accordance with the AHRI Water-Cooled Water-Chilling and Heat Pump Water-Heating Packages Certification Program, which is based on AHRI Standard 550/590 (I-P) and AHRI Standard 551/591 (SI). Certified units may be found in the AHRI Directory at www.ahridirectory.org.

Warranty

Parts whole unit	Year 2nd-5th Parts Warranty Unit	**Labor 1st year**	1st year labor warranty whole unit
		Labor after 1st year	2nd-5th year labor warranty whole unit

Information for LEED Projects

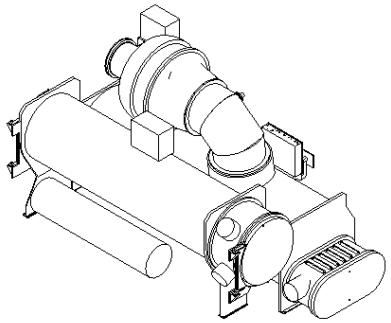
Refrigeration capacity	1600 tons	**Total power**	911.8 kW
Refrigerant charge	2400.0 lb	**NPLV.IP**	0.3408 kW/ton
		Rated NPLV.IP	0.3408 kW/ton

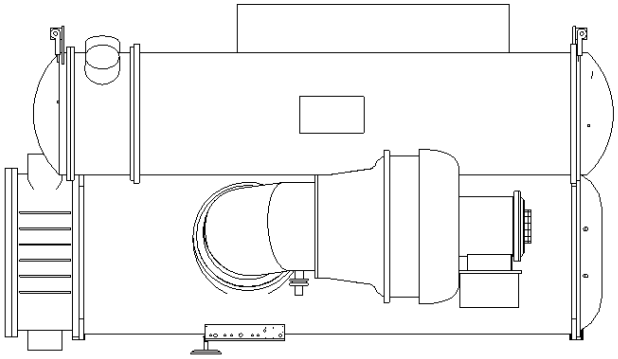
Compliant with the requirements of the LEED Energy and Atmosphere Enhanced Refrigerant Management Credit (EAc4) due to the R-514A refrigerant GWP being less than 2.

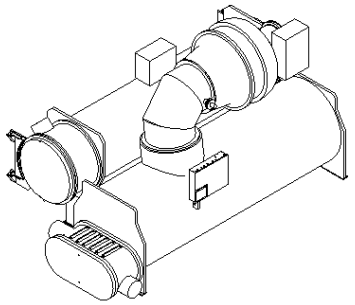
Note: Trane recognizes and respects the U.S. Green Building Council® mandate that a default 2% Refrigerant Leakage Rate (Lr) be used by all manufacturers of centrifugal chillers when calculating the Enhanced Refrigerant Management Credit because there is no industry standard. Trane has exhaustively documented a leak rate of less than 0.5% for CenTraVac™ chillers (models CVHE, CVHF, CVHG, CVHS, CVHM, CDHF, CDHG, CVHH and CDHH) and utilizes an average design refrigerant charge of less than 2 lb./ton.

The U.S. Green Building Council's LEED® green building program is the preeminent program for the design, construction, maintenance and operations of high-performance green buildings. It provides independent, third-party verification that a building project meets the highest green building and performance measures.

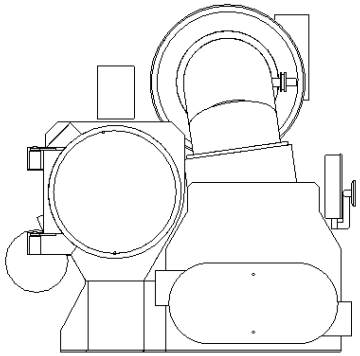
Trane Select Assist Version Number: 55252
Data Generation Date: 3/3/2023



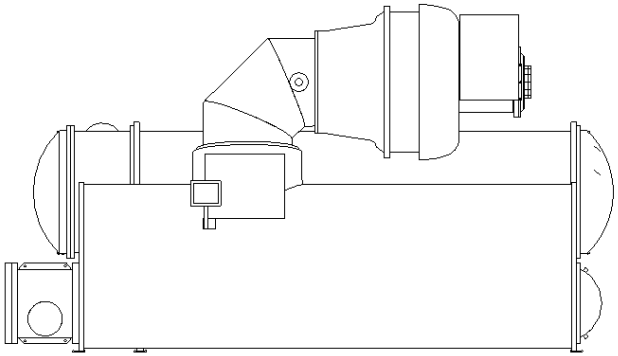




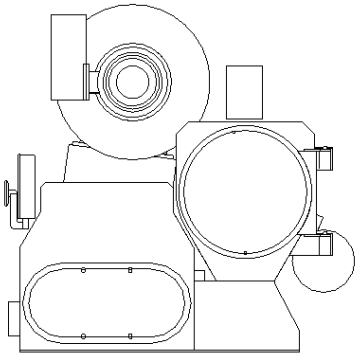
TOP VIEW



LEFT SIDE VIEW



FRONT VIEW



RIGHT SIDE VIEW

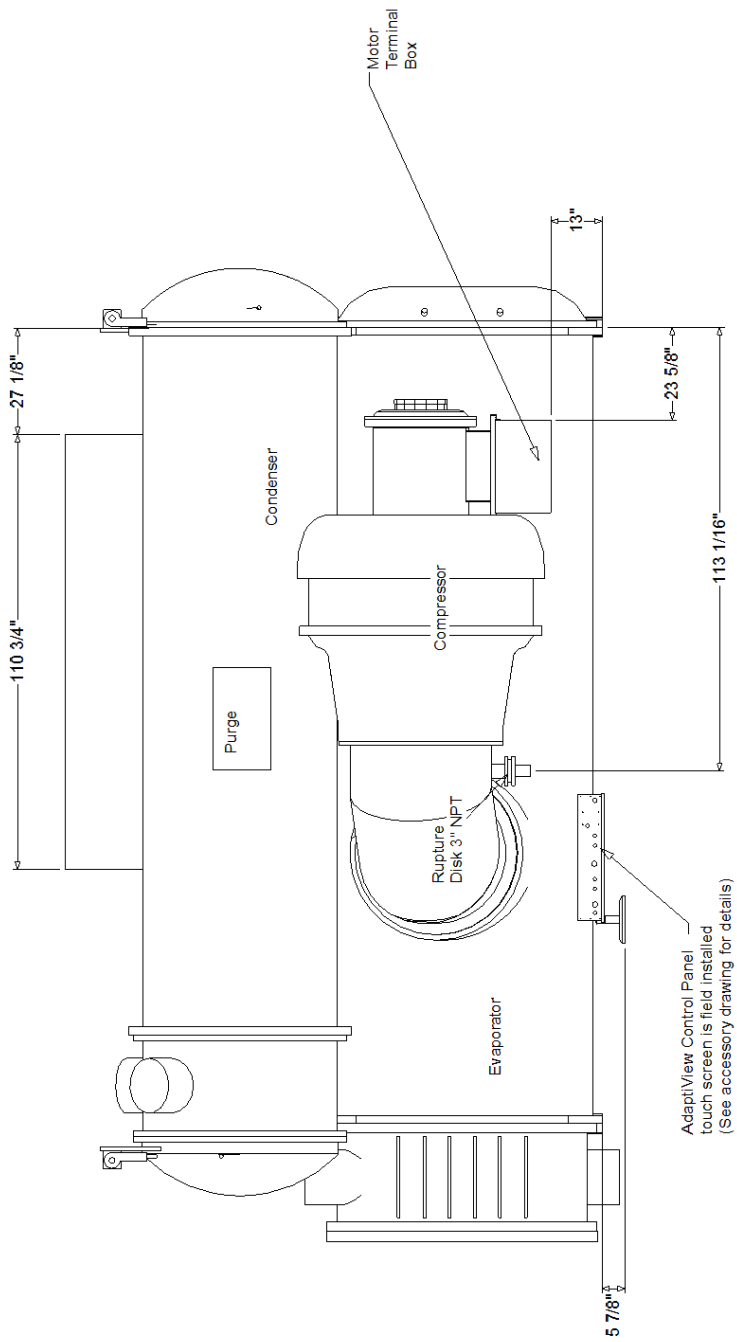
CUSTOMER NOTES:

GRAPHICS ON SUBMITTAL ARE SIMPLIFIED TO SHOW MAJOR ENVELOPE COMPONENTS.
UNIT STRUCTURE AND SUBCOMPONENTS MAY BE REMOVED FOR CLARITY.

UNLESS OTHERWISE SPECIFIED DIMENSIONAL TOLERANCE +/-1/2".
COOLING COND CONN ANGLES ARE 45 DEGREES TOP AND 22.5 DEGREES BELOW HORIZ FOR BOT.
EVAP CONNS ARE FRONT INLET AND REAR OUTLET.
WATER BOX DRAIN AND VENT LOCATIONS ARE SHOWN ON THE WATER BOX END PLATES.
WATER CONNECTION GROOVES ARE NOT COMPATIBLE WITH AGS FITTINGS

SHELL TYPE	CONN DIA	CONN TYPE	FLOW DIRECTION
EVAPORATOR	14"	VICTAULIC	IN FRONT OUT REAR
COOLING COND	14"	VICTAULIC	IN BOTTOM OUT TOP

CVHF Compressor size: 1470
Evap shell size: 250E
Cond shell size: 250L
Without additional condenser



TOP VIEW

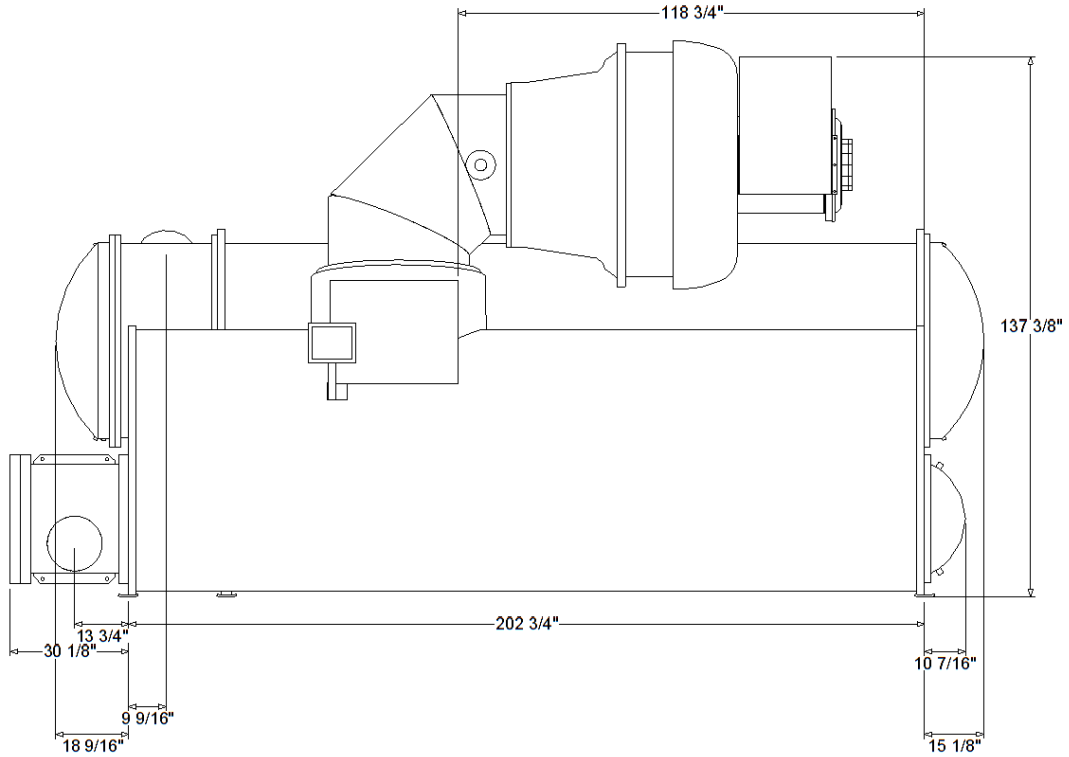
SHELL TYPE	CONN DIA	CONN TYPE	FLOW DIRECTION
EVAPORATOR	14"	VICTAULIC	IN FRONT OUT REAR
COOLING COND	14"	VICTAULIC	IN BOTTOM OUT TOP

CUSTOMER NOTES:

GRAPHICS ON SUBMITTAL ARE SIMPLIFIED TO SHOW MAJOR ENVELOPE COMPONENTS. UNIT STRUCTURE AND SUBCOMPONENTS MAY BE REMOVED FOR CLARITY.

UNLESS OTHERWISE SPECIFIED DIMENSIONAL TOLERANCE +/-1/2".
COOLING COND CONN ANGLES ARE 45 DEGREES TOP AND 22.5 DEGREES BELOW HORIZ FOR BOT.
EVAP CONNS ARE FRONT INLET AND REAR OUTLET.
WATER BOX DRAIN AND VENT LOCATIONS ARE SHOWN ON THE WATER BOX END PLATES.
WATER CONNECTION GROOVES ARE NOT COMPATIBLE WITH AGS FITTINGS

CVHF Compressor size: 1470
Evap shell size: 250E
Cond shell size: 250L
Without additional condenser



FRONT VIEW

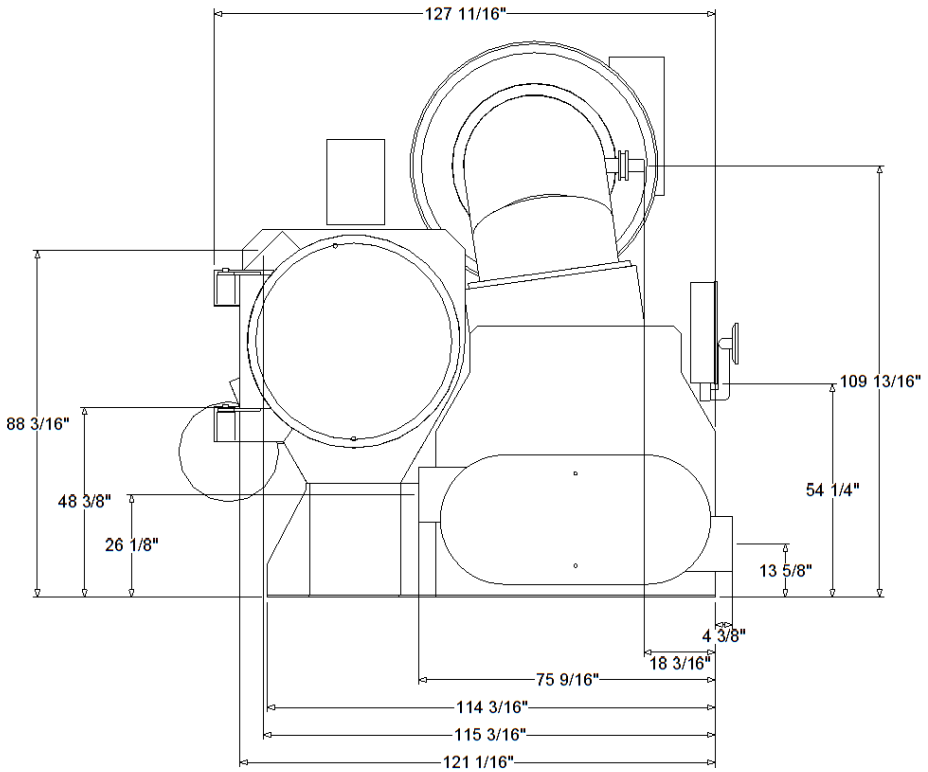
CUSTOMER NOTES:

GRAPHICS ON SUBMITTAL ARE SIMPLIFIED TO SHOW MAJOR ENVELOPE COMPONENTS.
UNIT STRUCTURE AND SUBCOMPONENTS MAY BE REMOVED FOR CLARITY.

UNLESS OTHERWISE SPECIFIED DIMENSIONAL TOLERANCE +/-1/2".
COOLING COND CONN ANGLES ARE 45 DEGREES TOP AND 22.5 DEGREES BELOW HORIZ FOR BOT.
EVAP CONNS ARE FRONT INLET AND REAR OUTLET.
WATER BOX DRAIN AND VENT LOCATIONS ARE SHOWN ON THE WATER BOX END PLATES.
WATER CONNECTION GROOVES ARE NOT COMPATIBLE WITH AGS FITTINGS

SHELL TYPE	CONN DIA	CONN TYPE	FLOW DIRECTION
EVAPORATOR	14"	VICTAULIC	IN FRONT OUT REAR
COOLING COND	14"	VICTAULIC	IN BOTTOM OUT TOP

CVHF Compressor size: 1470
Evap shell size: 250E
Cond shell size: 250L
Without additional condenser



LEFT SIDE VIEW

CUSTOMER NOTES:

GRAPHICS ON SUBMITTAL ARE SIMPLIFIED TO SHOW MAJOR ENVELOPE COMPONENTS.
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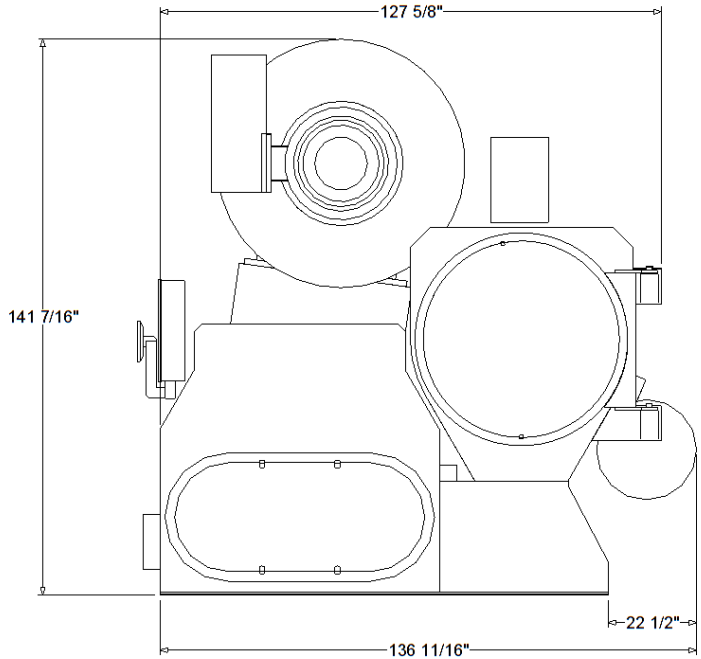
Cond shell size: 250L
Without additional condenser



RIGHT SIDE VIEW

CUSTOMER NOTES:

GRAPHICS ON SUBMITTAL ARE SIMPLIFIED TO SHOW MAJOR ENVELOPE COMPONENTS.
UNIT STRUCTURE AND SUBCOMPONENTS MAY BE REMOVED FOR CLARITY.

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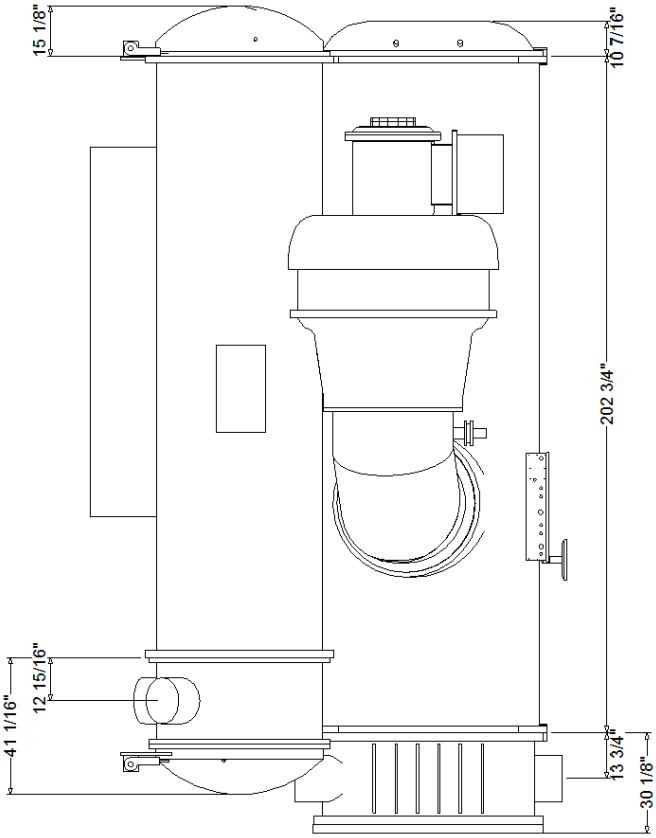
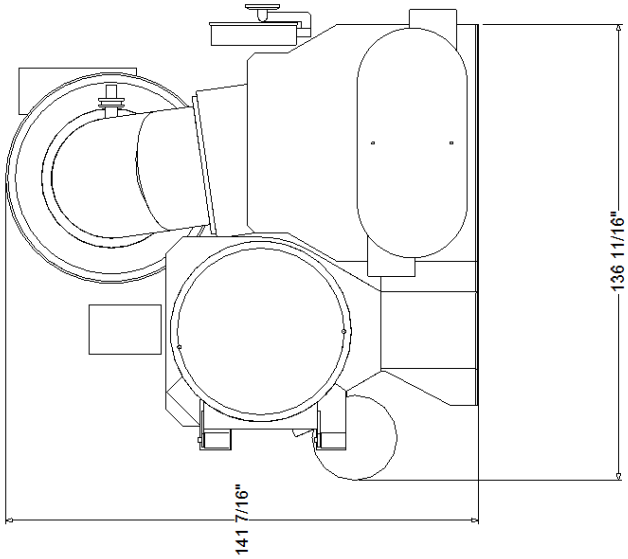


TOP VIEW



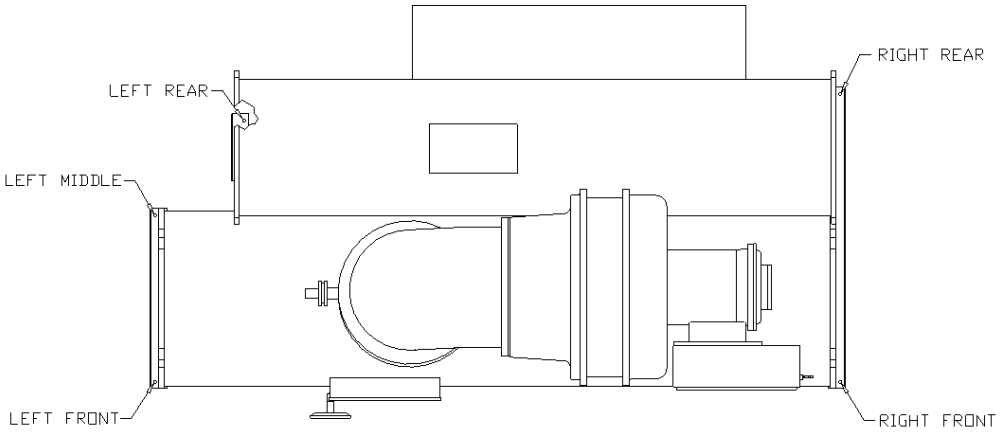
LEFT SIDE VIEW

SHIPPING WEIGHT **	50,413.0 lb
OPERATING WEIGHT	63,792.0 lb
COMPRESSOR SIZE	1470
EVAPORATOR SIZE	250E
EVAPORATOR WATERPASS	2
EVAPORATOR WATERBOX ARRANGEMENT	LFLR
CONDENSER SIZE	250L
CONDENSER WATERPASS	2
CONDENSER WATERBOX ARRANGEMENT	LRLR

* ALL PUBLISHED WEIGHTS ACCURATE TO +/- 10 %

** SHIPPING WEIGHT INCLUDES REFRIGERANT. IF ORDERED WITHOUT, CONSULT PRODUCT SUPPORT FOR DRY SHIP WEIGHT.

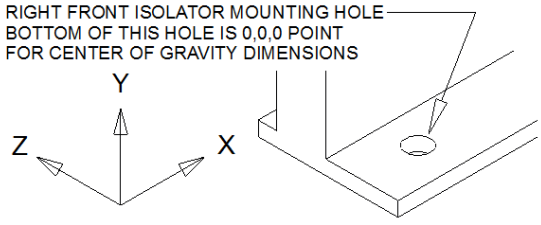
WEIGHTS AND CENTER OF GRAVITY



SPRING ISOLATOR SELECTION				
LOCATION	ISOLATOR LOAD*	VENDOR P/N	TRANE P/N	ISOLATOR COLOR
LEFT FRONT	9,440.0 lb			
LEFT REAR	11,514.0 lb			
RIGHT FRONT	15,111.0 lb			
RIGHT REAR	17,238.0 lb			
LEFT MIDDLE	10,488.0 lb			
RIGHT MIDDLE	N/A			

COMPONENT	WEIGHT*
COMPRESSOR WEIGHT	8,736.0 lb
MOTOR WEIGHT	3,934.0 lb
STARTER WEIGHT	0.0 lb
SUCTION ELBOW WEIGHT	722.0 lb
ECONOMIZER WEIGHT	878.0 lb
EVAPORATOR WEIGHT	15,766.0 lb
EVAPORATOR WATERBOXES WEIGHT	2,733.0 lb
CONDENSER WEIGHT	13,573.0 lb
CONDENSER WATERBOXES WEIGHT	2,736.0 lb
HEAT RECOVERY CONDENSER WEIGHT	N/A
HEAT RECOVERY CONDENSER WATERBOXES WEIGHT	N/A
AUXILIARY CONDENSER WEIGHT	N/A
AUXILIARY CONDENSER WATERBOXES WEIGHT	N/A
MISCELLANEOUS WEIGHT	1,334.0 lb

UNIT CENTER OF GRAVITY	
CG Z (DIMENSION FROM RIGHT TO LEFT)	95.000 in
CG X (DIMENSION FROM FRONT TO REAR)	58.000 in
CG Y (HEIGHT DIMENSION FROM FLOOR)	61.000 in



WEIGHTS	
SHIPPING	OPERATING
50,413.0 lb	63,792.0 lb

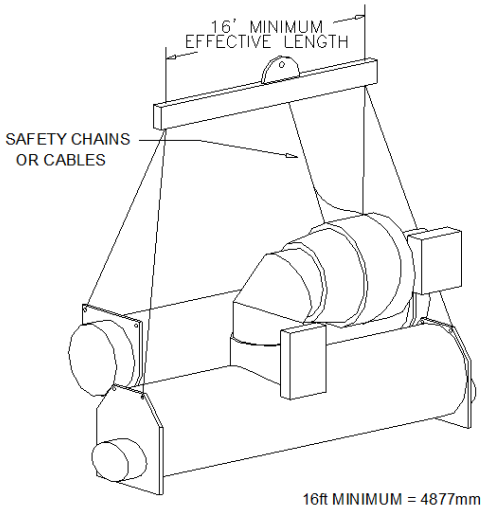
NAMEPLATE PRODUCT DESCRIPTION:

MODL	CVHF	VOLT	480	PTON	1,600.00 tons	NTON	1470
EVTM	IMC1	CDTM	TECU	CPKW	964	CPIM	336
CDBS	2300			EVSZ	250E	EVBS	2300
				ORSZ	2345	CDSZ	250L

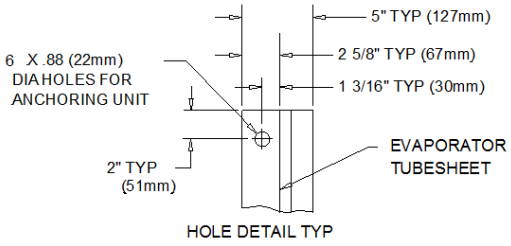
*ALL PUBLISHED WEIGHTS ACCURATE TO +/- 10 %

⚠ WARNING

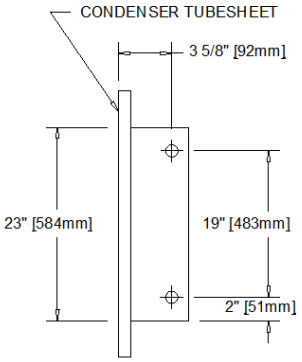
1. HEAVY OBJECTS!
   DO NOT USE CABLES (CHAINS OR SLINGS) EXCEPT AS SHOWN. EACH OF THE CABLES (CHAINS OR SLINGS) USED TO LIFT THE UNIT MUST BE CAPABLE OF SUPPORTING THE ENTIRE WEIGHT OF THE UNIT. LIFTING CABLES (CHAINS OR SLINGS) MAY NOT BE OF THE SAME LENGTH. ADJUST AS NECESSARY FOR EVEN UNIT LIFT. OTHER LIFTING ARRANGEMENTS MAY CAUSE EQUIPMENT OR PROPERTY-ONLY DAMAGE. FAILURE TO PROPERLY LIFT UNIT MAY RESULT IN DEATH OR SERIOUS INJURY. SEE DETAILS BELOW.
2. IMPROPER UNIT LIFT!
   TEST LIFT UNIT APPROXIMATELY 24 INCHES TO VERIFY PROPER CENTER OF GRAVITY LIFT POINT. TO AVOID DROPPING OF UNIT, REPOSITION LIFTING POINT IF UNIT IS NOT LEVEL. FAILURE TO PROPERLY LIFT UNIT COULD RESULT IN DEATH OR SERIOUS INJURY OR POSSIBLE EQUIPMENT OR PROPERTY-ONLY DAMAGE.
3. ATTACH SAFETY CHAIN OR CABLE AS SHOWN WITHOUT TENSION, NOT AS A LIFTING CHAIN OR CABLE, BUT TO PREVENT THE UNIT FROM ROLLING.
4. DO NOT FORKLIFT THE UNIT TO MOVE OR LIFT.
5. LIFTING HOLES PROVIDED ON CHILLER TO ATTACH CABLES (CHAINS OR SLINGS).
6. 36" (900 MM) RECOMMENDED CLEARANCE ABOVE HIGHEST POINT OF COMPRESSOR.
7. FOLLOW NEC SECTION 110 AND OTHER APPLICABLE LOCAL CODES FOR CLEARANCES IN FRONT OF ELECTRICAL ENCLOSURES.
8. SPECIFIC SHIPPING AND OPERATING WEIGHTS OF THE SUBMITTED CHILLER ARE PROVIDED IF THE CENTRIFUGAL CHILLER SELECTION WAS ENTERED IN TOPSS. DETAILED LOAD POINT AND SPRING ISOLATOR APPLICATION WEIGHTS ARE AVAILABLE FROM "CENTRAVAC ISOLATOR SELECTION REPORT" AVAILABLE FROM THE REPORT GENERATOR OF THE TRANE TOPSS CHILLER SELECTION PROGRAM. CONTACT YOUR LOCAL TRANE SALES ENGINEER IF THIS DATA IS REQUIRED.



16ft MINIMUM = 4877mm

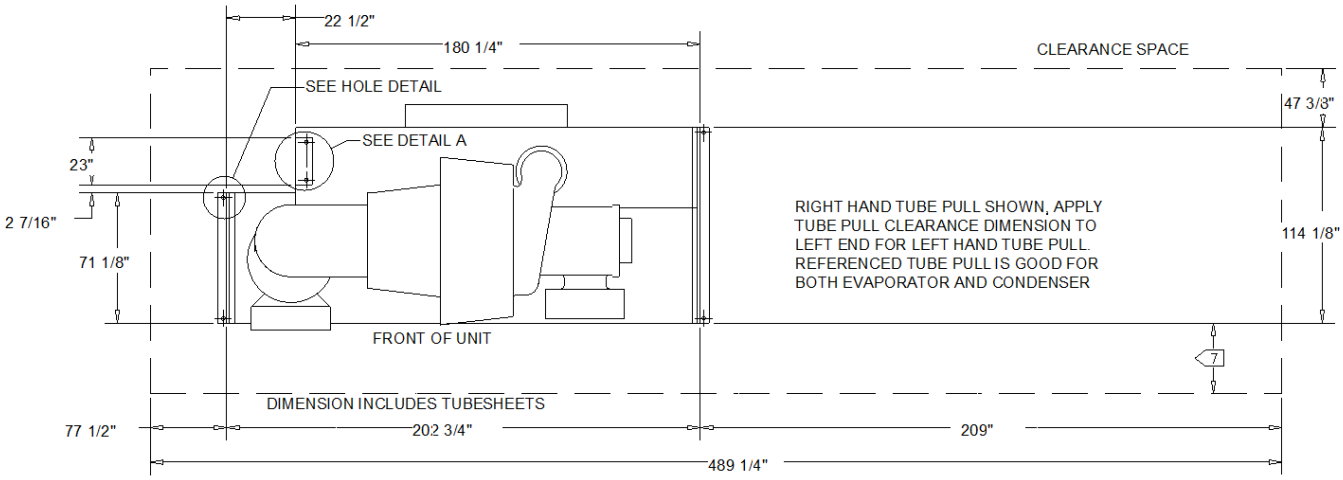


HOLE DETAIL TYP



DETAIL A

(SEE NOTE 8 ABOVE)	
MAXIMUM SHIPPING	50,413.0 lb
MAXIMUM OPERATING	63,792.0 lb



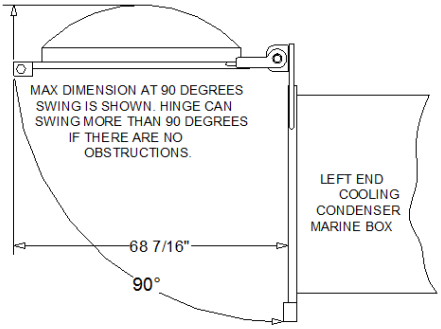
HINGE SWING DETAIL DRAWING

ALL VIEWS ON THIS PAGE ARE TOP VIEWS

DO NOT INSTALL PIPING OR ANY NON-REMOVABLE HARDWARE IN FRONT OF HINGED WATERBOXES/COVERS OR ANY ATTACHED BRACKETS AND HINGES

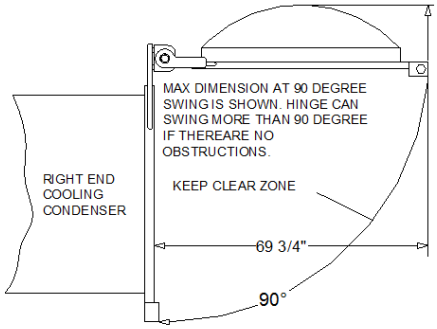
LEFT END OF COOLING CONDENSER

LEFT HAND 150 PSI MAR BOX COVER AND HINGE SWING



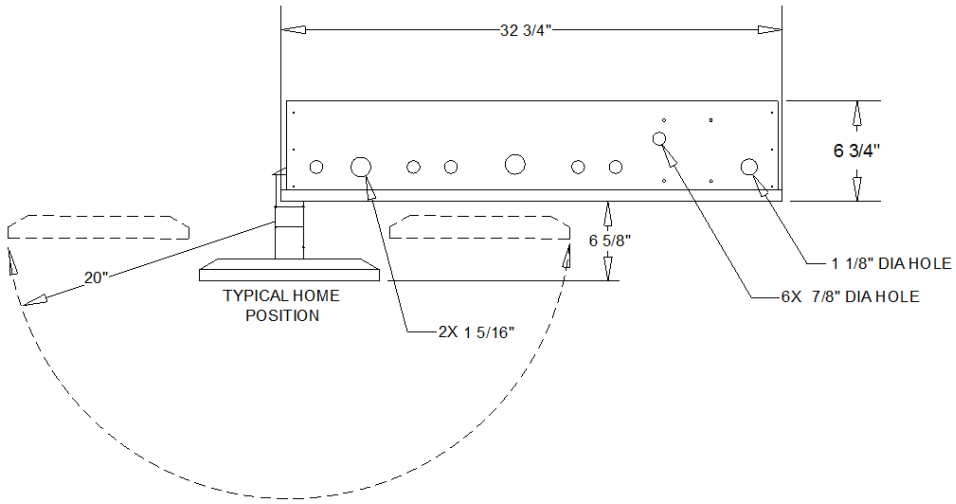
RIGHT END OF COOLING CONDENSER

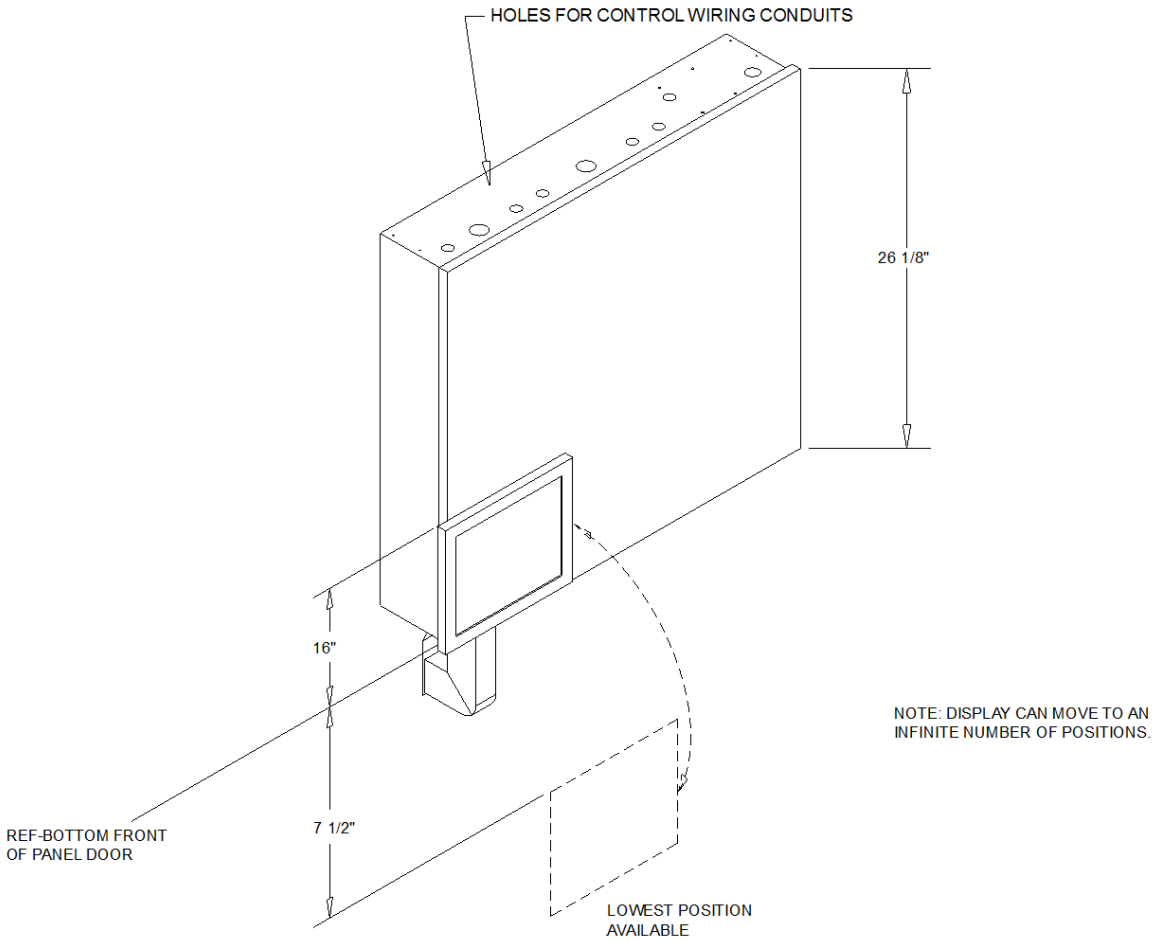
RIGHT HAND 150 PSI RETURN BOX AND HINGE SWING



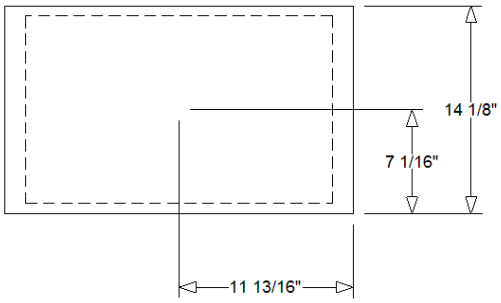
ADAPTIVIEW CONTROL PANEL

TOP VIEW



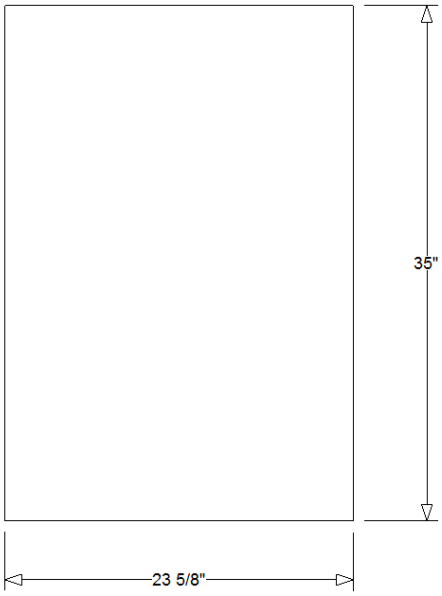


MOTOR TERMINAL BOX



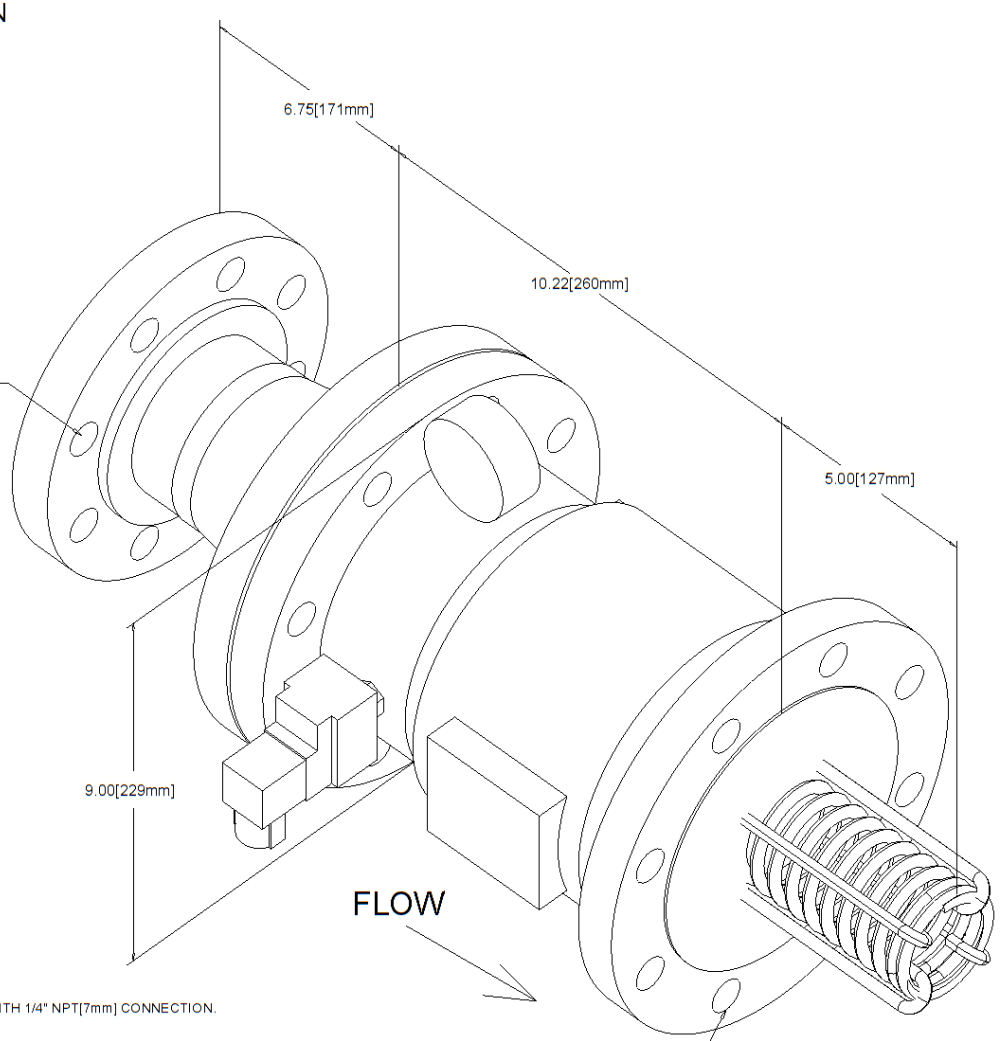
TOP VIEW

MOTOR TERMINAL BOX IS FACTORY MOUNTED
MOTOR TERMINAL BOX CAN ACCOMODATE TOP, SIDE OR BOTTOM ELECTRICAL ENTRANCE



FRONT ELEVATION

RUPTUREGUARD RELIEF VALVE FIELD INSTALLATION



BOLT PATTERN FOR 3" ANSI[76.2mm] 150 PSI[1034 kPar] FLANGE
(8X) Ø.75[19mm] HOLES EQUALLY SPACED
6.0[152.4mm] B.C.

RUPTURE DISK
NON-FRAGMENTING, SOLID METAL, REVERSE BUCKLING DISK.
RUPTURE DISK RATING OF 15 PSIG[104 kPa] ± 2 PSIG[14 kPa] AT 115 °F[46 °C].

RELIEF VALVE
VALVE RATING 15 PSIG[104 kPa] ± 5 %; COMPATIBLE WITH LOW PRESSURE CHILLERS.
STAINLESS STEEL VALVE BODY.
O-RING SEAL LOCATED IN VALVE PLUG.
FIELD SERVICEABLE O-RING.
O-RINGS COMPATIBLE WITH REFRIGERANT.

FLANGED INLET AND OUTLET ON VALVE BODY:
THREE 1/4" NPT[7mm], SQUARE RECESSED DRAIN PLUGS TO PROVIDE
DRAIN ACCESS TO THE INTERNAL CAVITY OF THE VALVE BODY. THESE ARE
LOCATED AT THE BASE OF THE VALVE PLUG AND SPACED AT 120 °.
(SEE IOM MANUAL CTV-SVX06)

THREE 1/4" NPT[7mm] TAPPINGS INTO THE DISK VALVE INTERSPACE;
AN EXCESS FLOW VALVE, PRESSURE GAUGE AND A SQUARE RECESSED
PLUG TO BE LOCATED IN THESE HOLES.
THESE ARE TO BE SPACED AT 120 °.
EXCESS FLOW VALVE - A 1/4" NPT[7mm], VALVE USED TO ENSURE THE
DISK/VALVE INTERSPACE IS MAINTAINED AT ATMOSPHERIC PRESSURE
DURING NORMAL CHILLER SERVICE.
DURING DISK/VALVE OPERATION, THIS VALVE WILL CLOSE.
PRESSURE GAUGE - A 2"[51mm] FACE, 30"[762mm]HG TO 30 PSIG[207 kPa], BRONZE TUBE, WITH 1/4" NPT[7mm] CONNECTION.
(SEE IOM MANUAL CTV-SVX06)

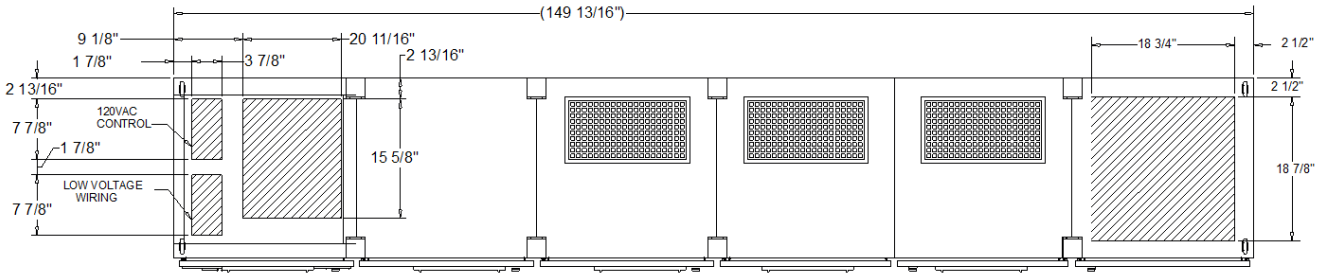
VALVES TO UNDERGO A LEAK TEST, PRESSURE TEST, AND A PULL TEST BEFORE LEAVING THE FACTORY.

2828 SCFM [1335 L/s]
"C" VALUE FOR RUPTURE GUARD ONLY = 212.1 LBS/MIN [1.6 kg/s]

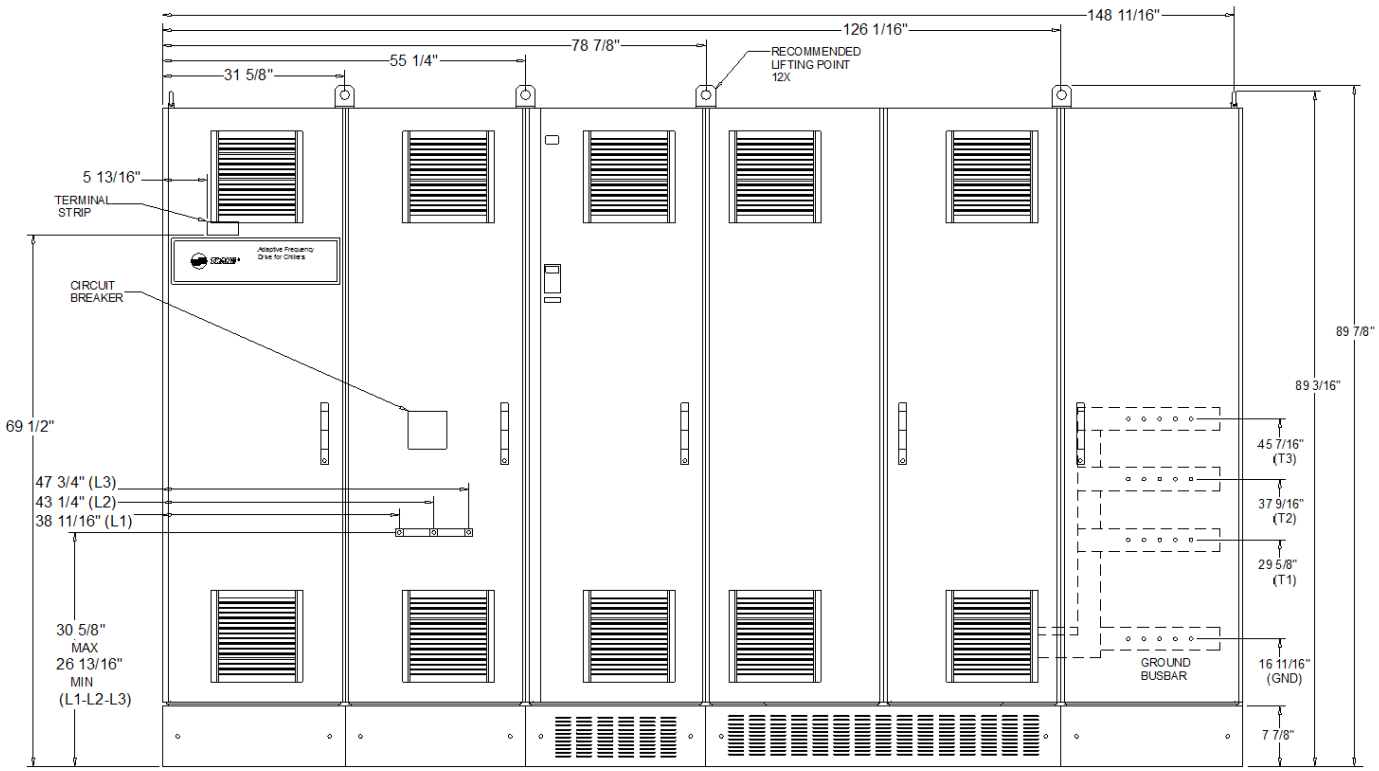
BOLT PATTERN FOR 4" ANSI[102mm] 150 PSI[1034 kPar] FLANGE
(8X) Ø.75[19mm] HOLES EQUALLY SPACED
7.50[191mm] B.C. (EACH END)

VALVE BODY	WEIGHT
4"	40LBS[18kg]

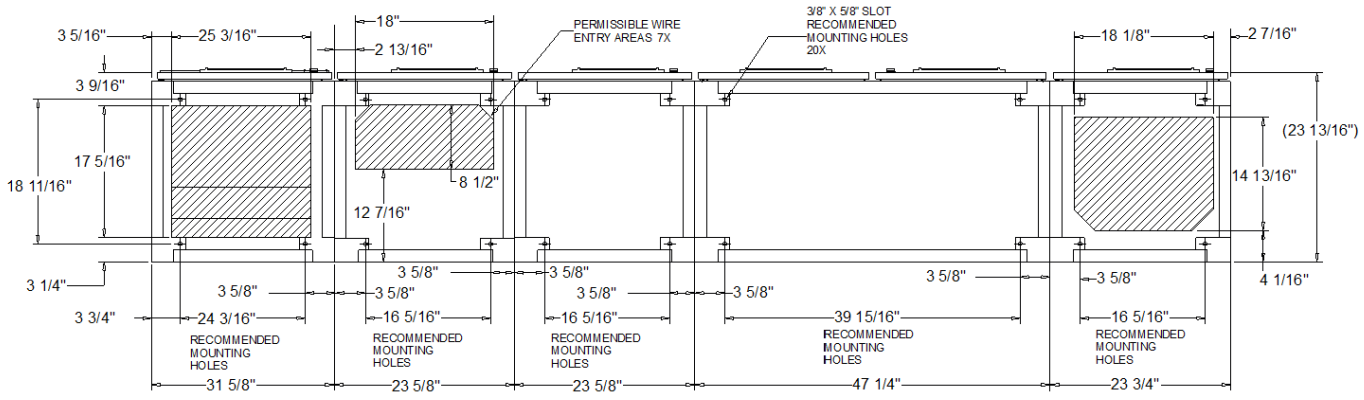
REMOTE MOUNTED ADAPTIVE FREQUENCY DRIVE W/NEMA 1 ENCLOSURE, PAGE 1 OF 2



TOP VIEW



FRONT VIEW



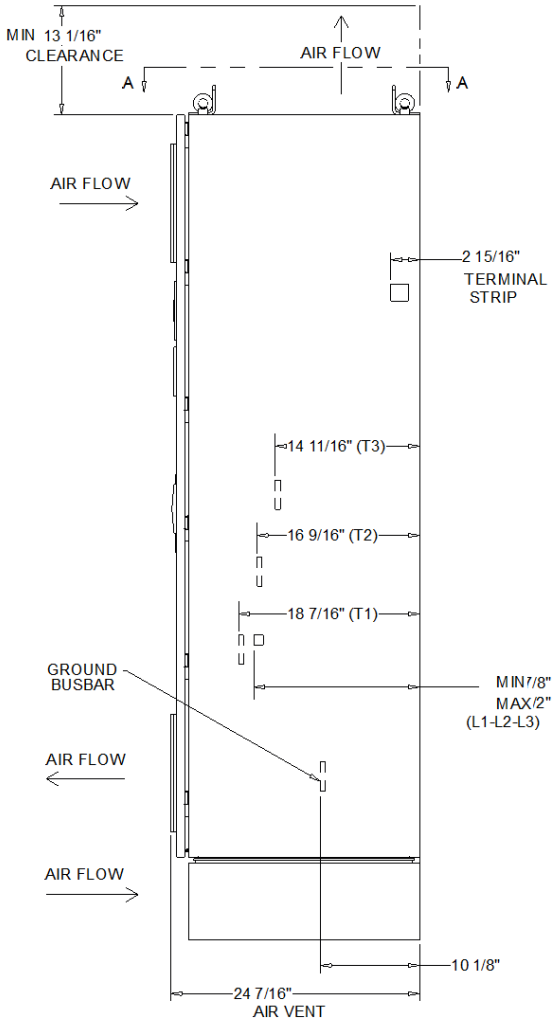
BOTTOM VIEW

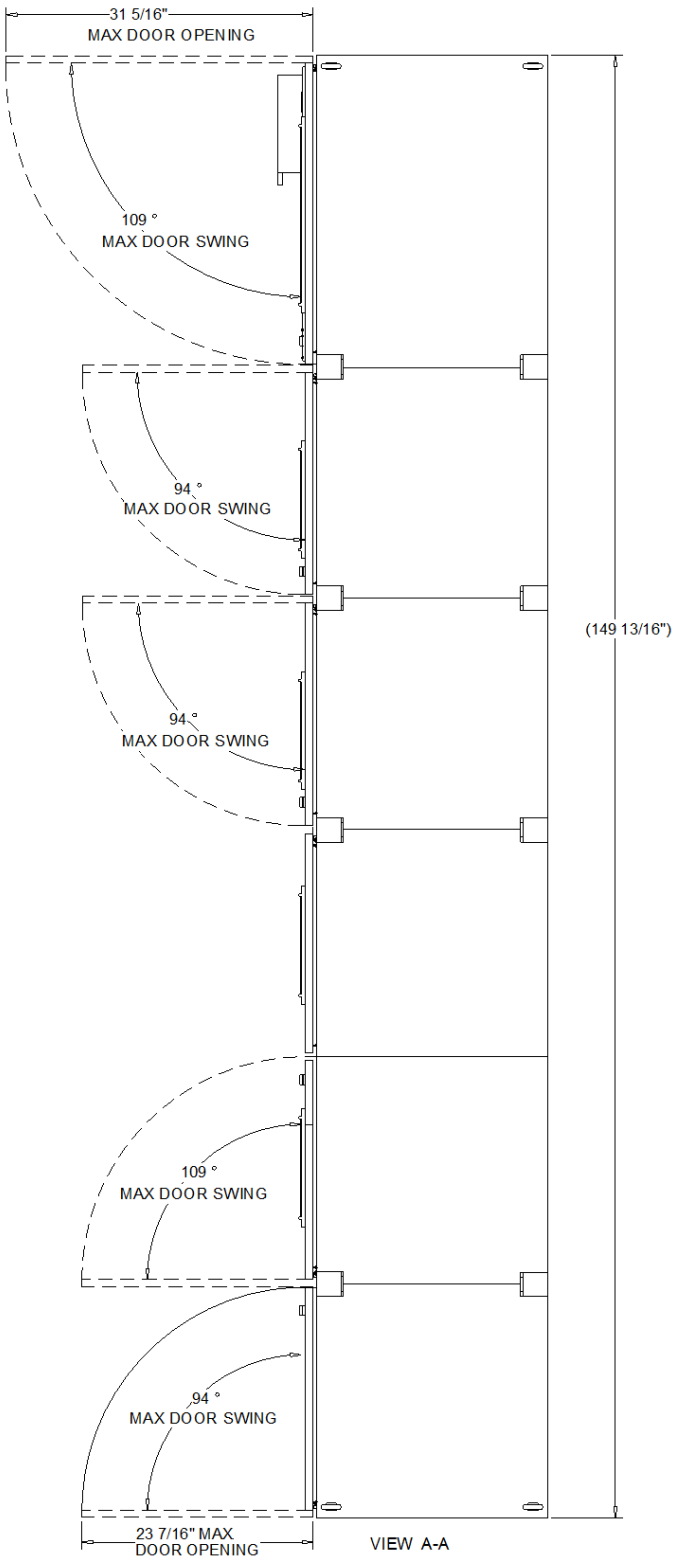
REMOTE MOUNTED ADAPTIVE FREQUENCY DRIVE W/NEMA 1 ENCLOSURE, PAGE 2 OF 2

MAX RLA	BREAKER AIC AMPS	SHORT CIRCUIT WITHSTAND RATINGS (RMS SYSMETRICAL AMPS)	INCOMING LINE PROVISIONS	OUTPUT LOAD PROVISIONS	PANEL CONNECTION	STARTER WEIGHT
1380	100,000	100,000	(8) 300-500 MCM	(5) 300-500 MCM	CBIC	3619.0 lb

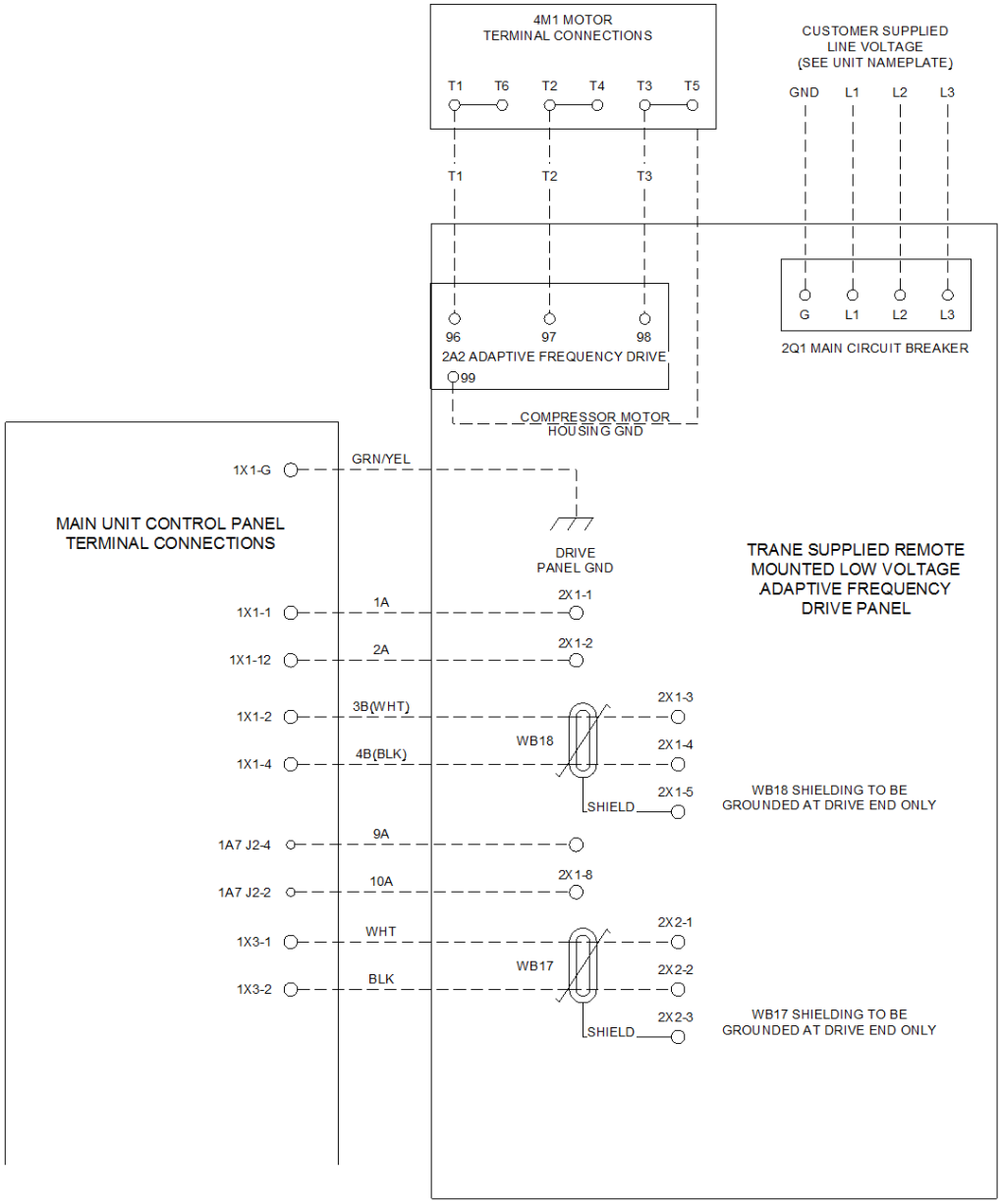
CBIC = CIRCUIT BREAKER HIGH INTERRUPT CAPACITY

NOTES:
1. FAILURE TO REMOUNT CABINET FLOOR GLAND PLATES WILL HAVE A NEGATIVE INFLUENCE ON THE UNIT'S INTERNAL COOLING CAPACITY AND CAN CAUSE TRIP FAULTS.
2. MAXIMUM CABLE LENGTH BETWEEN DRIVE AND MOTOR SHOULD BE 100 FEET OR LESS.
3. CUSTOMER PROVIDED LOAD LUGS TO BE CRIMP ON CONNECTION FOR BOLT ON LUG.
4. CONNECTIONS ARE SPACED HORIZONTALLY WITH DIMENSION/LOCATION SHOWN IN THE FRONT VIEW.
5. SEE PREVIOUS PAGE FOR STARTER ENCLOSURE DIMENSIONAL INFORMATION.
6. BREAKER AIC (AMPS INTERRUPTING CAPACITY) = APPLIES TO THE CIRCUIT BREAKER AS A COMPONENT ONLY AND IS THE MAXIMUM CURRENT THAT A CIRCUIT BREAKER CAN INTERRUPT WITHOUT DAMAGE TO ITSELF.
7. STARTER SCR (SHORT CIRCUIT RATING) = THE MAXIMUM FAULT CURRENT TO WHICH A STARTER MAY BE EXPOSED AND SAFELY BE CONTAINED WITHIN THE STARTER ENCLOSURE. HOWEVER, THE COMPONENTS MAY SUSTAIN DAMAGE.
8. CONTACT TRANE CENTRAVAC MARKETING WITH ANY QUESTIONS.
9. THE VALUES LISTED ARE 460/480 AND 575/600 VOLT.
10. TERMINALS ACCEPT COPPER OR ALUMINUM WIRE.





REMOTE AFD CONNECTION DIAGRAM PAGE 1



⚠ WARNING

HAZARDOUS VOLTAGE!

DISCONNECT ALL ELECTRIC POWER INCLUDING REMOTE DISCONNECTS AND FOLLOW LOCK OUT AND TAG PROCEDURES BEFORE SERVICING. INSURE THAT ALL MOTOR CAPACITORS HAVE DISCHARGED STORED VOLTAGE. UNITS WITH VARIABLE SPEED DRIVE, REFER TO DRIVE INSTRUCTIONS FOR CAPACITOR DISCHARGE.

FAILURE TO DO THE ABOVE BEFORE SERVICING COULD RESULT IN DEATH OR SERIOUS INJURY.

⚠ AVERTISSEMENT

TENSION DANGEREUSE!

COUPER TOUTES LES TENSIONS ET OUVRIR LES SECTIONNEURS À DISTANCE, PUIS SUIVRE LES PROCÉDURES DE VERROUILLAGE ET DES ÉTIQUETTES AVANT TOUTE INTERVENTION. VÉRIFIER QUE TOUS LES CONDENSATEURS DES MOTEURS SONT DÉCHARGÉS. DANS LE CAS D'UNITÉS COMPORTANT DES ENTRAÎNEMENTS À VITESSE VARIABLE, SE REPORTER AUX INSTRUCTIONS DE L'ENTRAÎNEMENT POUR DÉCHARGER LES CONDENSATEURS.

NE PAS RESPECTER CES MESURES DE PRÉCAUTION PEUT ENTRAÎNER DES BLESSURES GRAVES POUVANT ÊTRE MORTELLES.

⚠ ADVERTENCIA

¡VOLTAJE PELIGROSO!

DESCONECTE TODA LA ENERGÍA ELÉCTRICA, INCLUSO LAS DESCONEXIONES REMOTAS Y SIGA LOS PROCEDIMIENTOS DE CIERRE Y ETIQUETADO ANTES DE PROCEDER AL SERVICIO. ASEGÚRESE DE QUE TODOS LOS CAPACITORES DEL MOTOR HAYAN DESCARGADO EL VOLTAJE ALMACENADO. PARA LAS UNIDADES CON EJE DE DIRECCIÓN DE VELOCIDAD VARIABLE, CONSULTE LAS INSTRUCCIONES PARA LA DESCARGA DEL CONDENSADOR.

EL NO REALIZAR LO ANTERIORMENTE INDICADO, PODRÍA OCASIONAR LA MUERTE O SERIAS LESIONES PERSONALES.

CAUTION

USE COPPER CONDUCTORS ONLY!

UNIT TERMINALS ARE NOT DESIGNED TO ACCEPT OTHER TYPES OF CONDUCTORS.

FAILURE TO DO SO MAY CAUSE DAMAGE TO THE EQUIPMENT.

ATTENTION

N'UTILISER QUE DES CONDUCTEURS EN CUIVRE!

LES BORNES DE L'UNITÉ NE SONT PAS CONÇUES POUR RECEVOIR D'AUTRES TYPES DE CONDUCTEURS.

L'UTILISATION DE TOUT AUTRE CONDUCTEUR PEUT ENDOMMAGER L'ÉQUIPEMENT.

PRECAUCIÓN

¡UTILICE ÚNICAMENTE CONDUCTORES DE COBRE!

LAS TERMINALES DE LA UNIDAD NO ESTÁN DISEÑADAS PARA ACEPTAR OTROS TIPOS DE CONDUCTORES.

SI NO LO HACE, PUEDE OCASIONAR DAÑO AL EQUIPO.

DEVICE PREFIX CODE

1 = MAIN UNIT CONTROL PANEL DEVICE
2 = REMOTE MOUNTED DEVICE
4 = UNIT MOUNTED DEVICE
5 = CUSTOMER PROVIDED DEVICE

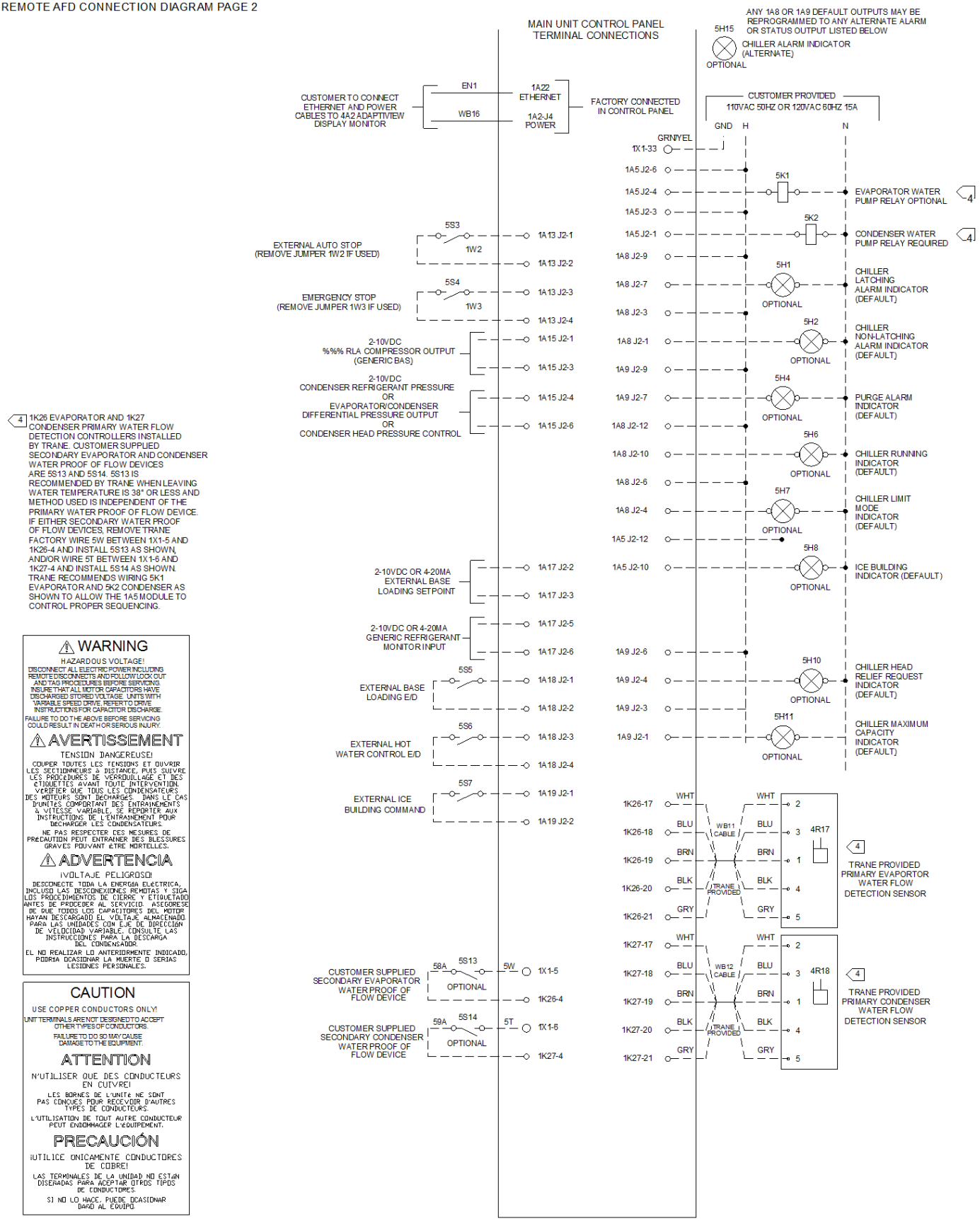
WIRE NO OR DEVICE	FIELD WIRING CIRCUIT SELECTION INFORMATION
SUPPLY AND MOTOR LEADS	SEE NAMEPLATE; MINIMUM CIRCUIT AMPACITY
1A*, 2A* AND GRN/YEL	4000VA AT 115VAC, 8 AWG MAX WIRE SIZE
9A* AND 10A*	PUMP MOTOR; 1PH 3/4 HP, 11.7 FULL LOAD AMPS AT 115VAC. 14 AWG MAX WIRE SIZE.
WB17 AND WB18	TWISTED, SHIELDED PAIR, 30VDC, MAX LENGTH 1500 FT (BELDEN TYPE 8760 RECOMMENDED)
5S1* AND 5S2*	CIRCUIT PROTECTED AT 20A, 115VAC 1PH, 10 AWG MAX WIRE SIZE
5S3 THRU 5S8	24VDC, 12MA RESISTIVE LOAD, 14 AWG MAX WIRE SIZE
ALL REMAINING LLID TERMINALS	CONTACT RATING; 2.88A INDUCTIVE, 1/3 HP, 0.25KW AT 115VAC. 14 AWG MAX WIRE SIZE.

* TAPPED CONTROL CONDUCTORS

NOTES:

1. DASHED LINES INDICATE FIELD WIRING BY OTHERS. WIRE NUMBERS SHOWN ARE RECOMMENDED BY TRANE.
2. DO NOT ROUTE LOW VOLTAGE (30V) WITH CONTROL VOLTAGE (110-120V) AND DO NOT POWER UNIT UNTIL CHECK-OUT AND START-UP PROCEDURES HAVE BEEN COMPLETED.

REMOTE AFD CONNECTION DIAGRAM PAGE 2



4 1K26 EVAPORATOR AND 1K27 CONDENSER PRIMARY WATER FLOW DETECTION CONTROLLERS INSTALLED BY TRANE. CUSTOMER SUPPLIED SECONDARY EVAPORATOR AND CONDENSER WATER PROOF OF FLOW DEVICES ARE 5S13 AND 5S14. 5S13 IS RECOMMENDED BY TRANE WHEN LEAVING WATER TEMPERATURE IS 38° OR LESS AND METHOD USED IS INDEPENDENT OF THE PRIMARY WATER PROOF OF FLOW DEVICE. IF EITHER SECONDARY WATER PROOF OF FLOW DEVICES, REMOVE TRANE FACTORY WIRE 5W BETWEEN 1X1-5 AND 1K26-4 AND INSTALL 5S13 AS SHOWN, AND/OR WIRE 5T BETWEEN 1X1-6 AND 1K27-4 AND INSTALL 5S14 AS SHOWN. TRANE RECOMMENDS WIRING 5K1 EVAPORATOR AND 5K2 CONDENSER AS SHOWN TO ALLOW THE 1A5 MODULE TO CONTROL PROPER SEQUENCING.

⚠ WARNING

HAZARDOUS VOLTAGE!

DISCONNECT ALL ELECTRIC POWER INCLUDING REMOTE DISCONNECTS AND FOLLOW LOCK OUT AND TAG PROCEDURES BEFORE SERVICING. INSURE THAT ALL MOTOR CAPACITORS HAVE DISCHARGED STORED VOLTAGE. UNITS WITH VARIABLE SPEED DRIVE, REFER TO DRIVE INSTRUCTIONS FOR CAPACITOR DISCHARGE.

FAILURE TO DO THE ABOVE BEFORE SERVICING COULD RESULT IN DEATH OR SERIOUS INJURY.

⚠ AVERTISSEMENT

TENSION DANGEREUSE!

COUPER TOUTES LES TENSIONS ET OUVRIR LES SECTIONNEURS À DISTANCE, PUIS SUIVRE LES PROCÉDURES DE VERROUILLAGE ET DES ÉTIQUETTES AVANT TOUTE INTERVENTION. VÉRIFIER QUE TOUS LES CONDENSATEURS DES MOTEURS SONT DÉCHARGÉS. DANS LE CAS D'UNITÉS COMPORTANT DES ENTRAÎNEMENTS À VITESSE VARIABLE, SE REPORTER AUX INSTRUCTIONS DE L'ENTRAÎNEMENT POUR DÉCHARGER LES CONDENSATEURS.

NE PAS RESPECTER CES MESURES DE PRÉCAUTION PEUT ENTRAÎNER DES BLESSURES GRAVES POUVANT ÊTRE MORTELLES.

⚠ ADVERTENCIA

¡VOLTAJE PELIGROSO!

DESCONECTE TODA LA ENERGÍA ELÉCTRICA, INCLUSO LAS DESCONEXIONES REMOTAS Y SIGA LOS PROCEDIMIENTOS DE CIERRE Y ETIQUETADO ANTES DE PROCEDER AL SERVICIO. ASEGÚRESE DE QUE TODOS LOS CAPACITORES DEL MOTOR HAYAN DESCARGADO EL VOLTAJE ALMACENADO. PARA LAS UNIDADES CON EJE DE DIRECCIÓN DE VELOCIDAD VARIABLE, CONSULTE LAS INSTRUCCIONES PARA LA DESCARGA DEL CONDENSADOR.

EL NO REALIZAR LO ANTERIORMENTE INDICADO, PODRÍA OCASIONAR LA MUERTE O SERIAS LESIONES PERSONALES.

CAUTION

USE COPPER CONDUCTORS ONLY!

UNIT TERMINALS ARE NOT DESIGNED TO ACCEPT OTHER TYPES OF CONDUCTORS.

FAILURE TO DO SO MAY CAUSE DAMAGE TO THE EQUIPMENT.

ATTENTION

N'UTILISER QUE DES CONDUCTEURS EN CUIVRE!

LES BORNES DE L'UNITÉ NE SONT PAS CONÇUES POUR RECEVOIR D'AUTRES TYPES DE CONDUCTEURS.

L'UTILISATION DE TOUT AUTRE CONDUCTEUR PEUT ENDOMMAGER L'ÉQUIPEMENT.

PRECAUCIÓN

¡UTILICE ÚNICAMENTE CONDUCTORES DE COBRE!

LAS TERMINALES DE LA UNIDAD NO ESTÁN DISEÑADAS PARA ACEPTAR OTROS TIPOS DE CONDUCTORES.

SI NO LO HACE, PUEDE OCASIONAR DAÑO AL EQUIPO.

Compressor-Motor
Direct drive multiple-stage compressor, multi-stage capacity control guide vanes. Shrouded aluminum alloy impellers dynamically balanced. Motor-compressor assembly balanced to .15 in./sec (.0038m/sec) maximum vibration measured on motor and bearing housings. Refrigerant cooled, hermetically sealed, two-pole, squirrel cage induction motor. Two pressure lubricated bearings support the rotating assembly. A direct drive submerged oil pump motor, 3/4 hp (.560 kW) 115V/50/60/1 provides filtered and temperature controlled oil to compressor bearings.

Evaporator-Condenser
Shells are carbon steel plate. Evaporator includes rupture disk per BSR/ASHRAE 15 Safety Code. Carbon steel tube sheets are drilled, reamed and grooved to accommodate tubes. Tubes are individually replaceable externally finned seamless copper. Tubes are mechanically expanded into tube sheets. Eliminators are installed over entire length of the evaporator tube bundle. A multiple orifice control system maintains proper refrigerant flow. Condenser baffle prevents direct impingement of compressor discharge gas upon the tubes. Refrigerant side of the assembled unit is tested at both pressure(30.00 psi leak test) and vacuum. Water side is hydrostatically tested at one and one-half times design working pressure, but not less than 225.00 psi.

Trane reserves the right to implement chiller technology enhancements that will reduce the chiller's refrigerant charge, with no impact on chiller performance. Changes may be reflected in the chiller's nameplate refrigerant charge and the quantity of refrigerant charge shipped to the jobsite, depending upon the final date of equipment manufacture.

Water Boxes
Drains and vents - Water boxes typically have 3/4-inch NPTI vents and drain connections provided. Evaporators have 2 vents and 2 drains, condensers have 1 vent and 1 drain. If grooved connections are offered, the design is based on Style 77.

Marine water boxes have removable end plates and water connections on the sides.

CondenserWater box Hinge
The water box is provided with a hinge on one or both ends of the condenser to facilitate access to and maintenance of the condenser tubes as needed without the need for separate rigging. See the dedicated drawing of the hinge(s) being supplied.

Economizer
A flash economizer with no moving parts provides power saving capability.

Purge System
The EarthWise(TM) purge includes a 1/4 hp 115V/60/1, 100V/50/1 air cooled condensing unit, purge tank, drier elements, and a 1/20 hp (.037 kW) 115V/60/1, 110V/50/1 pump-out compressor. The purge is designed with an activated carbon filtration system that includes an autoregeneration feature which results in automatic high-efficiency removal of noncondensibles from the chiller without manual carbon maintenance. The purge meets Green Seal GS-31 with a leak rate less than 1.0% of the charge per year and also meets ASHRAE 147 with a leak rate of less than one unit mass of refrigerant per unit of air.

AdaptiView Control Panel:

The Tracer(tm) AdaptiView is a microprocessor-based chiller control system that provides complete stand alone system control and monitoring for the water cooled CenTraVac (TM). It is a factory mounted package including a full complement of controls to safely and efficiently operate the CenTraVac chiller, including oil management, purge operation, interface to the starter, and comprehensive motor protection including three phase solid state motor overload. Inlet and outlet water (fluid) temperature sensors are located in the evaporator and condenser waterbox connections as standard.

The display is a touch sensitive 12 1/8" diagonal color liquid crystal display (LCD) that uses color graphics and animation to ensure ease of use. The touch sensitive interface allows the operator to view the chiller graphically and receive a status indication via subsystem animations. The operator can navigate easily between the primary chiller subsystems including: compressor, evaporator, condenser, and motor. For each subsystem, you can view status and detailed operating parameters. In addition, alarms, reports, trending, and settings can all be accessed quickly from the main screen. The display is mounted on a flexible "arm" that allows extensive height and viewing angle variations.

The panel supports an extensive list of languages including the default English. The data can be set to be viewed in inch pounds IP or metric units SI. For remote starters - Class 1 control panel voltage (30-115 V) are clearly labeled in the control panel. Class 2 input voltage (30V max) is also labeled in the control panel.

Operating Data including:
*operating hours
*number of starts
*chilled water setpoint
*evaporator and condenser water flow status
*evaporator entering and leaving water temperatures
*evaporator saturated refrigerant temperatures
*evaporator approach temperature
*evaporator refrigerant pressure
*condenser entering and leaving water temperatures
*condenser saturated refrigerant temperatures
*condenser approach temperature
*condenser refrigerant pressure
*oil differential pressure
*oil tank temperature
*purge mode
*purge average daily pump-out time
*RLA per phase - load
*% RLA per phase - load
*volts per phase- input
*frequency command

The AdaptiView also contains the following dedicated reports:
Evaporator, Condenser, Compressor, Motor, Purge, and ASHRAE. Each report is comprised of a detailed listing of operational data relative to that chiller subsystem.

Control functions including:
*leaving chilled water temperature
*percent demand limit
*chiller water reset (based on return water temperature
*front panel control type
*setpoint source
*differential to start
*differential to stop

Status data including:
*waiting to start
*running
*run limit
*run inhibit (adaptive)
*auto
*free cooling (option)
*preparing to shutdown
*shutting down (post lube)
*stopped

Safeties including:
Automatic safety shutdown for:

*Low chilled water temperature,
*low evaporator refrigerant temperature
*high condenser refrigerant pressure
*evaporator and condenser flow status
*low oil pressure
*oil pressure overdue
*high or low oil temperature
*high bearing oil temperature (requires enhanced protection option)
*high motor current
*high motor temperature
*starter function faults
*critical temperature and pressure sensor faults

The devices are of a latching trip out type requiring manual reset. Non-latching safety trip outs for operating conditions external to the chiller automatically permits unit to resume normal operation when condition is corrected.

Advanced motor protection monitors 3-phase current to provide latching trip out protection from adverse effects of phase loss, phase unbalance, phase reversal, loss of phase reversal protection, and electrical distribution faults (momentary power loss) by instantaneous trip out of motor.

Surge protection - Detects surge and limits chiller loading through inlet vane modulation. Head relief through lowering cooling tower water temperature can be requested. If not corrected within 7 minutes, chiller is shut down.

Enhanced Adaptive Control(TM) - Built in intelligence to keep the chiller on line (safely making maximum tons) while simultaneously preventing chiller damage/failure. During any chiller limiting mode of operation, the control panel enunciates the condition via a relay output.

Trending:
The controller provides 10 standard graphs for trending multiple parameters, The operator can add an additional 6 custom graphs if desired. On any one custom graph, the operator can choose to trend up to 10 unique parameters from a more comprehensive list. Two Y axes are available for any graph to facilitate readability.

Diagnostics:
AdaptiView includes comprehensive diagnostic monitoring. All active diagnostics are available, and up to 20 historic diagnostics are communicated to the operator via the 12 1/8" LCD display with graphic navigation system. Each diagnostic is time and date stamped.

Service Tool:
A PC-based service tool called Tracer TU, connected to the chiller via USB port, is available for additional cost and displays the last 100 diagnostics, indicating the time, date of occurrence, and system parameters at the time of the diagnostic. The service tool provides advanced troubleshooting and access to sophisticated configuration settings not needed during operation of the chiller.

Security:
The AdaptiView can be set to prevent unauthorized access to the chiller settings. The operator can choose to secure the operating settings with a password. Data and reports can still be accessed once the settings are locked out.

The memory for the AdaptiView is non-volatile type, so if power is lost, operating settings are retained. A life time battery is standard, which is used only to support the clock function for the chiller.

Chilled and Condenser water pump relays:
Chilled water and condenser water pump relays are provided and it is recommended that they be used for pump control.

BACnet(MSTP) Direct Points List:
The following points are available directly from the chiller. Recognize that some of these points require chiller options or configurations.

Inputs Including
Chiller Auto/Stop
Chiller Mode (e.g. cool)
External Base Loading Enable/Disable (requires Extended Operation option)
External Base Loading Setpoint (requires Extended Operation option)
Chilled Water Setpoint
Current Limit Setpoint
Heating Setpoint (requires Extended Operation option)
Wall Mounted Refrigerant Specific Monitor (requires Extended Operation option)
Clear Diagnostics

Outputs Including
Evaporator Pump relay
Condenser Pump relay
Chilled Water Flow Status
Condenser Water Flow Status
Evaporator Water Flow Rate (requires Flow Compensation option)
Condenser Water Flow Rate (requires Flow Compensation option)
Chiller capacity (requires Flow Compensation option)
Leaving Chilled Water Temperature
Entering Chilled Water Temperature
Entering Condenser Water Temperature
Leaving Condenser Water Temperature
Second Condenser Entering Water Temperature (requires HR or Aux condenser bundle)
Second Condenser Leaving Water Temperature (requires HR or Aux condenser bundle)
Active Chilled/Hot Water Setpoint
Active Current Limit Setpoint
Active Base Loading Setpoint (requires Extended Operation option)
Head Relief Request relay
Compressor Running relay
Chiller On/Off
Limit Warning relay
Maximum Capacity relay
Alarms Description1
- Manual Reset Alarm relay
- Auto Reset Alarm relay
- Purge Alarm relay

Alarm Reset
Condenser Refrigerant Pressure
Condenser Refrigerant Temperature
Evaporator Refrigerant Pressure
Evaporator Refrigerant Temperature
Compressor Discharge Refrigerant Temperature (requires Enhanced Protection option)
Differential refrigerant pressure (not for head pressure control)
Operating Status (Alarm, Run Enabled, Local Control, Limited)
Chiller Modes (i.e. Off, Starting, Running, Shutting Down)
Base Loading Active (requires Extended Operation option)
Hot Gas Bypass Active (requires Hot Gas Bypass option)
Operating Mode (e.g. Cool)
Current Per Line
Voltage Per Phase
Unit Power Consumption (kW)
Motor winding temperature
Motor power factor (uncorrected)
Oil Temperature
Oil Pressure Differential
- High Side Oil Pressure
- Low Side Oil Pressure

Compressor Starts
Compressor Run Time
Inlet guide vane position
Inboard bearing oil temperature (requires Enhanced Protection option)
Outboard bearing oil temperature (requires Enhanced Protection option)
Purge Status2
Purge pumpout Average (24 hour)
Purge pump-out
Purge regeneration
Purge carbon tank temperature
Purge liquid temperature
Purge suction temperature
Purge time to next purge run
Purge pump-out chiller on-7 days

Purge pump-out chiller off-7 days
Purge pump-out life
Purge regeneration life
Refrigerant Monitor
AFD output frequency
AFD transistor temperature

Condenser Pressure Output:
A hardwire output signal of condenser pressure, or differential pressure between the evaporator and condenser is provided.

Operating Status:
The following hardwire binary outputs are available:
Compressor running relay
Alarm relay - manual reset
Alarm relay - auto reset
Limit warning relay
Purge alarm relay
Head relief request relay
Maximum capacity relay

Enhanced Flow Management Package:
This provides a flow display and enhanced variable flow control and compensation. The flow compensation component enhances the unit controllers variable flow rate of change capabilities from 30% per minute up to 50% per minute. Included are factory mounted differential water pressure sensors for both the evaporator and the condenser. Differential pressure switches or some other means to prove flow are still required Max pressure rating for the pressure sensors is 365 psig.

The following will be displayed on the unit controller:
Evaporator differential water pressure
Condenser differential water pressure
Evaporator GPM
Condenser GPM
Evaporator Tons
Due to their accuracy, these parameters are not designed to be used for detailed metering or analysis.

Evaporator Proof of Flow - Thermal Dispersion
A factory provided, field installed thermal dispersion type proof of flow switch (IFM) is provided. The thermal dispersion controller is mounted in the chiller control panel, the piping probe and wiring is shipped lose for field installation in the ship with components box. Follow the installation instructions in the chiller installation manual. Reference specific IFM Installation manual (PART-SVN223*-EN) notes shipped with your rupture guard /contact local Trane sales office

Condenser Proof of Flow - Thermal Dispersion
A factory provided, field installed thermal dispersion type proof of flow switch (IFM) is provided. The thermal dispersion controller is mounted in the chiller control panel, the piping probe and wiring is shipped lose for field installation in the ship with components box. Follow the installation instructions in the chiller installation manual. Reference specific IFM Installation manual (PART-SVN223*-EN) notes shipped with your rupture guard /contact local Trane sales office

Paint
All CenTraVac(TM) painted surfaces are coated with a primer and an air-dry beige primer-finisher prior to shipment.

Isolation
All units ship with neoprene isolator pads as standard, except when spring isolators are chosen. Enough pads are provided to cover the area under the chiller supports.

Shipment

All units are of hermetic design, leak tested, charged to 5.00 psi and shipped as a single factory assembled package. Full oil charge shipped in oil sump. Refrigerant shipped to jobsite from refrigerant manufacturer. The entire chiller is shrink wrapped for protection.

RuptureGuard-Relief Valve-Field Install

RuptureGuard is a Trane supplied field installed refrigerant containment system that replaces a chiller's rupture disk. The system consists of a non-fragmenting rupture disk and a pressure relief valve that can be applied to all low pressure centrifugal chillers. This system functions as the chiller's primary pressure relieving device and provides a leak free seal between the chiller and atmosphere. The pressure relief valve is installed in place of the factory shipped rupture disk (which must be removed) and functions as an interim primary pressure relieving device and seal. When the chiller's internal pressure exceeds 15 psig [104 kPa], the non-fragmenting rupture disk bursts allowing the pressure to be relived through the relief valve. After the chiller's pressure is reduced, the pressure relief valve recloses stopping the flow of refrigerant to the atmosphere. A pressure switch is included with the RuptureGuard package as standard. This switch has single pole, double throw contacts for interface to external monitoring systems. The switch has a trip setting of 11 psig, reset values of 8 psig, and is rated for 5A at 220 volts. Reference specific Rupture guard Installation manual (CTV-SVX06*-EN) notes shipped with your rupture guard /contact local Trane sales office.

Required Installer Responsibilities

The following are considered functions normally required of the equipment installer./n

Install unit on a foundation with flat support surfaces level within 1/16" and of sufficient length to support concentrated loading. (Spring isolators should be considered whenever chiller installation is planned for an upper story location.)

Place isolation pads or optional spring type isolators provided by the chiller manufacturer under the unit. When spring isolators are chosen, no pads are provided.

Install unit per applicable Trane Installation Manual.

Complete all water and electrical connections.

Where specified, provide and install valves in water piping upstream and downstream of the evaporator and condenser water boxes as means of isolating shells for maintenance and to balance and trim system.

Furnish and install a flow switch or equivalent device in both the chilled water and condenser water piping properly interlocked to insure that unit can operate only when water flow is established.

Furnish and install taps for thermometers and pressure gauges in water piping adjacent to inlet and outlet connections of both evaporator and condenser.

Furnish and install drain valves to each water box.

Install vent cocks on each water box.

Furnish and install strainers upstream of chiller evaporator and condenser bundles to protect tubes from potential damage caused by debris in the circulating water. Note: Failure to install strainers in all water piping entering the chiller could result in tube plugging conditions that could damage unit components. If the circulating pumps are immediately upstream of the chiller bundles, then the strainer can be installed immediately ahead of the pumps. If the circulating pumps are downstream of the chiller bundles, then the strainers should be installed immediately ahead of the chiller bundles.

Furnish sufficient refrigerant 25.0 lb per machine and dry nitrogen 50.0 lb per machine for pressure testing under manufacturer's supervision.

Start-up unit under supervision of a qualified Trane field engineer.

Where specified, insulate evaporator and any other portions of machine required to prevent sweating under normal operating conditions.

Water connection piping must not transfer forces to the chiller. Because of cumulative tolerances in manufacture and field installation, prepiping of water connections closer than 36" is not recommended. Any problems associated with prepiping of water connections closer than 36" to the chiller are the responsibility of the installing contractor.

Furnish and install vent lines for rupture disk and purge venting to atmosphere per ASHRAE 15 and unit installation manual. If RuptureGuard-Relief Valve option is ordered, remove factory rupture disk and install RuptureGuard-Relief Valve per the IOM manual. In some chiller configurations the RuptureGuard may not bolt directly to the chiller flange. Locally sourced and approved piping may be required between the chiller and the RuptureGuard.

Field Disassembly

With chillers that may require field disassembly (for example due to clearance concerns during unit installation) reference the Disassembly and Reassembly manual and your Trane Sales representative prior to the order being placed. Caution: if certain components are removed in the field, for example the economizer, the necessary components (gaskets, seals, etc.) are not provided as standard.

Separable Shells

With chillers that have been ordered with the Separable Shell option, the evaporator is bolted to the condenser to allow for the separation of the evaporator from the condenser in the field. The components (gaskets, seals, etc.) needed to reassemble the shells together, the compressor, and remove and replace the economizer are included with this option.
Note:
Compressor doweling is always included with this option, see Compressor Doweling option for more details.
The purge assembly is not modified so it can be removed easier with this option, additional parts may be required to remove the purge in the field.
If you have a 405 or 608 Amp unit mounted drive, this option does not include bolt on support arms or replacement gaskets and bolts.
If you have a 900 or 1210 Amp unit mounted drive, the support arms are bolted on however replacement gaskets and bolts are not included with this option.
Additional items that are not included with this option are: touch up paint, vacuum pump oil, replacement compressor oil, and spare insulation.

Compressor Doweling

With chillers that have been ordered with Compressor Doweling, this option includes dowel pins located between the interstage casings to help facilitate disassembly and reassembly of the compressor itself. Dowel pins at the compressor connections to the evaporator and condenser shells are standard with or without this option. These dowel pins help to facilitate reassembly of the compressor onto the unit. The components (gaskets, seals, etc.) needed to reassemble the compressor onto the shells are included with this option.
Reference the Disassembly and Reassembly manual for more information and contact Water-Cooled Product Support if you have further questions or would like to special order a chiller with non-standard take apart items.

Leak-Tight Warranty

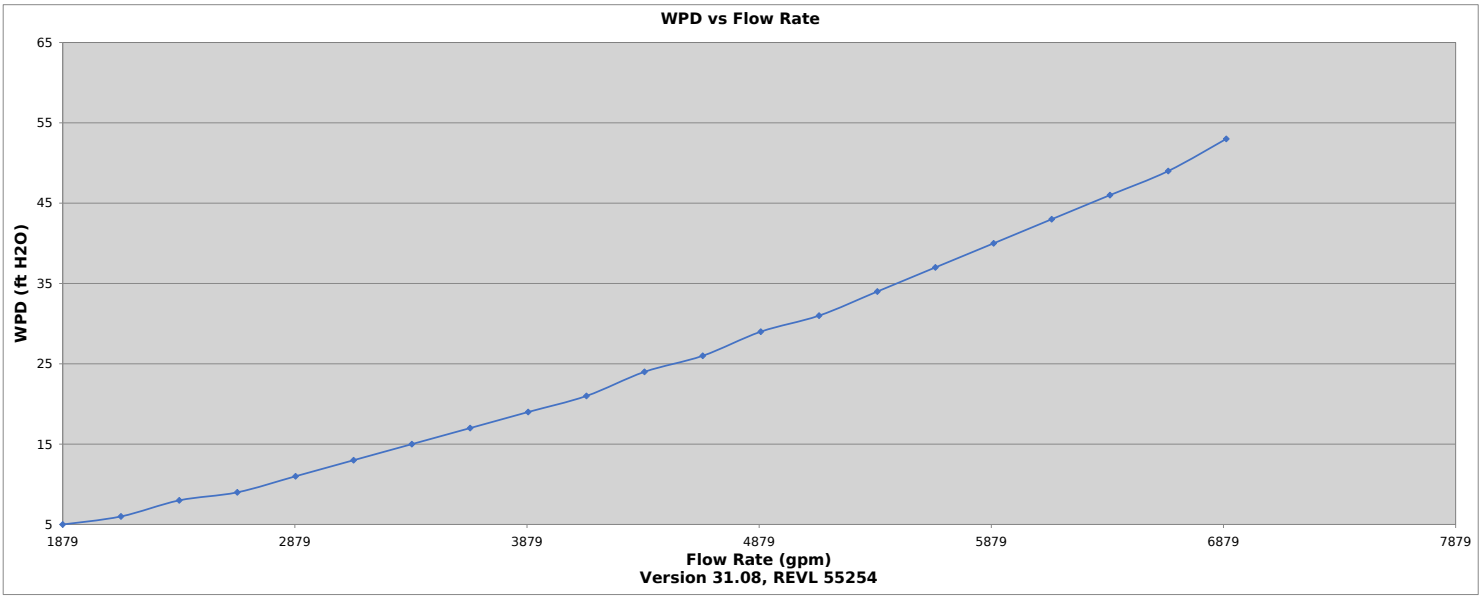
The CenTraVac chiller features a 5-year limited Leak-Tight Warranty which is valid for the lesser of 60 months from initial start-up or 66 months from date of shipment. The limited Leak-Tight Warranty covers models CVHE/F/L, CVHS, CVHM and CDHF chillers installed in the United States or Canada. The Company's obligations and liabilities under this warranty are limited to furnishing replacement refrigerant; no other parts or labor are covered under this limited warranty. No liability whatever shall attach to the Company until appropriate actions have been taken (acceptable to Company) to eliminate the source of the leak, and then said liability shall be limited to furnishing the replacement refrigerant.

If the chiller is placed under a comprehensive Trane service and maintenance agreement (Trane Select Agreement or better) prior to the expiration of the standard Leak-Tight Warranty, the protection against refrigerant loss shall continue under the Trane Select Agreement for as long as an active Trane Select Agreement remains in effect without interruption.

If a 10-Year Parts, Labor and Refrigerant Warranty was purchased for the chiller and the chiller is placed under a Trane Select Agreement (or better) prior to the expiration of the 10-Year Parts, Labor and Refrigerant Warranty, the protection against refrigerant loss shall continue under the Trane Select Agreement for as long as an active Trane Select Agreement remains in effect without interruption

CenTraVac Condenser WPD Curve

Pressure Drop Curve



Flow Rate Table

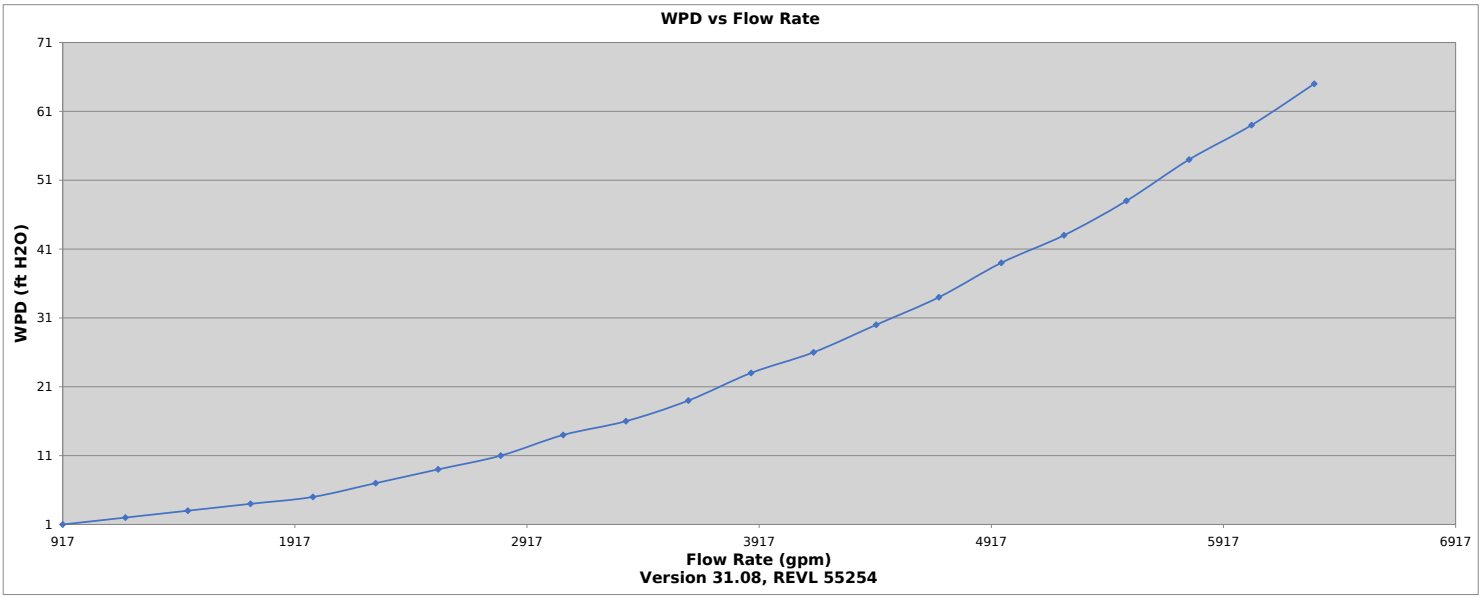
Flow Rate (gpm)	WPD (ft H2O)
1879	5
2130	6
2381	8
2631	9
2882	11
3132	13
3383	15
3634	17
3884	19
4135	21
4385	24
4636	26
4886	29
5137	31
5388	34
5638	37
5889	40
6139	43
6390	46
6641	49
6891	53

Unit Configuration

FCLT-LAX	CDSZ-250L	OPTI-SPSH
MODL-CVHF	CDBS-2300	RCRQ-NONE
NTON-1470	CDTM-TECU	ARCL-CERT
CNIF-ADPV	CDTH- 28	AH07-COMP
INDP- NO	CDVF- NO	AH7M-COMP
IHRZ- 60	CDWP- 2	AH10-COMP
HRTZ- 60	HGCD-HGBT	AH13-COMP
SRTY-NAFD	TSTY-STD	AH16-COMP
IVLT-480	CDFP-TDFS	EXOP-YES
ENCL-STD	ORSZ-2345	WPSR-WFC
VOLT-480	TEST-AIR	CDRP-YES
CPKW-964	TTOL-AIR	TRMM-BCNT
FRAM-5000	WCNM-SNMP	RPGD-YES
CPIM-336	FTST-YES	CRFG-R514
EVSZ-250E	ASTT- NO	
EVBS-2300	OPMM-IPLV	
EVTM-IM48	ASKT-NONE	
EVTH- 25	CHEE- NO	
EVVF- NO	ACOU- NO	
EVWP- 2	TYPE-SNGL	
EVFP-TDFS	INSL- NO	

CenTraVac Evaporator WPD Curve

Pressure Drop Curve



Flow Rate Table

Flow Rate (gpm)	WPD (ft H2O)
917	1
1187	2
1456	3
1726	4
1995	5
2265	7
2534	9
2804	11
3073	14
3343	16
3612	19
3882	23
4151	26
4421	30
4691	34
4960	39
5230	43
5499	48
5769	54
6038	59
6308	65

Unit Configuration

FCLT-LAX	CDSZ-250L	OPTI-SPSH
MODL-CVHF	CDBS-2300	RCRQ-NONE
NTON-1470	CDTM-TECU	ARCL-CERT
CNIF-ADPV	CDTH- 28	AH07-COMP
INDP- NO	CDVF- NO	AH7M-COMP
IHRZ- 60	CDWP- 2	AH10-COMP
HRTZ- 60	HGCD-HGBT	AH13-COMP
SRTY-NAFD	TSTY-STD	AH16-COMP
IVLT-480	CDFP-TDFS	EXOP-YES
ENCL-STD	ORSZ-2345	WPSR-WFC
VOLT-480	TEST-AIR	CDRP-YES
CPKW-964	TTOL-AIR	TRMM-BCNT
FRAM-5000	WCNM-SNMP	RPGD-YES
CPIM-336	FTST-YES	CRFG-R514
EVSZ-250E	ASTT- NO	
EVBS-2300	OPMM-IPLV	
EVTM-IM48	ASKT-NONE	
EVTH- 25	CHEE- NO	
EVVF- NO	ACOU- NO	
EVWP- 2	TYPE-SNGL	
EVFP-TDFS	INSL- NO	

Unit Features

Chiller Model	Refrigeration Capacity	Total Power	Fullload Eff	Refrigerant	Line Volt	Line Frequency	Starter Type
CVHF	800.0 tons	476.7 kW	0.5959 kW/ton	R-514A	460. V	60. Hz	VFD

Unit Overview

Application type	Standard cooling
Rupture Guard	RuptureGuard-relief valve-field install
Tracer Controls	BACnet
Compressor	760
Impeller	308
Orifice	1185
NPLV.IP	0.3617 kW/ton
Rated NPLV.IP	0.3617 kW/ton

Selection Tolerances

Selection Tolerance	AHRI Tolerance

Shell Information

	Evaporator	Condenser
	Fluid Temperature	
Entering	54.00 F	85.00 F
Leaving	44.00 F	99.18 F
	Fluid Properties	
Fluid Type	water	water
Fluid Concentration	0.00 %	0.00 %
Fouling Factor	0.000100 hr-sq ft-deg F/ Btu	0.000250 hr-sq ft-deg F/ Btu
	Flow Rate	
Design Flow	1911 gpm	1600 gpm
Min Flow	424.1 gpm	778.2 gpm
Max Flow	3110 gpm	2853 gpm
	Fluid Pressure Drop	
PD at Design Flow	22.2 ft H2O	13.0 ft H2O
PD at Min Flow	0.790 ft H2O	3.60 ft H2O
PD at Max Flow	60.7 ft H2O	36.4 ft H2O

	Evaporator	Condenser
	Construction Features	
Shell Size	080L	080L
Bundle Size	1050	800
Tube Type	IMC1	IECU
Tube Thickness	0.025"	0.025"
Connection Type	Victaulic connection evap.	Victaulic connection cond.
Water box type	marine	marine
Water box pressure	150 psig	150 psig
Wbox Arrangement	Evap in LH rear - evap out LH front	Cond in LH rear - cond out LH rear
Flow Proving	Thermal dispersion flow switch (IFM)	Thermal dispersion flow switch (IFM)
Number of Passes	Two pass evap water box	Two pass cond water box
Shell Side Volume	165.42 cu ft	53.20 cu ft

Unit Electrical

Low Voltage AFD type	UM refrig-cooled AFD w/ harmonic filter
Low Voltage AFD connection type	Circuit breaker
AFD frame size	900 max RLA
Low Voltage AFD enclosure type	Standard enclosure - NEMA 1
Motor	598
Total Power	476.7 kW

Min Circuit Ampacity	793.00 A
Max Overcurrent Protection	1200.00 A
Nameplate RLA	684.30 A
Primary RLA	635.40 A
Motor Locked Rotor Amps	4743.00 A

Physical Information

Operating Weight	32927.0 lb	**Shipping Weight - No Charge**	28291.0 lb	**Refrigerant charge**	1100.0 lb
Cond Shell Construction	Standard condenser construction	**Regional Code Requirement**	No Requirement	**AFD Heat Rejected to ambient**	16.93 MBh
Agency Listing	U.L. / CUL listed	**Chiller Heat Rejected to ambient**	8.14 MBh		

Information for AHRI and ASHRAE Projects

AHRI 550/590 2015 classification	Certified
ASHRAE 90.1 - 2007	Complies
ASHRAE 90.1 - 2007 Add. M	Complies
ASHRAE 90.1-2010	Complies
ASHRAE 90.1-2013	Complies
ASHRAE 90.1 - 2016	Complies

Certified in accordance with the AHRI Water-Cooled Water-Chilling and Heat Pump Water-Heating Packages Certification Program, which is based on AHRI Standard 550/590 (I-P) and AHRI Standard 551/591 (SI). Certified units may be found in the AHRI Directory at www.ahridirectory.org.

Warranty

Parts whole unit	Year 2nd-5th Parts Warranty Unit	**Labor 1st year**	1st year labor warranty whole unit
		Labor after 1st year	2nd-5th year labor warranty whole unit

Information for LEED Projects

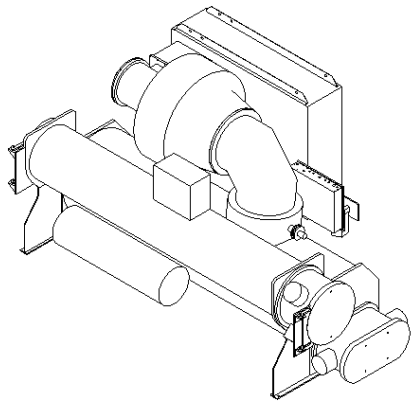
Refrigeration capacity	800.0 tons	**Total power**	476.7 kW
Refrigerant charge	1100.0 lb	**NPLV.IP**	0.3617 kW/ton
		Rated NPLV.IP	0.3617 kW/ton

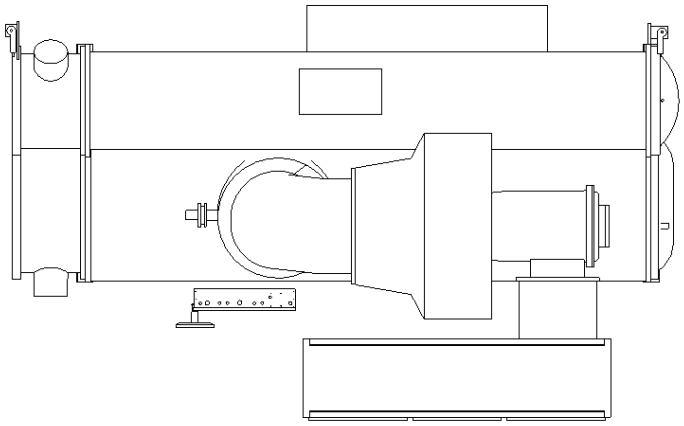
Compliant with the requirements of the LEED Energy and Atmosphere Enhanced Refrigerant Management Credit (EAc4) due to the R-514A refrigerant GWP being less than 2.

Note: Trane recognizes and respects the U.S. Green Building Council® mandate that a default 2% Refrigerant Leakage Rate (Lr) be used by all manufacturers of centrifugal chillers when calculating the Enhanced Refrigerant Management Credit because there is no industry standard. Trane has exhaustively documented a leak rate of less than 0.5% for CenTraVac™ chillers (models CVHE, CVHF, CVHG, CVHS, CVHM, CDHF, CDHG, CVHH and CDHH) and utilizes an average design refrigerant charge of less than 2 lb./ton.

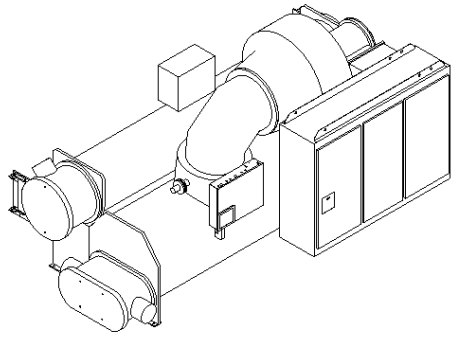
The U.S. Green Building Council's LEED® green building program is the preeminent program for the design, construction, maintenance and operations of high-performance green buildings. It provides independent, third-party verification that a building project meets the highest green building and performance measures.

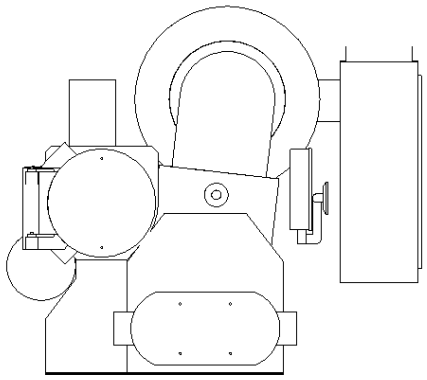
Trane Select Assist Version Number: 55251
Data Generation Date: 2/10/2023



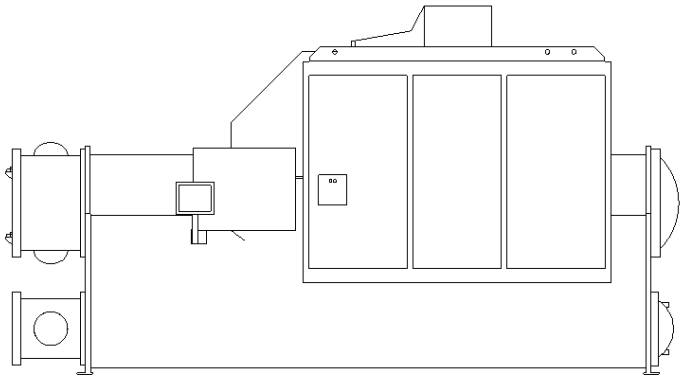


TOP VIEW

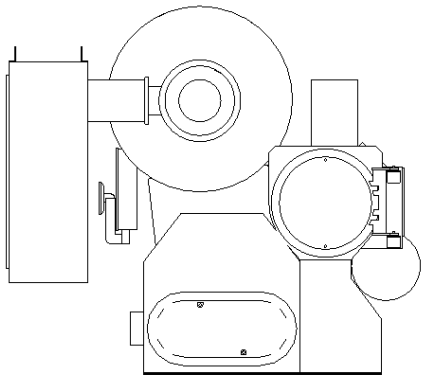




LEFT SIDE VIEW



FRONT VIEW



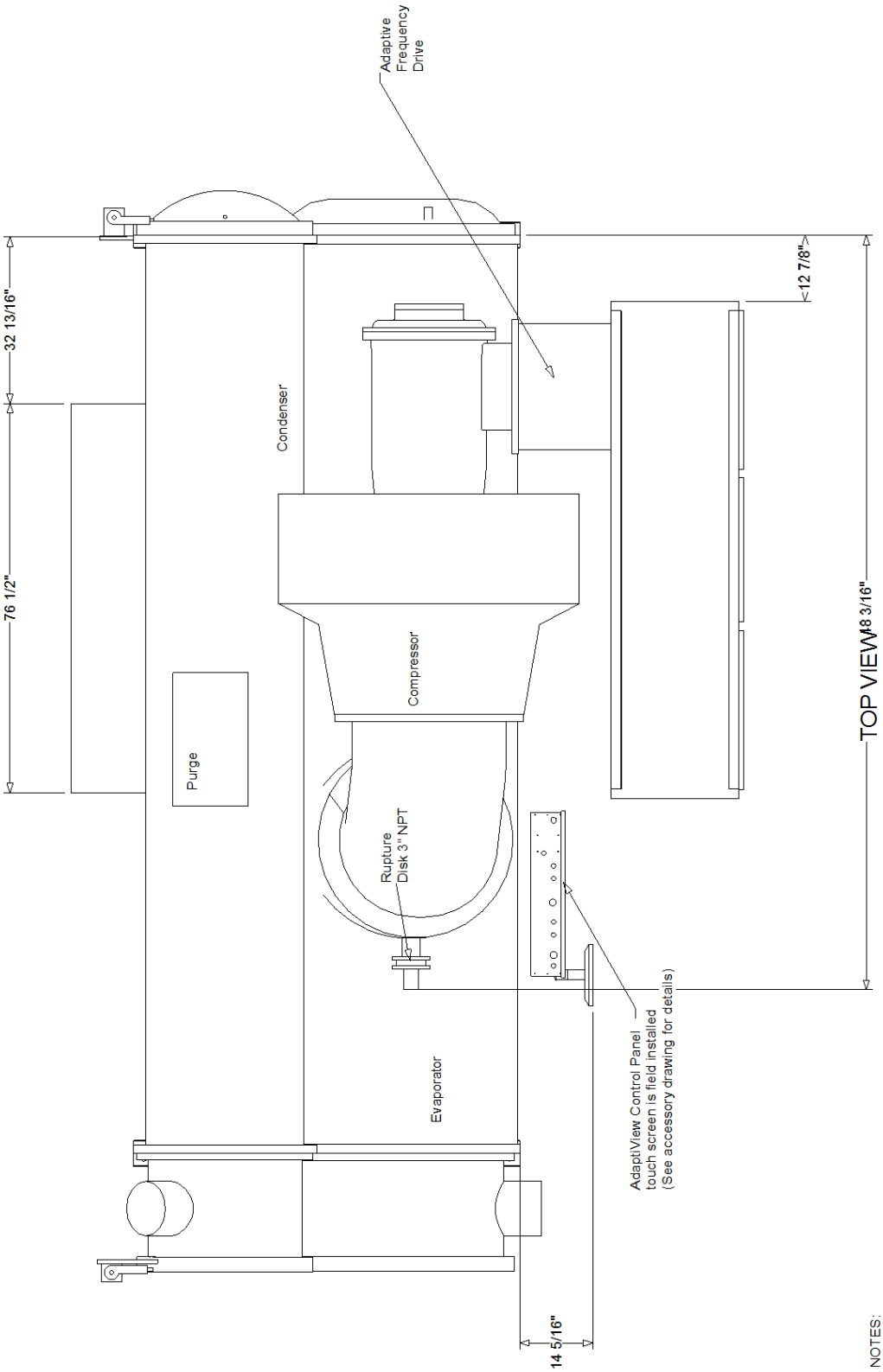
RIGHT SIDE VIEW

CUSTOMER NOTES:

GRAPHICS ON SUBMITTAL ARE SIMPLIFIED TO SHOW MAJOR ENVELOPE COMPONENTS.
UNIT STRUCTURE AND SUBCOMPONENTS MAY BE REMOVED FOR CLARITY.

UNLESS OTHERWISE SPECIFIED DIMENSIONAL TOLERANCE +/-1/2".
COOLING COND CONNS ARE AT 45 DEGREES FOR BOTTOM AND TOP.
EVAP CONNS ARE REAR INLET AND FRONT OUTLET.
WATER BOX DRAIN AND VENT LOCATIONS ARE SHOWN ON THE WATER BOX END PLATES.

SHELL TYPE	CONN DIA	CONN TYPE	FLOW DIRECTION
EVAPORATOR	10"	VICTAULIC	IN REAR OUT FRONT
COOLING COND	10"	VICTAULIC	IN BOTTOM OUT TOP



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COOLING COND	10"	VICTAULIC	IN BOTTOM OUT TOP

CUSTOMER NOTES:

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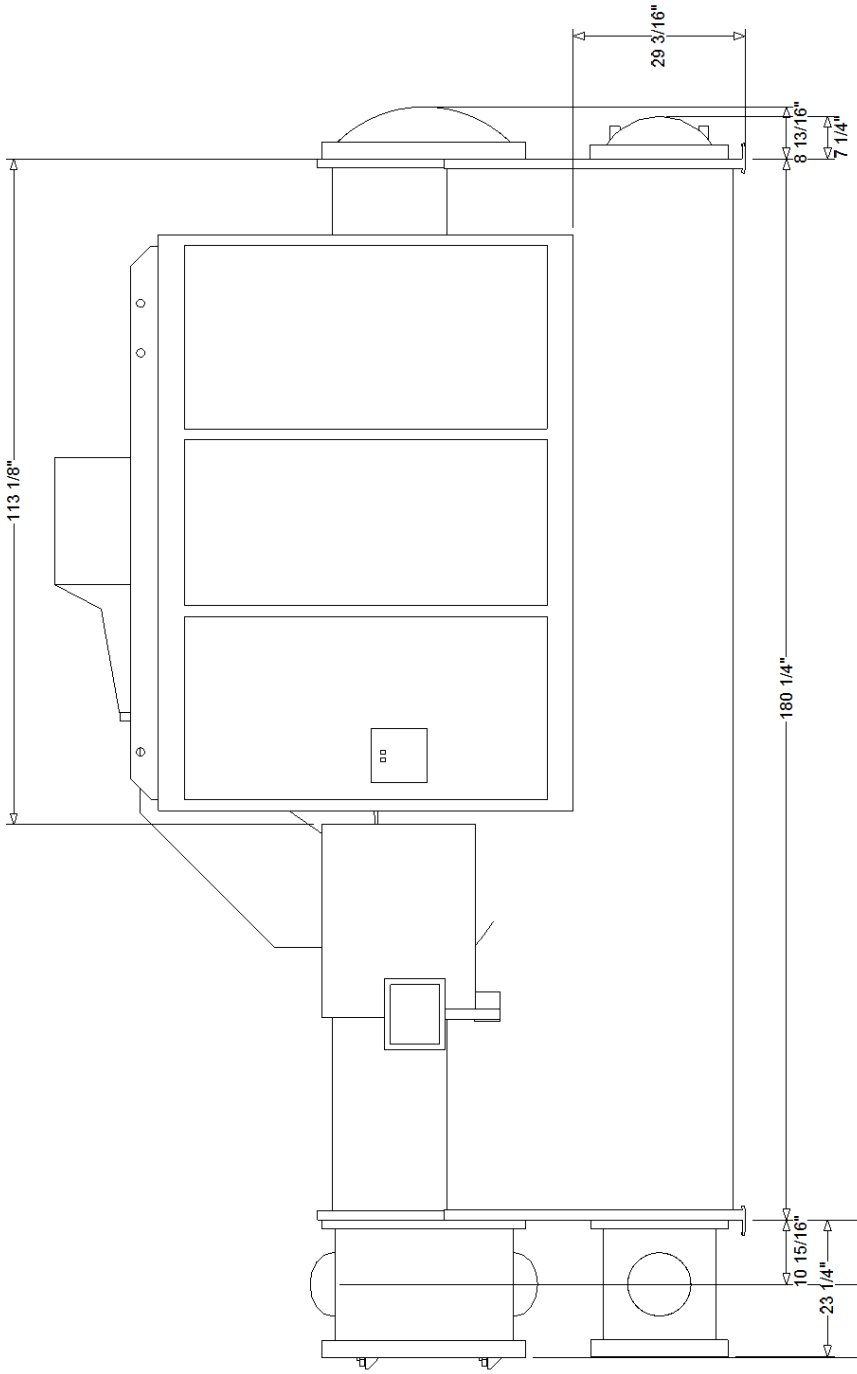
COOLING COND CONNS ARE AT 45 DEGREES FOR BOTTOM AND TOP.
EVAP CONNS ARE REAR INLET AND FRONT OUTLET.
WATER BOX DRAIN AND VENT LOCATIONS ARE SHOWN ON THE WATER BOX END PLATES.

CVHF Compressor size: 760
Evap shell size: 080L
Cond shell size: 080L
Without additional condenser

CVHF Compressor size: 760
Evap shell size: 080L
Cond shell size: 080L
Without additional condenser



FRONT VIEW

	SHELL TYPE	CONN DIA	CONN TYPE	FLOW DIRECTION
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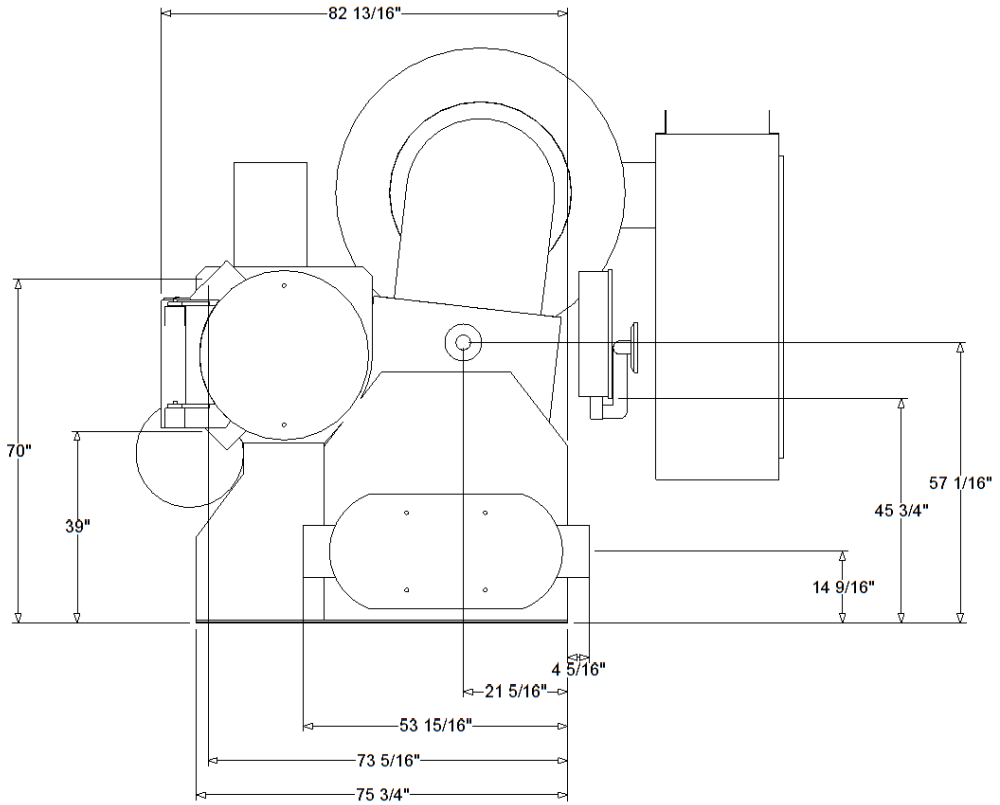

LEFT SIDE VIEW

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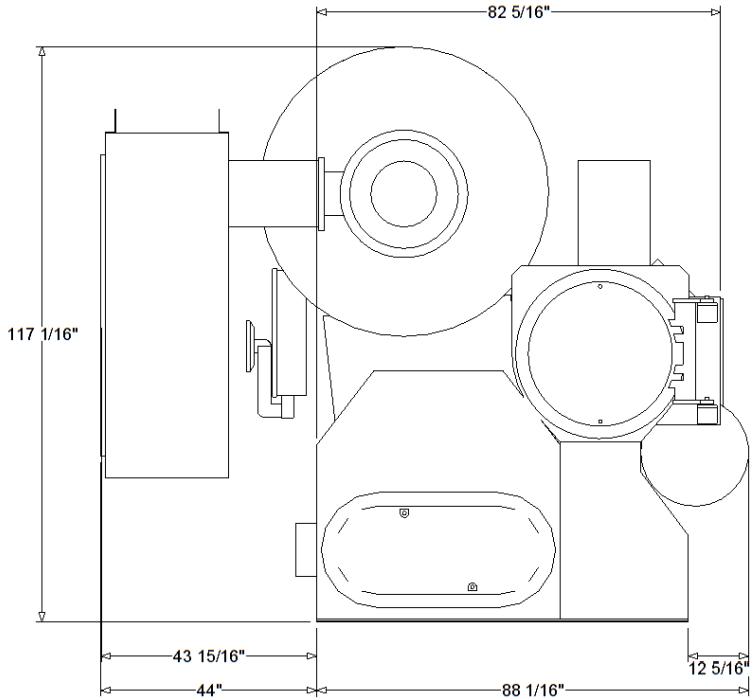

RIGHT SIDE VIEW

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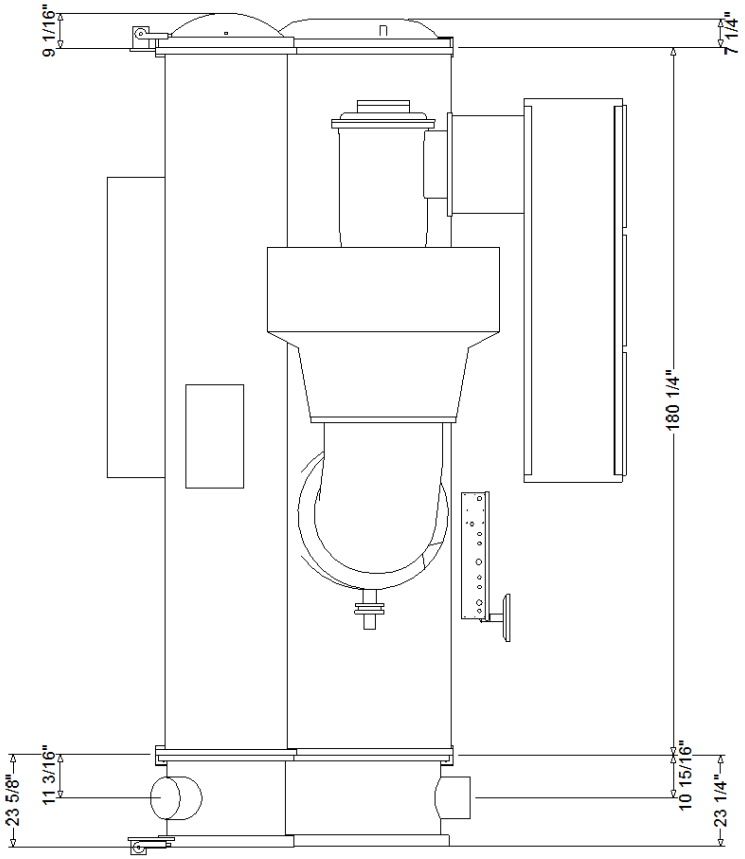
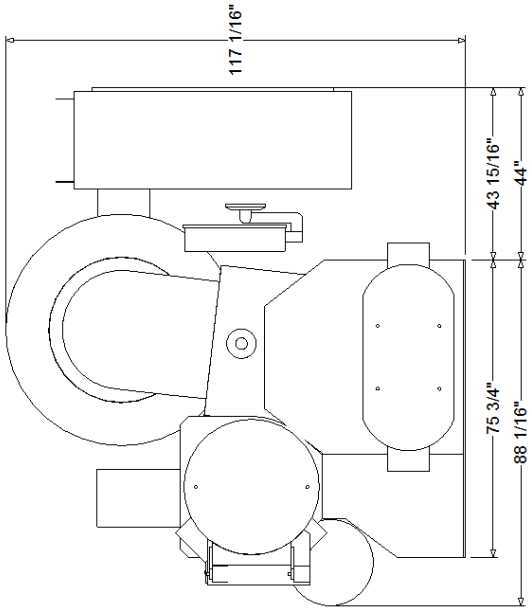


TOP VIEW

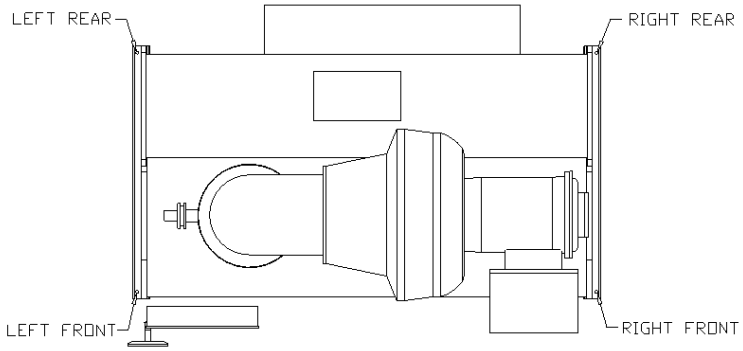


LEFT SIDE VIEW

SHIPPING WEIGHT **	28,291.0 lb
OPERATING WEIGHT	32,927.0 lb
COMPRESSOR SIZE	760
EVAPORATOR SIZE	080L
EVAPORATOR WATERPASS	2
EVAPORATOR WATERBOX ARRANGEMENT	LRLF
CONDENSER SIZE	080L
CONDENSER WATERPASS	2
CONDENSER WATERBOX ARRANGEMENT	LRLR

* ALL PUBLISHED WEIGHTS ACCURATE TO +/- 10 %
** SHIPPING WEIGHT INCLUDES REFRIGERANT. IF ORDERED WITHOUT, CONSULT PRODUCT SUPPORT FOR DRY SHIP WEIGHT.

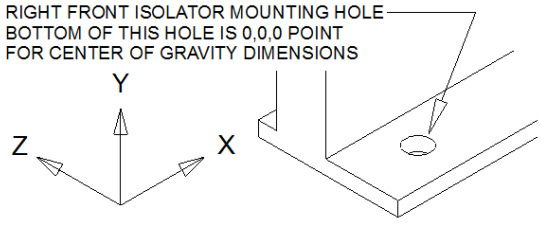
WEIGHTS AND CENTER OF GRAVITY



SPRING ISOLATOR SELECTION				
LOCATION	ISOLATOR LOAD*	VENDOR P/N	TRANE P/N	ISOLATOR COLOR
LEFT FRONT	9,540.0 lb			
LEFT REAR	6,012.0 lb			
RIGHT FRONT	10,546.0 lb			
RIGHT REAR	6,828.0 lb			
LEFT MIDDLE	N/A			
RIGHT MIDDLE	N/A			

COMPONENT	WEIGHT*
COMPRESSOR WEIGHT	6,045.0 lb
MOTOR WEIGHT	2,803.0 lb
STARTER WEIGHT	3,000.0 lb
SUCTION ELBOW WEIGHT	519.0 lb
ECONOMIZER WEIGHT	735.0 lb
EVAPORATOR WEIGHT	7,122.0 lb
EVAPORATOR WATERBOXES WEIGHT	1,609.0 lb
CONDENSER WEIGHT	4,293.0 lb
CONDENSER WATERBOXES WEIGHT	1,056.0 lb
HEAT RECOVERY CONDENSER WEIGHT	N/A
HEAT RECOVERY CONDENSER WATERBOXES WEIGHT	N/A
AUXILIARY CONDENSER WEIGHT	N/A
AUXILIARY CONDENSER WATERBOXES WEIGHT	N/A
MISCELLANEOUS WEIGHT	1,108.0 lb

UNIT CENTER OF GRAVITY	
CG Z (DIMENSION FROM RIGHT TO LEFT)	84.000 in
CG X (DIMENSION FROM FRONT TO REAR)	29.000 in
CG Y (HEIGHT DIMENSION FROM FLOOR)	54.000 in



WEIGHTS	
SHIPPING	OPERATING
28,291.0 lb	32,927.0 lb

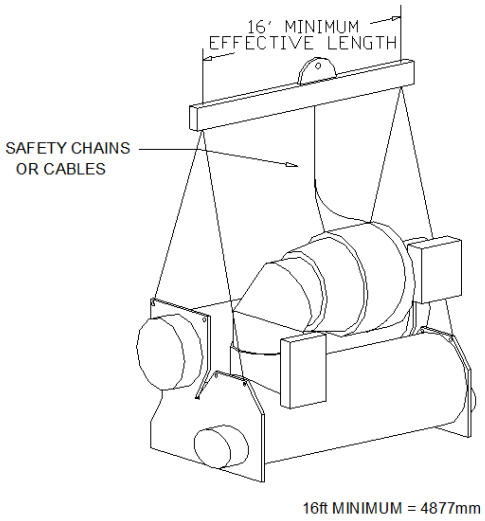
NAMEPLATE PRODUCT DESCRIPTION:

MODL	CVHF	VOLT	460	PTON	800.00 tons	NTON	760
EVTM	IMC1	CDTM	IECU	CPKW	598	CPIM	308
CDBS	800			EVSZ	080L	EVBS	1050
				ORSZ	1185	CDSZ	080L

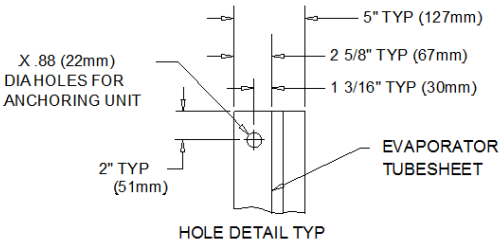
*ALL PUBLISHED WEIGHTS ACCURATE TO +/- 10 %

⚠ WARNING

1. HEAVY OBJECTS!
   DO NOT USE CABLES (CHAINS OR SLINGS) EXCEPT AS SHOWN. EACH OF THE CABLES (CHAINS OR SLINGS) USED TO LIFT THE UNIT MUST BE CAPABLE OF SUPPORTING THE ENTIRE WEIGHT OF THE UNIT. LIFTING CABLES (CHAINS OR SLINGS) MAY NOT BE OF THE SAME LENGTH. ADJUST AS NECESSARY FOR EVEN UNIT LIFT. OTHER LIFTING ARRANGEMENTS MAY CAUSE EQUIPMENT OR PROPERTY-ONLY DAMAGE. FAILURE TO PROPERLY LIFT UNIT MAY RESULT IN DEATH OR SERIOUS INJURY. SEE DETAILS BELOW.
2. IMPROPER UNIT LIFT!
   TEST LIFT UNIT APPROXIMATELY 24 INCHES TO VERIFY PROPER CENTER OF GRAVITY LIFT POINT. TO AVOID DROPPING OF UNIT, REPOSITION LIFTING POINT IF UNIT IS NOT LEVEL. FAILURE TO PROPERLY LIFT UNIT COULD RESULT IN DEATH OR SERIOUS INJURY OR POSSIBLE EQUIPMENT OR PROPERTY-ONLY DAMAGE.
3. ATTACH SAFETY CHAIN OR CABLE AS SHOWN WITHOUT TENSION, NOT AS A LIFTING CHAIN OR CABLE, BUT TO PREVENT THE UNIT FROM ROLLING.
4. DO NOT FORKLIFT THE UNIT TO MOVE OR LIFT.
5. LIFTING HOLES PROVIDED ON CHILLER TO ATTACH CABLES (CHAINS OR SLINGS).
6. 36" (900 MM) RECOMMENDED CLEARANCE ABOVE HIGHEST POINT OF COMPRESSOR.
7. FOLLOW NEC SECTION 110 AND OTHER APPLICABLE LOCAL CODES FOR CLEARANCES IN FRONT OF ELECTRICAL ENCLOSURES.
8. SPECIFIC SHIPPING AND OPERATING WEIGHTS OF THE SUBMITTED CHILLER ARE PROVIDED IF THE CENTRIFUGAL CHILLER SELECTION WAS ENTERED IN TOPSS. DETAILED LOAD POINT AND SPRING ISOLATOR APPLICATION WEIGHTS ARE AVAILABLE FROM "CENTRAVAC ISOLATOR SELECTION REPORT" AVAILABLE FROM THE REPORT GENERATOR OF THE TRANE TOPSS CHILLER SELECTION PROGRAM. CONTACT YOUR LOCAL TRANE SALES ENGINEER IF THIS DATA IS REQUIRED.

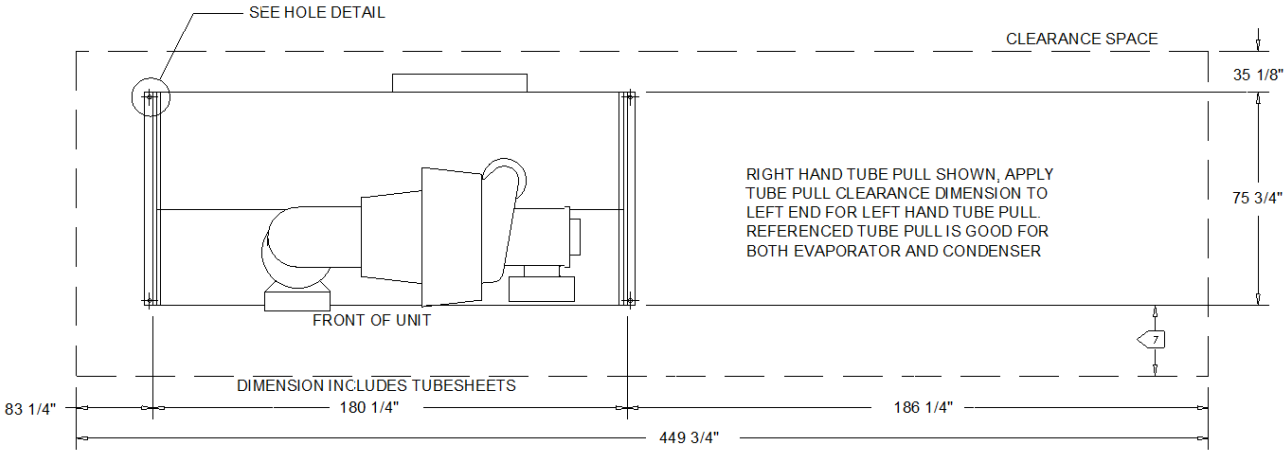


16ft MINIMUM = 4877mm



HOLE DETAIL TYP

(SEE NOTE 8 ABOVE)	
MAXIMUM SHIPPING	28,291.0 lb
MAXIMUM OPERATING	32,927.0 lb



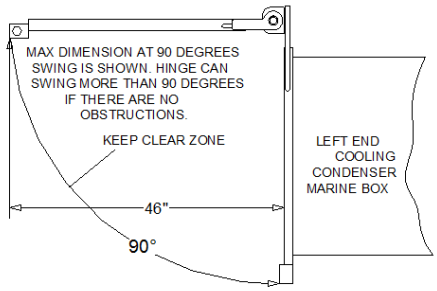
HINGE SWING DETAIL DRAWING

ALL VIEWS ON THIS PAGE ARE TOP VIEWS

DO NOT INSTALL PIPING OR ANY NON-REMOVABLE HARDWARE IN FRONT OF HINGED WATERBOXES/COVERS OR ANY ATTACHED BRACKETS AND HINGES

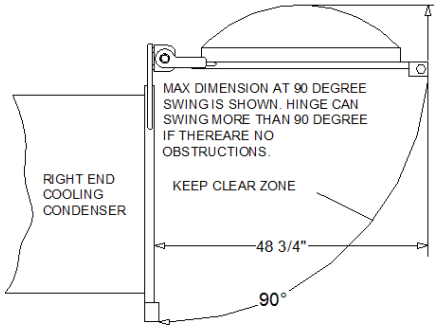
LEFT END OF COOLING CONDENSER

LEFT HAND 150 PSI MAR BOX COVER AND HINGE SWING



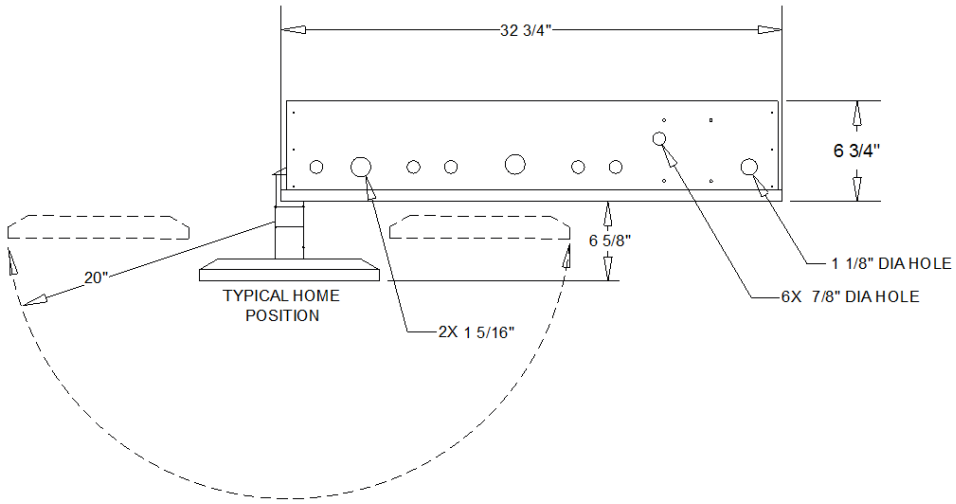
RIGHT END OF COOLING CONDENSER

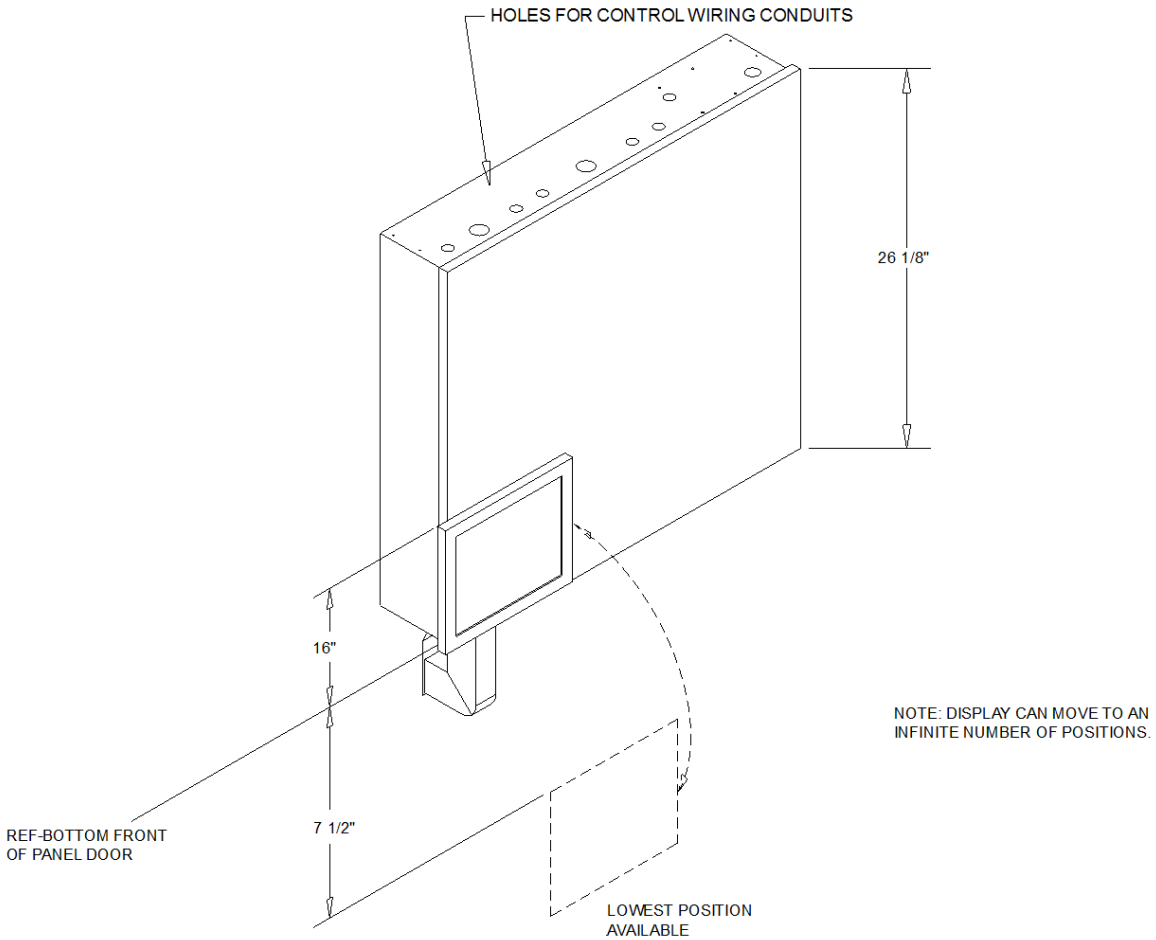
RIGHT HAND 150 PSI RETURN BOX AND HINGE SWING



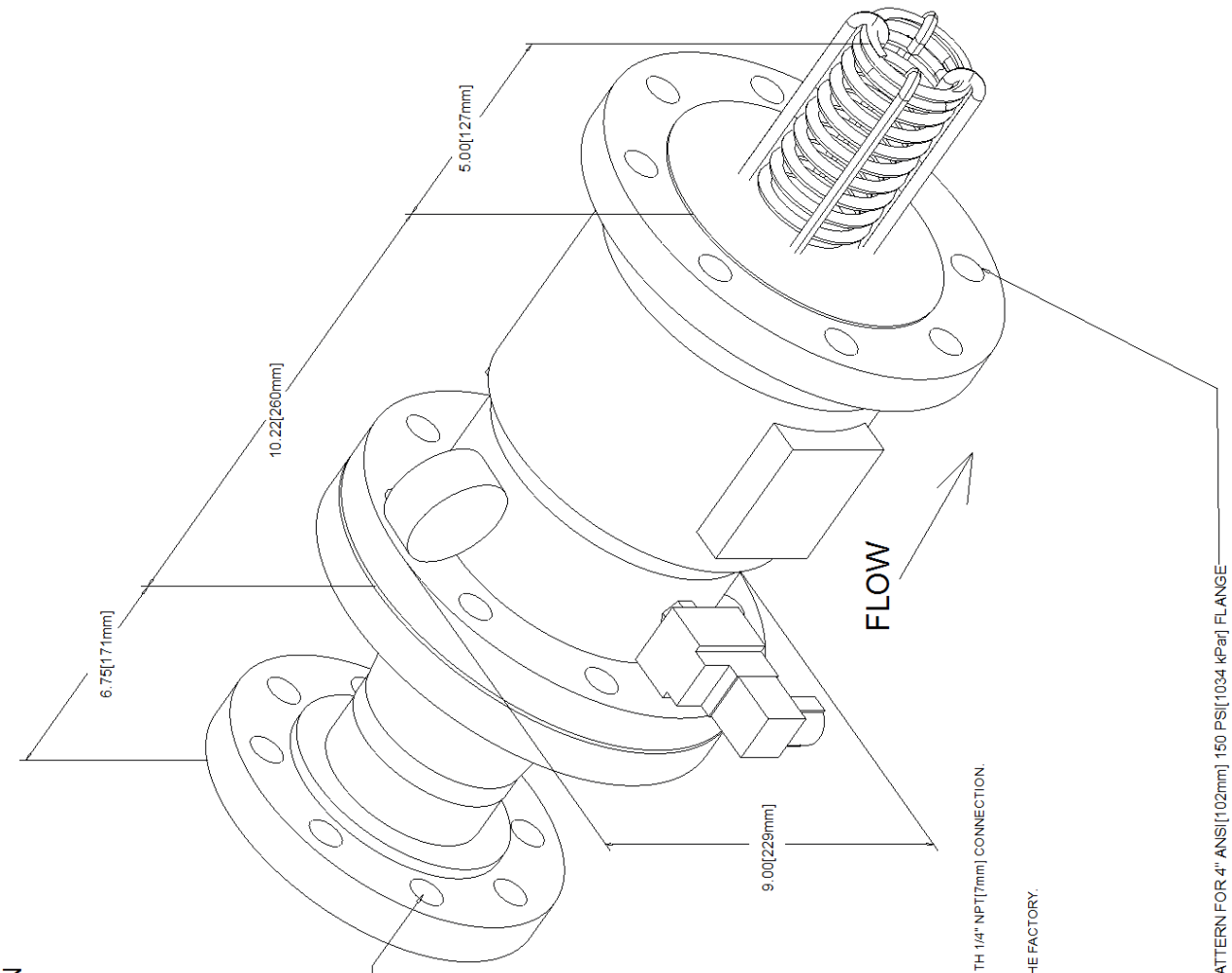
ADAPTIVIEW CONTROL PANEL

TOP VIEW





RUPTUREGUARD RELIEF VALVE FIELD INSTALLATION



BOLT PATTERN FOR 3" ANSI[76.2mm] 150 PSI[1034 kPar] FLANGE
(8X) Ø.75[19mm] HOLES EQUALLY SPACED
6.0[152.4mm] B.C.

RUPTURE DISK
NON-FRAGMENTING, SOLID METAL, REVERSE BUCKLING DISK.
RUPTURE DISK RATING OF 15 PSIG[104 kPa] ± 2 PSIG[14 kPa] AT 115 °F[46 °C].

RELIEF VALVE
VALVE RATING 15 PSIG[104 kPa] ± 5 %, COMPATIBLE WITH LOW PRESSURE CHILLERS.
STAINLESS STEEL VALVE BODY.
O-RING SEAL LOCATED IN VALVE PLUG.
FIELD SERVICEABLE O-RING.
O-RINGS COMPATIBLE WITH REFRIGERANT.

FLANGED INLET AND OUTLET ON VALVE BODY.
THREE 1/4" NPT[7mm], SQUARE RECESSED DRAIN PLUGS TO PROVIDE
DRAIN ACCESS TO THE INTERNAL CAVITY OF THE VALVE BODY. THESE ARE
LOCATED AT THE BASE OF THE VALVE PLUG AND SPACED AT 120 °.
(SEE IOM MANUAL CTV-SVX06)

THREE 1/4" NPT[7mm] TAPPINGS INTO THE DISK VALVE INTERSPACE;
AN EXCESS FLOW VALVE, PRESSURE GAUGE AND A SQUARE RECESSED
PLUG TO BE LOCATED IN THESE HOLES.
THESE ARE TO BE SPACED AT 120 °.
EXCESS FLOW VALVE - A 1/4" NP T[7mm], VALVE USED TO ENSURE THE
DISK/VALVE INTERSPACE IS MAINTAINED AT ATMOSPHERIC PRESSURE
DURING NORMAL CHILLER SERVICE.
PRESSURE GAUGE - A 2"[51mm] FACE, 30"[762mm]HG TO 30 PSIG[207 kPa], BRONZE TUBE, WITH 1/4" NPT[7mm] CONNECTION
(SEE IOM MANUAL CTV-SVX06)

VALVES TO UNDERGO A LEAK TEST, PRESSURE TEST, AND A PULL TEST BEFORE LEAVING THE FACTORY.

2828 SCFM [1335 L/s]
"C" VALUE FOR RUPTURE GUARD ONLY = 212.1 LBS/MIN [1.6 kg/s]

BOLT PATTERN FOR 4" ANSI[102mm] 150 PSI[1034 kPar] FLANGE
(8X) Ø.75[19mm] HOLES EQUALLY SPACED
7.50[191mm] B.C. (EACH END)

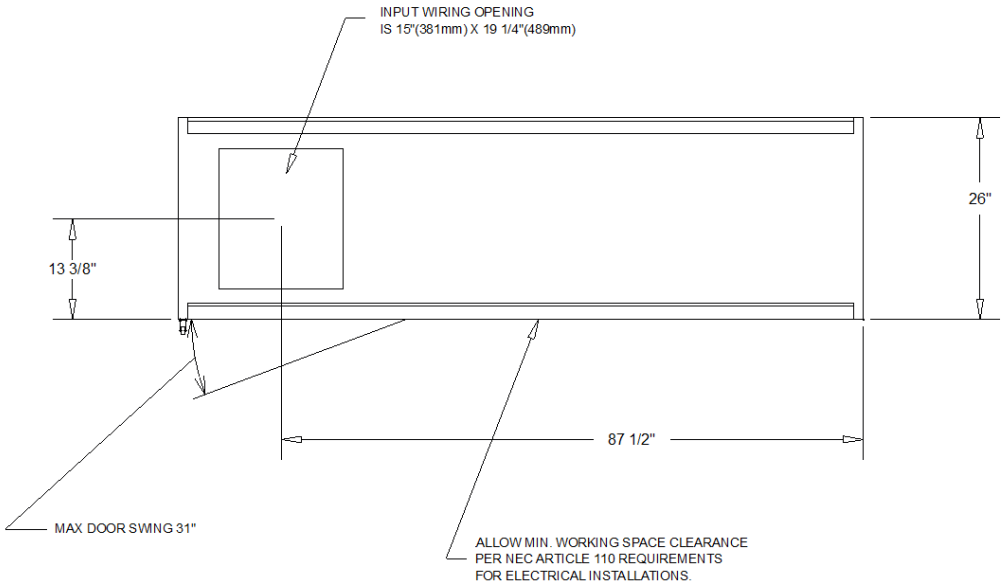
VALVE BODY	WEIGHT
4"	40LBS[18kg]

ADAPTIVE FREQUENCY DRIVE

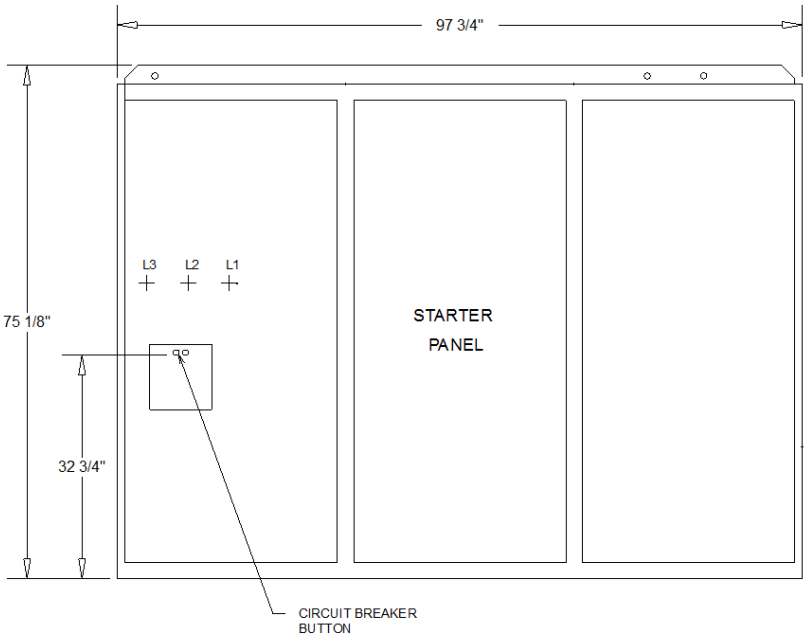
MAX RLA	BREAKER AIC AMPS	SHORT CIRCUIT WITHSTAND RATINGS (RMS SYMETRICAL AMPS)	LINE CONNECTION LUGS ADAPTIVE FREQUENCY DRIVE	PANEL CONNECTION	INTERNAL WIRE LENGTH
900	65000	65000	(4)1/0-750 MCM	CB	25 11/16"

THE NON-FUSED DISCONNECT OR CIRCUIT BREAKER IS DESIGNED FOR USE AS A SERVICE DISCONNECT ONLY.

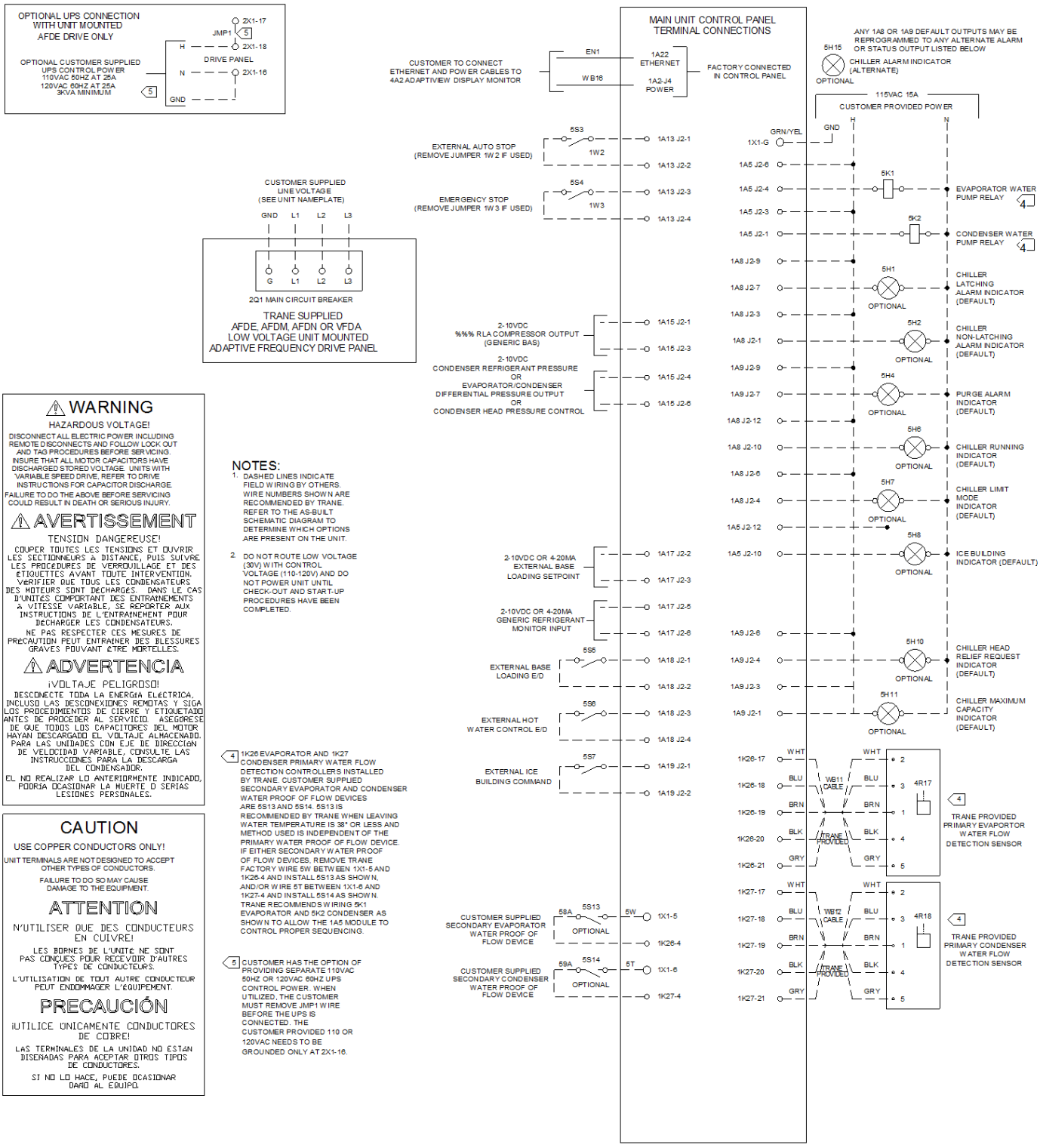
CB = CIRCUIT BREAKER



TOP VIEW



FRONT ELEVATION



WIRE NO OR DEVICE	FIELD WIRING CIRCUIT SELECTION INFORMATION
SUPPLY AND MOTOR LEADS	SEE NAMEPLATE; MINIMUM CIRCUIT AMPACITY
5S1*, 5S2*	CIRCUIT PROTECTED AT 20A, 115VAC 1PH, 10 AWG MAX WIRE SIZE
5S3 THRU 5S8	24VDC, 12MA RESISTIVE LOAD, 14 AWG MAX WIRE SIZE
ALL REMAINING LLID TERMINALS	CONTACT RATING; 2.88A INDUCTIVE, 1/3 HP, 0.25KW AT 115VAC. 14 AWG MAX WIRE SIZE.

* TAPPED CONTROL CONDUCTORS

DEVICE PREFIX CODE
1 = MAIN UNIT CONTROL PANEL DEVICE
2 = REMOTE MOUNTED DEVICE
4 = UNIT MOUNTED DEVICE
5 = CUSTOMER PROVIDED DEVICE

Compressor-Motor
Direct drive multiple-stage compressor, multi-stage capacity control guide vanes. Shrouded aluminum alloy impellers dynamically balanced. Motor-compressor assembly balanced to .15 in./sec (.0038m/sec) maximum vibration measured on motor and bearing housings. Refrigerant cooled, hermetically sealed, two-pole, squirrel cage induction motor. Two pressure lubricated bearings support the rotating assembly. A direct drive submerged oil pump motor, 3/4 hp (.560 kW) 115V/50/60/1 provides filtered and temperature controlled oil to compressor bearings.

Evaporator-Condenser
Shells are carbon steel plate. Evaporator includes rupture disk per BSR/ASHRAE 15 Safety Code. Carbon steel tube sheets are drilled, reamed and grooved to accommodate tubes. Tubes are individually replaceable externally finned seamless copper. Tubes are mechanically expanded into tube sheets. Eliminators are installed over entire length of the evaporator tube bundle. A multiple orifice control system maintains proper refrigerant flow. Condenser baffle prevents direct impingement of compressor discharge gas upon the tubes. Refrigerant side of the assembled unit is tested at both pressure(30.00 psi leak test) and vacuum. Water side is hydrostatically tested at one and one-half times design working pressure, but not less than 225.00 psi.

Trane reserves the right to implement chiller technology enhancements that will reduce the chiller's refrigerant charge, with no impact on chiller performance. Changes may be reflected in the chiller's nameplate refrigerant charge and the quantity of refrigerant charge shipped to the jobsite, depending upon the final date of equipment manufacture.

Water Boxes
Drains and vents - Water boxes typically have 3/4-inch NPTI vents and drain connections provided. Evaporators have 2 vents and 2 drains, condensers have 1 vent and 1 drain. If grooved connections are offered, the design is based on Style 77.

Marine water boxes have removable end plates and water connections on the sides.

CondenserWater box Hinge
The water box is provided with a hinge on one or both ends of the condenser to facilitate access to and maintenance of the condenser tubes as needed without the need for separate rigging. See the dedicated drawing of the hinge(s) being supplied.

Economizer
A flash economizer with no moving parts provides power saving capability.

Purge System
The EarthWise(TM) purge includes a 1/4 hp 115V/60/1, 100V/50/1 air cooled condensing unit, purge tank, drier elements, and a 1/20 hp (.037 kW) 115V/60/1, 110V/50/1 pump-out compressor. The purge is designed with an activated carbon filtration system that includes an autoregeneration feature which results in automatic high-efficiency removal of noncondensibles from the chiller without manual carbon maintenance. The purge meets Green Seal GS-31 with a leak rate less than 1.0% of the charge per year and also meets ASHRAE 147 with a leak rate of less than one unit mass of refrigerant per unit of air.

AdaptiView Control Panel:

The Tracer(tm) AdaptiView is a microprocessor-based chiller control system that provides complete stand alone system control and monitoring for the water cooled CenTraVac (TM). It is a factory mounted package including a full complement of controls to safely and efficiently operate the CenTraVac chiller, including oil management, purge operation, interface to the starter, and comprehensive motor protection including three phase solid state motor overload. Inlet and outlet water (fluid) temperature sensors are located in the evaporator and condenser waterbox connections as standard.

The display is a touch sensitive 12 1/8" diagonal color liquid crystal display (LCD) that uses color graphics and animation to ensure ease of use. The touch sensitive interface allows the operator to view the chiller graphically and receive a status indication via subsystem animations. The operator can navigate easily between the primary chiller subsystems including: compressor, evaporator, condenser, and motor. For each subsystem, you can view status and detailed operating parameters. In addition, alarms, reports, trending, and settings can all be accessed quickly from the main screen. The display is mounted on a flexible "arm" that allows extensive height and viewing angle variations.

The panel supports an extensive list of languages including the default English. The data can be set to be viewed in inch pounds IP or metric units SI. For remote starters - Class 1 control panel voltage (30-115 V) are clearly labeled in the control panel. Class 2 input voltage (30V max) is also labeled in the control panel.

Operating Data including:
*operating hours
*number of starts
*chilled water setpoint
*evaporator and condenser water flow status
*evaporator entering and leaving water temperatures
*evaporator saturated refrigerant temperatures
*evaporator approach temperature
*evaporator refrigerant pressure
*condenser entering and leaving water temperatures
*condenser saturated refrigerant temperatures
*condenser approach temperature
*condenser refrigerant pressure
*oil differential pressure
*oil tank temperature
*purge mode
*purge average daily pump-out time
*% RLA per phase for motor
*RLA per phase
*volts per phase
*power factor
*kw
*kwh
*frequency

The AdaptiView also contains the following dedicated reports:
Evaporator, Condenser, Compressor, Motor, Purge, and ASHRAE. Each report is comprised of a detailed listing of operational data relative to that chiller subsystem.

Control functions including:
*leaving chilled water temperature
*percent demand limit
*chiller water reset (based on return water temperature
*front panel control type
*setpoint source
*differential to start
*differential to stop

Status data including:

*waiting to start
*running
*run limit
*run inhibit (adaptive)
*auto
*free cooling (option)
*preparing to shutdown
*shutting down (post lube)
*stopped

Safeties including:
Automatic safety shutdown for:

*Low chilled water temperature,
*low evaporator refrigerant temperature
*high condenser refrigerant pressure
*evaporator and condenser flow status
*low oil pressure
*oil pressure overdue
*high or low oil temperature
*high bearing oil temperature (requires enhanced protection option)
*high motor current
*high motor temperature
*starter function faults
*critical temperature and pressure sensor faults

The devices are of a latching trip out type requiring manual reset. Non-latching safety trip outs for operating conditions external to the chiller automatically permits unit to resume normal operation when condition is corrected.

Advanced motor protection monitors 3-phase current to provide latching trip out protection from adverse effects of phase loss, phase unbalance, phase reversal, loss of phase reversal protection, and electrical distribution faults (momentary power loss) by instantaneous trip out of motor.

Surge protection - Detects surge and limits chiller loading through inlet vane modulation. Head relief through lowering cooling tower water temperature can be requested. If not corrected within 7 minutes, chiller is shut down.

Enhanced Adaptive Control(TM) - Built in intelligence to keep the chiller on line (safely making maximum tons) while simultaneously preventing chiller damage/failure. During any chiller limiting mode of operation, the control panel enunciates the condition via a relay output.

Trending:
The controller provides 10 standard graphs for trending multiple parameters, The operator can add an additional 6 custom graphs if desired. On any one custom graph, the operator can choose to trend up to 10 unique parameters from a more comprehensive list. Two Y axes are available for any graph to facilitate readability.

Diagnostics:
AdaptiView includes comprehensive diagnostic monitoring. All active diagnostics are available, and up to 20 historic diagnostics are communicated to the operator via the 12 1/8" LCD display with graphic navigation system. Each diagnostic is time and date stamped.

Service Tool:
A PC-based service tool called Tracer TU, connected to the chiller via USB port, is available for additional cost and displays the last 100 diagnostics, indicating the time, date of occurrence, and system parameters at the time of the diagnostic. The service tool provides advanced troubleshooting and access to sophisticated configuration settings not needed during operation of the chiller.

Security:
The AdaptiView can be set to prevent unauthorized access to the chiller settings. The operator can choose to secure the operating settings with a password. Data and reports can still be accessed once the settings are locked out.

The memory for the AdaptiView is non-volatile type, so if power is lost, operating settings are retained. A life time battery is standard, which is used only to support the clock function for the chiller.

Chilled and Condenser water pump relays:
Chilled water and condenser water pump relays are provided and it is recommended that they be used for pump control.

BACnet(MSTP) Direct Points List:
The following points are available directly from the chiller. Recognize that some of these points require chiller options or configurations.

Inputs Including
Chiller Auto/Stop
Chiller Mode (e.g. cool)
External Base Loading Enable/Disable (requires Extended Operation option)
External Base Loading Setpoint (requires Extended Operation option)
Chilled Water Setpoint
Current Limit Setpoint
Heating Setpoint (requires Extended Operation option)
Wall Mounted Refrigerant Specific Monitor (requires Extended Operation option)
Clear Diagnostics

Outputs Including
Evaporator Pump relay
Condenser Pump relay
Chilled Water Flow Status
Condenser Water Flow Status
Evaporator Water Flow Rate (requires Flow Compensation option)
Condenser Water Flow Rate (requires Flow Compensation option)
Chiller capacity (requires Flow Compensation option)
Leaving Chilled Water Temperature
Entering Chilled Water Temperature
Entering Condenser Water Temperature
Leaving Condenser Water Temperature
Second Condenser Entering Water Temperature (requires HR or Aux condenser bundle)
Second Condenser Leaving Water Temperature (requires HR or Aux condenser bundle)
Active Chilled/Hot Water Setpoint
Active Current Limit Setpoint
Active Base Loading Setpoint (requires Extended Operation option)
Head Relief Request relay
Compressor Running relay
Chiller On/Off
Limit Warning relay
Maximum Capacity relay
Alarms Description1
- Manual Reset Alarm relay
- Auto Reset Alarm relay
- Purge Alarm relay

Alarm Reset
Condenser Refrigerant Pressure
Condenser Refrigerant Temperature
Evaporator Refrigerant Pressure
Evaporator Refrigerant Temperature
Compressor Discharge Refrigerant Temperature (requires Enhanced Protection option)
Differential refrigerant pressure (not for head pressure control)
Operating Status (Alarm, Run Enabled, Local Control, Limited)
Chiller Modes (i.e. Off, Starting, Running, Shutting Down)
Base Loading Active (requires Extended Operation option)
Hot Gas Bypass Active (requires Hot Gas Bypass option)
Operating Mode (e.g. Cool)
Current Per Line
Voltage Per Phase
Unit Power Consumption (kW)
Motor winding temperature
Motor power factor (uncorrected)
Oil Temperature
Oil Pressure Differential
- High Side Oil Pressure
- Low Side Oil Pressure

Compressor Starts
Compressor Run Time
Inlet guide vane position
Inboard bearing oil temperature (requires Enhanced Protection option)
Outboard bearing oil temperature (requires Enhanced Protection option)
Purge Status2
Purge pumpout Average (24 hour)
Purge pump-out
Purge regeneration
Purge carbon tank temperature
Purge liquid temperature
Purge suction temperature
Purge time to next purge run
Purge pump-out chiller on-7 days

Purge pump-out chiller off-7 days
Purge pump-out life
Purge regeneration life
Refrigerant Monitor
AFD output frequency
AFD transistor temperature

Condenser Pressure Output:
A hardwire output signal of condenser pressure, or differential pressure between the evaporator and condenser is provided.

Enhanced Protection Option provides:
Bearing temperatures sensors installed for both bearings, displayed on unit controller
Compressor discharge refrigerant from the compressor
Actual pressure transducer in the condenser for enhanced condenser limit control

Operating Status:
The following hardwire binary outputs are available:
Compressor running relay
Alarm relay - manual reset
Alarm relay - auto reset
Limit warning relay
Purge alarm relay
Head relief request relay
Maximum capacity relay

Enhanced Flow Management Package:
This provides a flow display and enhanced variable flow control and compensation. The flow compensation component enhances the unit controllers variable flow rate of change capabilities from 30% per minute up to 50% per minute. Included are factory mounted differential water pressure sensors for both the evaporator and the condenser. Differential pressure switches or some other means to prove flow are still required Max pressure rating for the pressure sensors is 365 psig.

The following will be displayed on the unit controller:
Evaporator differential water pressure
Condenser differential water pressure
Evaporator GPM
Condenser GPM
Evaporator Tons
Due to their accuracy, these parameters are not designed to be used for detailed metering or analysis.

Evaporator Proof of Flow - Thermal Dispersion
A factory provided, field installed thermal dispersion type proof of flow switch (IFM) is provided. The thermal dispersion controller is mounted in the chiller control panel, the piping probe and wiring is shipped lose for field installation in the ship with components box. Follow the installation instructions in the chiller installation manual. Reference specific IFM Installation manual (PART-SVN223*-EN) notes shipped with your rupture guard /contact local Trane sales office

Condenser Proof of Flow - Thermal Dispersion
A factory provided, field installed thermal dispersion type proof of flow switch (IFM) is provided. The thermal dispersion controller is mounted in the chiller control panel, the piping probe and wiring is shipped lose for field installation in the ship with components box. Follow the installation instructions in the chiller installation manual. Reference specific IFM Installation manual (PART-SVN223*-EN) notes shipped with your rupture guard /contact local Trane sales office

Paint
All CenTraVac(TM) painted surfaces are coated with a primer and an air-dry beige primer-finisher prior to shipment.

Isolation
All units ship with neoprene isolator pads as standard, except when spring isolators are chosen. Enough pads are provided to cover the area under the chiller supports.

Shipment
All units are of hermetic design, leak tested, charged to 5.00 psi and shipped as a single factory assembled package. Full oil charge shipped in oil sump. Refrigerant shipped to jobsite from refrigerant manufacturer. The entire chiller is shrink wrapped for protection.

RuptureGuard-Relief Valve-Field Install
RuptureGuard is a Trane supplied field installed refrigerant containment system that replaces a chiller's rupture disk. The system consists of a non-fragmenting rupture disk and a pressure relief valve that can be applied to all low pressure centrifugal chillers. This system functions as the chiller's primary pressure relieving device and provides a leak free seal between the chiller and atmosphere. The pressure relief valve is installed in place of the factory shipped rupture disk (which must be removed) and functions as an interim primary pressure relieving device and seal. When the chiller's internal pressure exceeds 15 psig [104 kPa], the non-fragmenting rupture disk bursts allowing the pressure to be relived through the relief valve. After the chiller's pressure is reduced, the pressure relief valve recloses stopping the flow of refrigerant to the atmosphere. A pressure switch is included with the RuptureGuard package as standard. This switch has single pole, double throw contacts for interface to external monitoring systems. The switch has a trip setting of 11 psig, reset values of 8 psig, and is rated for 5A at 220 volts. Reference specific Rupture guard Installation manual (CTV-SVX06*-EN) notes shipped with your rupture guard /contact local Trane sales office.

TRANE Adaptive Frequency Drive (AFD)
The Trane AFD is a closed-loop, liquid refrigerant cooled, microprocessor based pulsed width modulation design. The AFD is both voltage and current regulated. Output power devices: IGBT transistors.

The AFD is factory mounted on the chiller and ships completely assembled, wired and tested. Patented Trane AFD control logic is specifically designed to interface with the centrifugal water chiller controls. AFD control adapts to the operating ranges and specific characteristics of the chiller, and chiller efficiency is optimized by coordinating compressor motor speed and compressor inlet guide vane position. Chilled water control and AFD control work together to maintain the chilled water setpoint, improve efficiency and avoid surge. If a surge is detected, AFD surge avoidance logic will make adjustments to move away from and avoid surge at similar conditions in the future. Use only copper conductors for terminal connections. Failure to do so may cause corrosion or overheating, and starter damage.

This unit mounted AFD is supported by three cantilevered support brackets. These support brackets are normally welded to the side of the evaporator shell and extend out the depth of the AFD. For some AFD sizes and chiller configurations, the support brackets have a bolt plate which allows the majority of the length of these support brackets to be removable.

Frame 3 (405A/608A): AFD Support brackets are welded to the evaporator shell.

Exceptions: The following compressor/shell combinations have supports with bolt plate as standard for a Frame 3 AFD:

- compressor sizes 620/760/870 on 080 evaporator with 080 condenser shells
- compressor sizes 1070/1300 on 142 evaporator with 210 condenser shells.

Frame 4 (900A/1210A): AFD Support brackets have bolt plate so most of the bracket is removable.

AFD Design Features

* NEMA 1 ventilated enclosure with a hinged, locking door is tested to a short circuit rating of 65,000 amps. It includes a padlockable door-mounted circuit breaker/shunt trip with AIC rating of 65,000 amps. The circuit breaker is NOT interlocked with the enclosure door.The entire package is UL/CUL listed.
* Simple modular construction.
* The drive is rated for maximum 480/60/3 input power, +/-10%.
* Displacement power factor of 0.98 at full load, and 0.96 at part load.
* Minimum efficiency of 97% at rated load and 60 hertz.
* Full motor voltage is applied regardless of the input voltage.
* Soft-start; linear acceleration; coast to stop.
* Adjustable output frequency from 38 to 60 hertz.
* All control circuit voltages are physically and electrically isolated from power circuit voltage.
* 150% instantaneous torque available for improved surge control.
* Output line-to-line and line-to-ground short circuit protection.

* Harmonic attenuation- integrated active rectification control of the building AC power assures low line -generated harmonics back to the user's power grid. The AFD has less than or equal to 5% current total demand distortion (TDD) as measured at the AFD. This is based on an electrical system with voltage distortion less than 1.5 %.

Chiller Unit Control Features for AFD

Chiller Unit Control Features for AFD
The chiller unit control panel capabilities provide for the control/configuration interface to, and the retrieval/display of, AFD-related data. AFD standard design features controlled through AdaptiView include:
* Current limited to 100%
* Motor overload protection.
* Motor overtemperature protection.
* Phase loss, reversal, imbalance protection.
* Overvoltage/undervoltage protection.

Digitally displayed on the AdaptiView panel: output speed in hertz, input frequency, output speed in rpm, input line voltage, output voltage, input line kw, output kw, input line amps per phase, average input line amps, output/motor amps average current in % RLA, load power factor, fault, AFD transistor temperature.

Environmental Ratings:
* 32F to 104 (0C to 40) operating ambient temperature
* Altitude to 3300 feet (1000m), amperage derate of 1% per every 300 feet above 3300 feet
* Humidity, 95% non-condensing

Required Installer Responsibilities

The following are considered functions normally required of the equipment installer./n

Install unit on a foundation with flat support surfaces level within 1/16" and of sufficient length to support concentrated loading. (Spring isolators should be considered whenever chiller installation is planned for an upper story location.)

Place isolation pads or optional spring type isolators provided by the chiller manufacturer under the unit. When spring isolators are chosen, no pads are provided.

Install unit per applicable Trane Installation Manual.

Complete all water and electrical connections.

Where specified, provide and install valves in water piping upstream and downstream of the evaporator and condenser water boxes as means of isolating shells for maintenance and to balance and trim system.

Furnish and install a flow switch or equivalent device in both the chilled water and condenser water piping properly interlocked to insure that unit can operate only when water flow is established.

Furnish and install taps for thermometers and pressure gauges in water piping adjacent to inlet and outlet connections of both evaporator and condenser.

Furnish and install drain valves to each water box.

Install vent cocks on each water box.

Furnish and install strainers upstream of chiller evaporator and condenser bundles to protect tubes from potential damage caused by debris in the circulating water. Note: Failure to install strainers in all water piping entering the chiller could result in tube plugging conditions that could damage unit components. If the circulating pumps are immediately upstream of the chiller bundles, then the strainer can be installed immediately ahead of the pumps. If the circulating pumps are downstream of the chiller bundles, then the strainers should be installed immediately ahead of the chiller bundles.

Furnish sufficient refrigerant 25.0 lb per machine and dry nitrogen 50.0 lb per machine for pressure testing under manufacturer's supervision.

Start-up unit under supervision of a qualified Trane field engineer.

Where specified, insulate evaporator and any other portions of machine required to prevent sweating under normal operating conditions.

Water connection piping must not transfer forces to the chiller. Because of cumulative tolerances in manufacture and field installation, prepiping of water connections closer than 36" is not recommended. Any problems associated with prepiping of water connections closer than 36" to the chiller are the responsibility of the installing contractor.

Furnish and install vent lines for rupture disk and purge venting to atmosphere per ASHRAE 15 and unit installation manual. If RuptureGuard-Relief Valve option is ordered, remove factory rupture disk and install RuptureGuard-Relief Valve per the IOM manual. In some chiller configurations the RuptureGuard may not bolt directly to the chiller flange. Locally sourced and approved piping may be required between the chiller and the RuptureGuard.

Field Disassembly

With chillers that may require field disassembly (for example due to clearance concerns during unit installation) reference the Disassembly and Reassembly manual and your Trane Sales representative prior to the order being placed. Caution: if certain components are removed in the field, for example the economizer, the necessary components (gaskets, seals, etc.) are not provided as standard.

Separable Shells

With chillers that have been ordered with the Separable Shell option, the evaporator is bolted to the condenser to allow for the separation of the evaporator from the condenser in the field. The components (gaskets, seals, etc.) needed to reassemble the shells together, the compressor, and remove and replace the economizer are included with this option.
Note:
Compressor doweling is always included with this option, see Compressor Doweling option for more details.
The purge assembly is not modified so it can be removed easier with this option, additional parts may be required to remove the purge in the field.
If you have a 405 or 608 Amp unit mounted drive, this option does not include bolt on support arms or replacement gaskets and bolts.
If you have a 900 or 1210 Amp unit mounted drive, the support arms are bolted on however replacement gaskets and bolts are not included with this option.
Additional items that are not included with this option are: touch up paint, vacuum pump oil, replacement compressor oil, and spare insulation.

Compressor Doweling

With chillers that have been ordered with Compressor Doweling, this option includes dowel pins located between the interstage casings to help facilitate disassembly and reassembly of the compressor itself. Dowel pins at the compressor connections to the evaporator and condenser shells are standard with or without this option. These dowel pins help to facilitate reassembly of the compressor onto the unit. The components (gaskets, seals, etc.) needed to reassemble the compressor onto the shells are included with this option.
Reference the Disassembly and Reassembly manual for more information and contact Water-Cooled Product Support if you have further questions or would like to special order a chiller with non-standard take apart items.

Leak-Tight Warranty

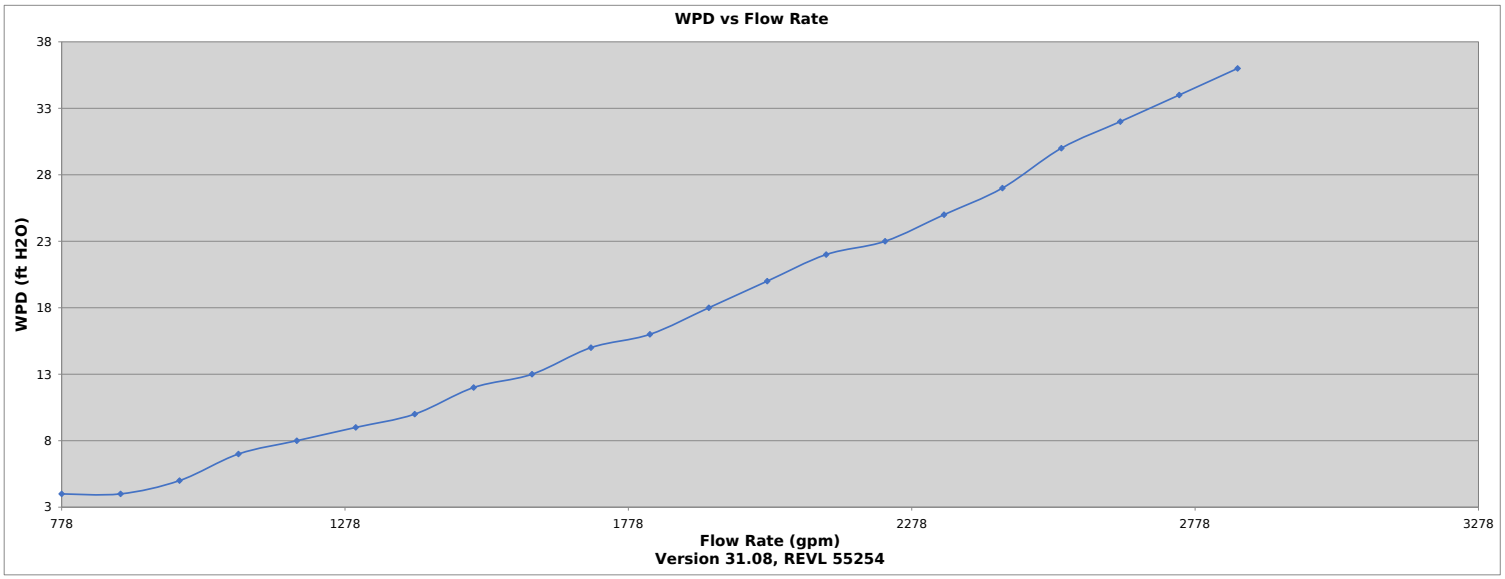
The CenTraVac chiller features a 5-year limited Leak-Tight Warranty which is valid for the lesser of 60 months from initial start-up or 66 months from date of shipment. The limited Leak-Tight Warranty covers models CVHE/F/L, CVHS, CVHM and CDHF chillers installed in the United States or Canada. The Company's obligations and liabilities under this warranty are limited to furnishing replacement refrigerant; no other parts or labor are covered under this limited warranty. No liability whatever shall attach to the Company until appropriate actions have been taken (acceptable to Company) to eliminate the source of the leak, and then said liability shall be limited to furnishing the replacement refrigerant.

If the chiller is placed under a comprehensive Trane service and maintenance agreement (Trane Select Agreement or better) prior to the expiration of the standard Leak-Tight Warranty, the protection against refrigerant loss shall continue under the Trane Select Agreement for as long as an active Trane Select Agreement remains in effect without interruption.

If a 10-Year Parts, Labor and Refrigerant Warranty was purchased for the chiller and the chiller is placed under a Trane Select Agreement (or better) prior to the expiration of the 10-Year Parts, Labor and Refrigerant Warranty, the protection against refrigerant loss shall continue under the Trane Select Agreement for as long as an active Trane Select Agreement remains in effect without interruption

CenTraVac Condenser WPD Curve

Pressure Drop Curve



Flow Rate Table

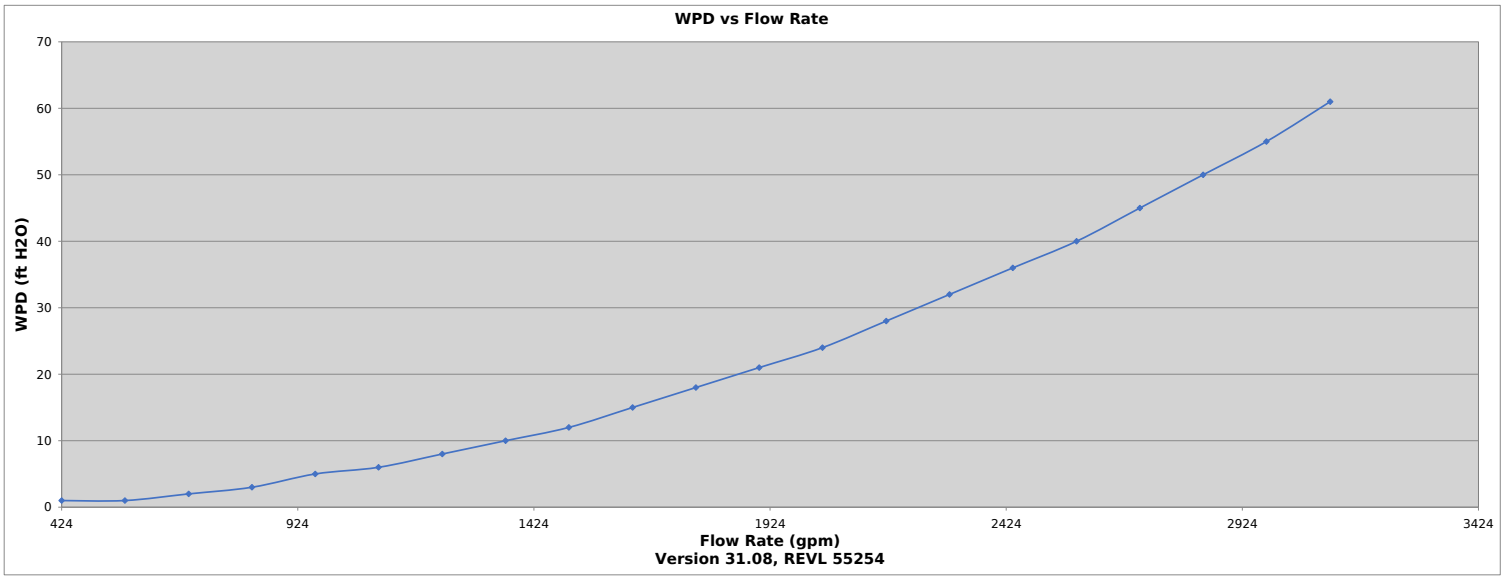
Flow Rate (gpm)	WPD (ft H2O)
778	4
882	4
986	5
1090	7
1193	8
1297	9
1401	10
1505	12
1608	13
1712	15
1816	16
1920	18
2023	20
2127	22
2231	23
2335	25
2438	27
2542	30
2646	32
2750	34
2853	36

Unit Configuration

FCLT-LAX	CDSZ-080L	ARCL-CERT
MODL-CVHF	CDBS-800	AH07-COMP
NTON-760	CDTM-IECU	AH7M-COMP
CNIF-ADPV	CDTH- 25	AH10-COMP
INDP- NO	CDVF- NO	AH13-COMP
IHRZ- 60	CDWP- 2	AH16-COMP
HRTZ- 60	HGCD-HGBT	EXOP-YES
SRTY-UAFD	TSTY-STD	WPSR-WFC
IVLT-460	CDFP-TDFS	CDRP-YES
ENCL-STD	ORSZ-1185	TRMM-BCNT
VOLT-460	TEST-AIR	RPGD-YES
CPKW-598	TTOL-AIR	CRFG-R514
FRAM-440E	WCNM-SNMP	
CPIM-308	FTST-YES	
EVSZ-080L	ASTT- NO	
EVBS-1050	OPMM-KWTN	
EVTM-IM48	ASKT-NONE	
EVTH- 25	TYPE-SNGL	
EVVF- NO	INSL- NO	
EVWP- 2	OPTI-SPSH	
EVFP-TDFS	RCRQ-NONE	

CenTraVac Evaporator WPD Curve

Pressure Drop Curve



Flow Rate Table

Flow Rate (gpm)	WPD (ft H2O)
424	1
558	1
693	2
827	3
961	5
1095	6
1230	8
1364	10
1498	12
1633	15
1767	18
1901	21
2035	24
2170	28
2304	32
2438	36
2573	40
2707	45
2841	50
2975	55
3110	61

Unit Configuration

FCLT-LAX	CDSZ-080L	ARCL-CERT
MODL-CVHF	CDBS-800	AH07-COMP
NTON-760	CDTM-IECU	AH7M-COMP
CNIF-ADPV	CDTH- 25	AH10-COMP
INDP- NO	CDVF- NO	AH13-COMP
IHRZ- 60	CDWP- 2	AH16-COMP
HRTZ- 60	HGCD-HGBT	EXOP-YES
SRTY-UAFD	TSTY-STD	WPSR-WFC
IVLT-460	CDFP-TDFS	CDRP-YES
ENCL-STD	ORSZ-1185	TRMM-BCNT
VOLT-460	TEST-AIR	RPGD-YES
CPKW-598	TTOL-AIR	CRFG-R514
FRAM-440E	WCNM-SNMP	
CPIM-308	FTST-YES	
EVSZ-080L	ASTT- NO	
EVBS-1050	OPMM-KWTN	
EVTM-IM48	ASKT-NONE	
EVTH- 25	TYPE-SNGL	
EVVF- NO	INSL- NO	
EVWP- 2	OPTI-SPSH	
EVFP-TDFS	RCRQ-NONE	