UNIVERSITY OF LOUISIANA AT LAFAYETTE

DETAILED SPECIFICATIONS

PROPOSAL FOR FURNISHING ALL LABOR, MATERIALS, EQUIPMENT, TRANSPORTATION, SUPERVISION, PERMITS, ETC. NECESSARY FOR THE MADISON HALL 500 TON CHILLER REPLACEMENT, LOCATED ON THE UL LAFAYETTE CAMPUS, IN LAFAYETTE, LOUISIANA, AS SHOWN ON THESE SPECIFICATIONS...

SCOPE OF WORK

Remove existing Chillers #1 and replace with new 500 Ton. Modify existing piping, controls to accommodate installation of new chiller. Reconnect existing systems as indicated herein and on the drawings. Refer to plans and specifications.

MECHANICAL SPECIFICATIONS

GENERAL:

The General Conditions of the Specifications, along with the supplementary conditions, special conditions, information to bidders, and any other pertinent information and documents shall apply the same as if repeated herein.

SCOPE OF WORK:

Furnish all labor and material necessary to provide and install the complete mechanical portion of this Contract called for herein and on accompanying drawings. Parts of the mechanical division may be bid separately or in combination, at the Contractor's option; however, it shall be the responsibility of the Prime Contractor to assure himself that all items covered in the Specification have been included if he chooses to accept separate bids.

This Contractor shall install equipment, piping, etc. to meet building and space requirements. No equipment shall be bid on or submitted for approval if it will not fit in the space provided.

It is the intention of these Specifications that all mechanical systems shall be furnished complete with all necessary valves, controls, insulation, piping, devices, equipment, etc. necessary to provide a satisfactory installation in working order.

Contractor shall visit the site and acquaint himself thoroughly with all existing facilities and conditions which would affect his portion of the work. Failure to do so shall not relieve the Contractor from the responsibility of installing his work to meet the conditions.

This Contractor shall protect the entire system and all parts thereof from injury throughout the project and up to acceptance of the work. Failure to do so shall be sufficient cause for the Owner to reject any piece of equipment.

DEMOLITION:

The contractor shall visit the site prior to bid to determine the extent of work required to complete the project.

Contractor shall coordinate demolition with the owner. Locate salvaged equipment as directed by owner. All equipment and materials not salvaged by the owner shall be removed from the site and discarded at the contractor's expense.

Contractor shall coordinate all work with the Prime Contractor and phase work as required by project.

All equipment piping, etc. required to be removed to accommodate the modifications shall be removed.

Contractor shall maintain services to existing facilities which shall remain during and after construction is complete.

Contractor shall coordinate any shutdown of services with the owner. It is intended that the buildings will remain occupied during construction. Contractor shall schedule shut down of services with the owner in order to prevent disruption of building occupancy. Refer to drawings for additional requirements.

Contractor shall be responsible for draining down of existing systems to complete demolition. All work shall be scheduled with the owner. Contractor shall also be responsible for refilling system and removing all air in order to return the systems to proper operating conditions. All work requiring drain down shall be done at one time (where possible) to minimize disruption.

All shutdown of services shall be done at a time period approved by the owner. The systems shall be required to be back up and fully operational each morning unless otherwise approved by the owner. Chiller and VFD replacement shall be staged to allow for constant operation.

CUTTING AND PATCHING:
Initial cutting and patching shall be the responsibility of the Prime Contractor, with the Mechanical Contractor being responsible for laying out and marking any and all holes required for the reception of his work. No structural beams or joists shall be cut or thimbled without first receiving the approval of the Owner. After initial surfacing has been done, any further cutting, patching, and painting shall be done at this Contractor's expense. Existing surfaces shall be restored to their original condition.

FILL AND CHARGES FOR EQUIPMENT:
Fill and charge with materials or chemicals all those devices or equipment as required to comply with the manufacturer's guarantee or as required for proper operation of the equipment.

REPAIRING ROADWAYS AND WALKS:
Where this Contractor cuts or breaks roadways or walks, in order to lay piping, he shall repair or replace these sections to meet the Owner's approval.

WELDING:
Weld piping and above grade steel tanks in accordance with qualified procedures using performance qualified welders and welding operators. Qualified procedures and welders in accordance with ASME Section IX. Welding procedures qualified by others and welders and welding operators qualified by another employer may be accepted as permitted by ANSI B31.1. Notify the A/E 24 hours in advance of tests and perform the tests at the work site if practicable. Furnish A/E with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Apply welders or welding operators assigned symbols near each weld they make as permanent record.

PAINTING:
All painting shall be by the Prime Contractor's Painting Sub-Contractor. All pipe, supports, hangers, etc. exposed in or outside of the building or equipment room shall be painted. This Contractor shall prepare the surface of the material to receive the first coat of paint. All subsequent coatings shall be prepared by the Painting Sub-Contractor. Requirements covering paints, workmanship and preparation of surfaces as stated in the Specifications shall govern. Colors shall be approved by the Owner.

All new steel piping, valves, elbows, welded connections, and fittings shall be coated with two (2) coats of rust inhibiting primer (Sherwin Williams Kem Kromik Universal Metal Primer Protective & Marine Coating Brown/Red Oxide or approved equivalent) prior to applying final paint color and/or insulation.

CLEANING AND ADJUSTING:
Upon completion of his work, the Contractor shall clean and adjust all equipment, controls, valves, etc.; clean all piping, etc.; and leave the entire installation in good working order.

OPERATING AND MAINTENANCE INSTRUCTIONS:
Provide services of authorized representatives of the manufacturer to ensure that the equipment is installed according to the manufacturer's recommendations and is operating properly and to instruct the owner's operating personnel during start-up and operating tests of complete mechanical systems. Prove proper operation of equipment to the Owner. Notify the Owner seven (7) days prior to beginning equipment start-up.

Certify in writing that these services have been performed.

Provide the Owner with three (3) copies of printed instructions indicating various pieces of equipment by name and model number, complete with parts lists, maintenance and repair instructions and test and balance report.

COPIES OF SHOP DRAWINGS WILL NOT BE ACCEPTABLE AS OPERATION AND MAINTENANCE INSTRUCTIONS BUT MUST BE INCLUDED IN SUBMITTAL PACKAGE.

All inspection test certificates such as piping inspections (city, state, or local), open wall inspections (city, state, or local), state boiler inspections, boiler start-up, and H.V.A.C start-up, shall be copied and included as part of the operation and maintenance instructions and close out documents.

This information shall be bound in plastic hardbound notebooks with the job name permanently embossed on the cover. Rigid board dividers with labeled tabs shall be provided for different pieces of equipment. Submit manuals to the Owner for approval.

In addition to the operation and maintenance brochure, the Contractor shall provide a separate brochure which shall include registered warranty certificates on all equipment, especially any pieces of equipment which carry warranties exceeding one (1) year.

The operation and maintenance brochure shall be furnished with a detailed list of all equipment furnished to the project, including the serial number and all pertinent nameplate data such as voltage,

amperage draw, recommended fuse size, rpm, etc. The Contractor shall include this data on each piece of equipment furnished under this contract.

SERVICE:
Inspect, clean and service new equipment immediately prior to final acceptance of project.

Provide lubrication for operation of equipment until final acceptance of the equipment by the Owner. Protect bearings during installation and thoroughly grease steel shafts to prevent corrosion. Provide extended lubrication lines for parts requiring lubrication which are concealed or inaccessible.

Provide complete and working charge of proper refrigerant, free of contaminants, into each refrigerant system. After each system has been in operation long enough to ensure completely balanced condition, check the charge and modify it for proper operation as required.

Place mechanical systems in complete working order and clean and polish fixtures, equipment and materials thoroughly returning to "as new" condition prior to request for final review.

Remove excess material and debris. Clean out lines and fittings and adjust valves. Broom clean areas.

GUARANTEE:
The Contractor shall guarantee all materials, equipment, and workmanship for a period of one (1) year from the date of final acceptance of the project. This guarantee shall include furnishing of all labor and material necessary to make any repairs, adjustments or replacement of any equipment, parts, etc. necessary to restore the project to first class condition. During this period, make good faults or imperfections that may arise due to defects or omissions in materials or workmanship with no additional compensation and as directed by the Owner. Warranties exceeding one (1) year are hereinafter specified with individual pieces of equipment.

If the Contractor's office is in excess of a fifty (50) mile radius of the project, he shall appoint a local qualified contractor to perform any emergency repairs or adjustments required during the guarantee period. The name of the contractor appointed to provide emergency services shall be submitted to the Owner for his and/or Owner's approval.

LOCAL CONDITIONS:
The location and elevation of all utility services is based on available plans and are reasonably accurate; however, these shall serve as a general guide only, and the Contractor shall visit the site and verify the location and elevation of all services to his satisfaction in order to determine the amount of work required for the execution of the Contract.

In case major changes are required, this fact, together with the reasons therefor, shall be submitted to the Owner, in writing, not less than seven (7) days before the date of bidding. Failure to comply with this requirement will make the Contractor liable for any changes, additions and expenses necessary for the successful completion of the project.

"A CHANGE ORDER WILL NOT BE GRANTED FOR LACK OF ANY INFORMATION OR INVESTIGATION.

PERMITS, INSPECTIONS AND TESTS:
All permits, fees, etc. for the installation, inspections, plan review, service connection locations, and/or

construction of the work which are required by any authority and/or agencies having jurisdiction, shall be obtained, and paid for by the Contractor. This shall be verified during the bidding process.

The Contractor shall make all tests required by the Owner or other governing authorities at no additional cost to the Owner.

The Contractor shall notify the Owner and local governing authorities before any tests are made, and the tests are not to be drawn off a line covered or insulated until examined and approved by the authorities. In event defects are found, these shall be corrected, and the work shall be retested.

Prior to requesting final inspection by the Owner, the Contractor shall have a complete coordination and adjustment meeting of all of his sub-contractors directly responsible for the operation of any portion of the system. At the time of this meeting, each and every sequence of operation shall be checked to assure proper operation. Notify the Owner in writing ten (10) days prior to this meeting, instructing him of the time, date and whom you are requesting to be present.

This project shall not be accepted until the above provisions are met to the satisfaction of the Owner.

CODES AND STANDARDS:
The entire mechanical work shall comply with the rules and regulations of the City, Parish and State in which this project is being constructed, including the State Fire Marshal, Office of Public Health, Local Health Unit, OSHA, ANSI. All modifications required by these authorities shall be made without additional charge to the Owners. The Mechanical Contractor shall report these changes to the Owner and secure his approval before work is started.

In addition to the codes heretofore mentioned, all mechanical work and equipment shall conform to the applicable portions of the following specifications, codes and/or regulations:

1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
2. National Electrical Code (NEC)
3. National Fire Protection Association (NFPA)
4. American Society of Mechanical Engineers (ASME)
5. Building Code (Latest local approved with local amendments)
6. Mechanical Code (Latest local approved with local amendments)
7. Underwriters Laboratories (UL)
8. Louisiana State Plumbing Code (Latest local approved with local amendments)
9. IECC 2021 (with local amendments)

All materials, equipment and accessories installed under this Contract shall conform to all rules, codes, etc. as recommended by National Associations governing the manufacturer, rating and testing of such materials, equipment and accessories. All materials shall be new and of the best quality and first class in every respect. Whenever directed by the Owner, the Contractor shall submit a sample for approval before proceeding.

Where laws or local regulations provide that certain accessories such as gauges, thermometers, relief valves and parts be installed on equipment, it shall be understood that such equipment be furnished

complete with the necessary accessories, whether or not called for in these Specifications.

All unfired pressure vessels shall be built in accordance with the A.S.M.E. Code and so stamped. Furnish shop certificates for each vessel.

REVIEW OF MATERIALS:
Whenever manufacturers or trade names are mentioned in these Plans or Specifications, the words "or approved equivalent" shall be assumed to follow whether or not so stated. Manufacturers or trade names are used to establish a standard of quality only and should not be construed to infer a preference. Equivalent products which meet the Owner 's approval will be accepted; however, these products must be submitted to the Owner a minimum of ten (10) days prior to the Bid Date.

Submission shall include the manufacturer's name, model number, rating table and construction features. Incomplete information which does not provide adequate information to verify compliance with specifications shall be grounds for rejection of submitted equipment or materials.

Upon receipt and checking of this submittal, the Owner will issue an addendum listing items which are approved as equivalent to those specified. THE CONTRACTOR SHALL BASE HIS BID SOLELY ON THOSE ITEMS SPECIFIED OR INCLUDED IN THE "PRIOR APPROVAL ADDENDUM", AS NO OTHER ITEM WILL BE ACCEPTABLE.

Prior approval of a particular piece of equipment does not mean automatic final acceptance and will not relieve the Contractor of the responsibility of assuring himself that this equipment is in complete accord with the Plans and Specifications and that it will fit into the space provided. Shop drawings must be submitted on all items of equipment for approval as hereinafter specified.

Before proceeding with work and/or within thirty (30) days after the award of the Prime Contract for this work, the Mechanical Contractor shall furnish to the Owner complete shop and working drawings of such apparatus, equipment, controls, insulation, etc. to be provided in this project. These drawings shall give dimensions, weights, mounting data, performance curves and other pertinent information.

The Owner's approval of shop drawings shall not relieve the Contractor from the responsibility of incorrectly figured dimensions or any other errors which may be contained in these drawings. Any omission from the shop drawings or specifications, even though approved by the Owner, shall not relieve the Contractor from furnishing and erecting same.

Ten (10) sets of shop drawings shall be submitted to the Owner for approval. These submittals shall be supplied as part of this Contractor's contract. Any drawings not approved shall be resubmitted until they are approved. SUBMIT ALL SHOP DRAWINGS AT THE SAME TIME. NO SEPARATE ITEMS WILL BE ACCEPTED.

MINOR DEVIATIONS:
Plans and detail sketches are submitted to limit, explain, and define conditions, specified requirements, pipe sizes and manner of erecting work. Structural or other conditions may require certain modifications from the manner of installation shown, and such deviations are permissible and shall be submitted for approval prior to any acceptance. Specified sizes and requirements necessary for satisfactory operation shall remain unchanged. It may be necessary to shift piping and these changes shall be made as required. All such changes shall be referred to the Owner for approval

before proceeding. Extra charges shall not be allowed for these changes. The contractor shall obtain a full set of plans and specifications for the coordination of his work prior to bidding this project. Items which are unclear to the bidding contractor shall be brought to the Owner's attention prior to bidding the project. An interpretation shall be clarified by the Owner prior to bidding.

The Contractor shall realize that the drawings could delve into every step, sequence or operation necessary for the completion of the project, without drawing on the Contractor's experience or ingenuity. However, only typical details are shown on the Plans. In cases where the Contractor is not certain about the method of installation of his work, he shall ask for details. Lack of details will not be an excuse for improper installation.

In general, the drawings are diagrammatic, and the Contractor shall install his work in a manner so that interferences between the various trades are avoided. In cases where interferences do occur, the Owner is to state which item was first installed.

WORKMANSHIP

Workmanship shall be of highest grade, highest quality and all construction shall be done according to the best practice of the trade.

AS-BUILT DRAWINGS:

The Contractor shall obtain at his cost, two sets of blueline prints of the original bid documents by the Owner. One set shall be kept on the site with all information as referenced below and shall update same as the work progresses. The other set will be utilized to record all field changes to a permanent record copy for the Owner.

If the Contractor elects to vary from the Contract Documents and secures prior approval from the Owner for any phase of the work, he shall record in a neat and readable manner, ALL such variances on the blueline print in red. The original blue lines shall be returned to the Owner for documentation.

All deviations from sizes, locations, and from all other features of the installations shown in the Contract Documents shall be recorded.

In addition, it shall be possible using these drawings to correctly and easily locate, identify and establish sizes of all piping, directions, and the like, as well as other features of the work which will be concealed underground and/or in the finished building.

Locations of underground work shall be established by dimensions to columns, lines, or walls, locating all turns, etc., and by properly referenced centerline or invert elevations and rates of fall.

For work concealed in the building, sufficient information shall be given so it can be located with reasonable accuracy and ease. In some cases, this may be by dimension. In others, it may be sufficient to illustrate the work on the drawings in relation to the spaces in the building near which it was actually installed. The Owner's decision in this matter will be final.
The following requirements apply to all "As-Built" drawings:

1. They shall be maintained at the Contractor's expense.
2. All such drawings shall be done carefully and neatly, and in a form approved by the Owner.
3. Additional drawings shall be provided as necessary for clarifications.

4. These drawings shall be kept up-to-date during the entire course of the work and shall be available upon request for examination by the Owner; and when necessary, to establish clearances for other parts of the work.
5. "As-built" drawings shall be returned to the Owner upon completion of the work and are subject to approval of the Owner.

MANUFACTURER'S DIRECTION:
The mechanical contractor shall install and operate all equipment and materials in strict accordance with the manufacturer's installation and operating instructions. The manufacturer's instructions shall become part of the Contract Documents and shall supplement the Drawings and Specifications.

Store equipment in a clean, dry place protected from other construction. While stored, maintain factory wrapping or tightly cover and protect equipment against dirt, water, construction debris, chemical, physical or weather damage, traffic and theft.

LABELING MECHANICAL EQUIPMENT:
All mechanical equipment (Chillers, etc.) furnished shall be labeled with permanent laminated plate secured to equipment. Units shall be labeled as indicated on plans and schedules and with commissioning addresses used by the manufacturer.

HAZARDOUS MATERIALS
This contractor shall not provide any material or component of equipment which contains asbestos, lead-based paint or PCBs. If any product or building material is found to contain asbestos, lead based paint or PCBs, the contractor shall bear all cost for removal, abatement, and disposal of materials in accordance with all state and federal regulations. The contractor shall install replacement materials to the satisfaction of the Owner at no additional cost to the project. During the construction, if the contractor suspects that any material in the building contains or is a hazard material (asbestos, lead, PCB, mercury, etc.) work shall be stopped to prevent disturbance and the Owner shall be notified immediately.

BASIC MATERIALS AND METHODS

CHILLED WATER PIPING ABOVE SLAB:
Shall be American made standard black steel, Schedule 40 pipe and fittings. Fittings 2” and below shall be malleable screw fittings. Piping above two inches shall be electrically welded utilizing welded fittings. All elbows shall be long radius type. Piping shall be insulated as per insulation specification.

All new piping, valves, elbows, welded connections, and fittings shall be coated with two (2) coats of rust inhibiting primer (Sherwin Williams Kem Kromik Universal Metal Primer Protective & Marine Coating Brown/Red Oxide or approved equivalent) prior to applying insulation.

INSTALLATION OF PIPING:
Contractor shall coordinate with chiller manufacturer for all fittings and couplings required to accommodate new piping system. Submit all fittings during submittal review.

All pipes shall be true and straight, without sags or traps.

The Contractor shall exercise care in cleaning joints after making cuts on pipe to prevent pipe particles from entering the system.

All pipe fittings shall be same as piping specified unless indicated otherwise.

Rigidly support pipes to make firm, well-braced installation. Loosely supported pipe or accessory is not acceptable.

Keep piping free from scale and dirt, protect open pipe ends wherever work is suspended during construction. To prevent foreign bodies entering and lodging in pipe, use temporary plugs or other approved material.

Where changes in pipe sizes occur, do not bush down; use only reducing fittings. For drainage piping changes in direction, use long sweep bends where possible; otherwise, short sweep 1/4 bends or combination Y and 1/8 bends; also, Y's in combination with other bends.

Provide shut off valves at all supply connections to all equipment. Supplier of equipment shall provide rough-in drawings and this contractor shall fully connect all items, supply necessary piping and fittings as required, unless otherwise noted individually.

Do not locate valves with stems below horizontal. Locate valves for easy access and operations.

Provide unions, screwed or flanged, where indicated, and in following locations even if not indicated.

In connection to equipment requiring disconnection for repairs or replacement. Locate between shut-off and equipment.

Weld-O-let fittings shall be used in iron pipe.

All screwed fittings and pipe shall have threads cut to standard pipe thread dimensions. Pipe shall be properly reamed after cutting of threads.

Joint compound, Rector seal Series 100, LACO Series slick-tite or equal thread lubricant shall be applied to male threads of the screwed pipe and fittings only.
Approved expansion joints or flexible couplings shall be provided, as necessary.

Care shall be taken in making up pipe and fittings such that the pipe does not extend into fitting sufficiently to reduce the waterway.

Standard, one-piece reducing fittings of approved design shall be used wherever a change in size is made. Changes in pipe sizes shall not be made by means of reducing flanges.

Bushings may be used only where standard, one-piece reducing fittings are not available and shall be subject to the following:

1.Bushings shall be of the face or flush type.
2.Bushings shall not be used in elbow fittings.
3.Bushings shall not be used when the reduction in size of the outlet is less than ½".

4.Bushings shall not be used in more than one outlet of any tee or two outlets of any cross fitting.

PIPE SPECIALTIES:
Dielectric unions shall be used between copper and iron pipe.

PIPE HANGERS AND SUPPORTS:
This Contractor shall furnish and install all foundations and supports required for his equipment unless indicated otherwise on the Drawings.

This Contractor shall furnish and install all escutcheons, inserts, thimbles, hangers, etc. required for the proper support and installation of his equipment and piping and he shall cooperate with other trades in locating and placing these items.

Where shown on plans, provide Grinnel, Fee & Mason, or equivalent malleable iron split ring hangers with rod supports throughout. STRAP HANGERS OR WIRE WILL NOT BE ACCEPTED.

Maximum spacing of hangers shall be 4 ft.

Provide galvanized iron shields between hangers and pipe covering.

VALVES AND UNIONS:
Furnish and install all valves, unions, stops, connections, etc. shown on plans and necessary to make a complete system in working order. Provide valves on inlet and outlet of all equipment.

Ball Valves, 2" and smaller, rated for 150 PSI saturated steam pressure, 600 PSI WOG pressure; shall be 2-piece construction, bronze body conforming to ASTM B-62, full port, chrome-plated brass vented ball, replaceable TFE seats and seals, blow-out proof stem, and vinyl-covered steel handle. Provide solder ends chilled water and domestic hot and cold water service of NIBCO Design S-580-70-66, Kitz #69, Apollo 70-240 or Milwaukee BA-150-S, threaded ends for heating hot water of NIBCO Design T-580-70-66, Kitz #68, Apollo 70-140 or Milwaukee BA-100-S. For insulated piping systems, provide ball valves with extended stem, insulated handle with protective thermal barrier sleeve to prevent condensate moisture drip and pipe insulation deterioration.

Butterfly Valves, 2-1/2-Inch and Larger: MSS SP-67; rated at 200 psi; ductile iron body conforming to ASTM A 126, Class B. Provide valves with molded in EPDM sleeve, nickel-plated ductile iron disc (except aluminum bronze disc for valves installed in condenser water piping), stainless steel stem, and EPDM O-ring stem seals. Provide lever operators with locks for sizes 2 through 6 inches and gear operators with position indicator for sizes 8 through 24 inches. Lug style butterfly valves shall be rated for bi-directional dead-end service to the full working pressure of the valve.

Select Valves with the following ends or types of pipe/tube connections:

Copper Tube Size 2 Inch and Smaller: Solder ends, except provide threaded ends for heating hot water.

Steel Pipe Sizes, 2 Inch and Smaller: Threaded or grooved end.

Steel Pipe Sizes, 2-1/2 Inch and Larger: Grooved end or flanged.

INSTALLATION OF VALVES:
Use ball and butterfly valves for shut-off duty.

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

Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

Install valves in horizontal piping with stem at or above the center of the pipe.

Install valves in a position to allow full stem movement.

All valves, on insulated piping shall be complete with extended lever handle stem.

TEST:
Make such tests of work as specified or required by Owner or by State and Municipal Bureaus having jurisdiction, and under their supervision. Perform tests in presence of Architect's representative. Notify Owner two days prior to testing.

Provide apparatus, temporary piping connections, or other requirements necessary for tests. Take precautions to prevent damage to building or contents by tests. Contractor is required to repair and make good at his expense damage so caused.

Correct leaks, defects, or deficiencies discovered as result of tests. Repeat tests until test requirements are met. Caulking of pipe joints to remedy leaks is not permitted.

ELECTRICAL WORK:
The Mechanical Contractor shall furnish to the Electrical Contractor for installation, all devices for each piece of motor driven equipment unless shown otherwise.

The Electrical Contractor shall install all devices as furnished by the Mechanical Contractor. The Electrical Contractor shall also provide and install all power wiring required for the installation of such mechanical equipment.

The Mechanical Contractor shall furnish and install equipment interlocking, control wiring, etc., as hereinafter specified under Temperature Controls. All work shall be done in accordance with the National Electric Code requirements. The Mechanical Contractor shall be responsible for coordinating all work to provide a complete system in working order.

All electrical equipment shall have the U.L. Label and shall meet the standards of the National Electrical Code and NEMA.

PIPE MARKERS:
Provide pipe markers and directional arrows on all piping in mechanical equipment rooms, or which is exposed in building, and on both sides of all valves located above ceiling. Markers shall be as manufactured by W.H. Bradley Co., or the equivalent. All letters shall be color-coded and sized as recommended by OSHA. Samples of the type of letters to be used shall be submitted with shop

drawings.

The following pipe shall be identified:

	Piping
HVAC Chilled Water Supply	X
HVAC Chilled Water Return	X

Pipe markers with arrows shall indicate lines content and shall be located 20 feet on center and at each charge of direction of line. Identification bands shall be color coded to match pipe markers and shall be provided 10 feet on center. Pipe identification markers shall be taped at each end and shall be taped around the entire circumference of pipe.

INSULATION

GENERAL:
Pipe insulation shall not begin until all work has been tested and found to be tight. All insulation adhesives, sealers, tapes, and mastic shall meet the latest NFPA requirements and shall meet 25/50 flame spread and smoke developed ratings.

All insulation shall be installed in strict accordance with the manufacturer's recommendations.

All pipe insulation were recommended by the manufacturer shall be banded with aluminum bands, three to a section and with one band on each side of each fitting, valve, etc.

Insulation shall be continuous through walls and ceilings.

All valves, strainers, etc. shall be insulated the same as its adjacent piping and the covering shall extend all the way up to the equipment.

SCOPE OF WORK:
The Contractor shall obtain the services of an independent Insulation Company which specializes in HVAC insulation to provide the materials and insulation as specified. Insulation shall not be installed in any area which has not been enclosed and protected from the weather unless approval has been granted by the Owner.

The work included in this section consists of furnishing labor, materials and tools required in insulating the systems as described in these specifications or shown on accompanying drawings. Services shall include coordination with all trades, and final verification of all installation prior to wall or ceiling closure.

USE HIGH DENSITY INSULATION INSERTS AT HANGERS ON ALL PIPING 1-1/2" AND ABOVE TO PREVENT CRUSHING OF INSULATION.

THERMAL INSULATION:
After all work has been tested and approved, insulate as follows:

INSULATION SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND INSTRUCTIONS.

CHILLED WATER SUPPLY AND RETURN PIPING ABOVE SLAB:
Insulate lines above the slab with Pittsburgh Corning foamglass pipe covering with factory applied Flame Bar Jacket. All joints shall be firmly butted together. Seal all laps and butt joint strips with vapor barrier adhesive or sealant to meet manufacturers recommendations. Fittings to be insulated with foamglass finished with an envelope coverage of vapor barrier mastic reinforced with Glassfab. All installation shall comply with manufacturers recommendations. Thickness to be 1" for pipe sizes up to and including 1" and 1-1/2" thick for pipe sizes 1-1/4" and above.

Chilled Water Lines on the exterior of the building shall be covered with smooth PVC jacket and pre-formed fitting and elbows.

CALIBRATED BALANCING VALVES:
Insulate calibrated balancing valves with molded insulated furnished with the unit and provide strap bands for access.

INSULATION THROUGH HANGERS AND SLEEVES:
The insulation shall be continuous through pipe hangers and pipe sleeves. At hangers where the pipe is supported by insulation, provide a galvanized iron protection shield. Provide pipes 2-inch i.p.s. and larger in insulation inserts at points of hanger supports. The inserts shall be of calcium silicate, cellular glass, prestressed molded glass fiber of minimum 13-pound density, or other approval material of the same thickness as adjacent insulation and not less than 13-pound density. The inserts shall have sufficient compression strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Inserts shall be 180 degrees and not less than the length of the protection shield. vapor barrier facing of the insert shall be the same as the facing on the adjacent insulation. Where copper clad hanger are used on domestic copper pipe, insulation may cover pipe and hanger. Provide 18 gauge metal saddles between all hangers and insulation.

INSULATION THROUGH FLANGES, VALVES, ELBOWS, ETC.:
The insulation shall be continuous around flanges, valves, elbows, and other devices located in the piping system. Provide fiberglass packing around devices where rigid insulation will not meet the contour of the device. Cover insulation with universal jacket and Glassfab with mastic. Cover entire installation as indicated above.

HVAC EQUIPMENT

CENTRIFUGAL MAGNETIC BEARING CHILLER

GENERAL

DELIVERY

A. Chiller shall be delivered two (2) weeks after issuance of purchase order and formal shop drawing approval. Contractor shall be responsible for properly securing and protection of chiller and insulation. Contractor shall repair all damaged insulation.

SYSTEM DESCRIPTION

A. Microprocessor-controlled liquid chiller shall use a semi-hermetic centrifugal compressor using refrigerant R-513a.

QUALITY ASSURANCE

A. Chiller performance shall be rated in accordance with AHRI (Air-Conditioning, Heating and Refrigeration Institute) Standard 550/590, latest edition. The chiller manufacturer, model number and refrigerant shall be listed on the AHRI.org website (www.ahridirectory.org).

B. Equipment and installation shall be in compliance with ANSI/ASHRAE (American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers) 15 (latest edition).

C. Evaporator and condenser refrigerant side shall include ASME "U" stamp and nameplate certifying compliance with ASME Section VIII, Division 1 code for unfired pressure vessels.

D. Chiller shall be designed and constructed to meet UL (Underwriters Laboratories) and UL, Canada requirements and have labels appropriately affixed.

E. Centrifugal compressor impellers shall be dynamically balanced and over-speed tested by the manufacturer at a minimum of 120% design operating speed. Each compressor assembly shall undergo a mechanical run-in test to verify vibration levels are within acceptable limits.

F. Each compressor assembly shall be proof tested at a minimum 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture.

G. Entire chiller assembly shall be proof tested at 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture on the refrigerant side. The water side of each heat exchanger shall be hydrostatically tested at 1.3 times rated working pressure.

H. Prior to shipment, the chiller automated controls test shall be executed to check for proper wiring and ensure correct controls operation.

I. The chiller and VFD (variable frequency drive) shall be factory wired and tested together to verify proper operation prior to shipment.

J. The management system governing the manufacture of this chiller shall be ISO 9001:2015 certified.

DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled in accordance with manufacturer's instructions.

B. Unit shall be shipped with all refrigerant piping and control wiring factory installed.

C. Unit shall be shipped charged with full charge of refrigerant HFO-513A, or a nitrogen holding charge as specified on the equipment schedule.

D. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, chiller model number, chiller serial number, and refrigerant used.

E. If the chiller is to be exported, the unit shall be sufficiently protected from the factory against sea water corrosion to be suitable for shipment in a standard open top, ocean shipping container (19MV heat exchanger frames 3 through 4 only).

WARRANTY

A. Warranty shall include parts, labor and refrigerant for one year after start-up or 18 months from shipment, whichever occurs first.

B. Extended warranty shall include 2nd-10.5 year complete unit parts, labor and refrigerant warranty.

Extended warranty annual service requirements shall be supported by the installing contractor with chiller technicians factory certified on the Carrier 19MV by Carrier University.

PERFORMANCE (REFER TO SHEET M1)

Required Performance

A. Tonnage: 500 tons

B. Chilled Water Temp: 45/55F

C. Condenser Water: 85F at 1,500 gpm

D. Full Load Efficiency: 0.5342 kW/TonR

E. NPLV: 0.3207 kW/TonR

Required Stability

A. Chiller shall be capable of 100% capacity (500 tons) with 92F entering Condenser Water at 1,500 gpm with 45F Chilled Water

B. Chiller shall be capable of 100% capacity (500 tons) with 85F entering Condenser Water at 1,500 gpm with 39F Chilled Water

C. Chiller shall be capable of 20% capacity (100 tons) with 95F entering Condenser Water at 1,500 gpm with 45F Chilled Water without the use of Hot Gas Bypass

Performance Verification

A. Performance is based on Carrier 19MV. Alternate chiller manufacturers shall meet or exceed all specified efficiency and stability requirements.

B. Performance for alternate chiller manufacturer shall be verified via a 6 point factory Zero Tolerance AHRI certified test.

Availability

A. Chiller shall be in stock availability stateside within 500 miles of the jobsite for emergency replacement.

PRODUCTS

Acceptable Manufacturers:

Carrier 19MV (Basis of Design) or prior approved equal meeting all performance and specification requirements. All equipment must fit within the space constraints. See Chiller Schedule.

EQUIPMENT

A. General: Factory assembled, single piece, liquid chiller shall consist of compressor, motor, variable frequency drive, evaporator, condenser, refrigerant operating charge, microprocessor control system, and documentation required prior to start-up. The compressor VFD will be wired and tested by the chiller manufacturer.

B. Compressor:

1. The compressor-motor assembly shall be direct drive semi-hermetic centrifugal with multi-stage design with magnetic bearings. Centrifugal compressors shall use variable inlet guide vanes to

provide partial capacity modulation while also providing pre-whirl of the refrigerant vapor entering the impeller.

2. Chiller shall be able to unload to 10% of design tonnage at design temperatures and flows without gas flow circulation, load balance valve or hot gas bypass.
3. Compressor shall be fully field serviceable. Compressors which must be removed and returned to the factory for service shall be unacceptable.
4. Compressors shall be fully manufactured and designed by the chiller manufacturer. Third party compressors shall be unacceptable.

C. Motor:

1. Compressor motor shall be of the semi-hermetic, liquid refrigerant cooled, permanent magnet type suitable for voltage shown on the equipment schedule.
2. Motors shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized refrigerant in contact with the motor windings.
3. Motor stator shall be arranged for service or removal with only minor compressor disassembly and without removing main refrigerant piping connections.
4. Full load operation of the motor shall not exceed nameplate rating.
5. At least one motor winding temperature sensor shall be provided.

D. Evaporator and Condenser:

1. Evaporator shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, minimum 1/4 in. (6 mm) steel shell and tube sheets with fabricated steel waterboxes.
    a. Waterbox shall be nozzle in head waterbox (150 psig [1034 kPa]).
    b. Waterbox shall have standard Victaulic grooves.
2. Condenser shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, minimum 1/4 in. (6 mm) steel shell and tube sheets with fabricated steel waterboxes.
    a. Waterbox shall be nozzle in head waterbox (150 psig [1034 kPa]).
    b. Waterbox shall have standard Victaulic grooves.
3. Waterboxes shall have vents, drains, and covers to permit tube cleaning within the space shown on the drawings. A thermistor type temperature sensor with quick connects shall be factory installed in each water nozzle.
4. Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.
5. Tubing shall be copper, high-efficiency type, with integral internal and external enhancement unless otherwise noted. Tubes shall be nominal 3/4 in. with nominal wall thickness of 0.025 in. measured at the root of the fin at the enhanced areas and nominal wall thickness of 0.049 in. where the tubes are in contact with the end tube sheets unless otherwise noted. Tubes shall be rolled into tube sheets and shall be individually replaceable. Tube sheet holes shall be double grooved for joint structural integrity.

6. Evaporator shall be designed to prevent liquid refrigerant from entering the compressor.
7. The condenser shell shall include a sub-cooler which cools the condensed liquid refrigerant to a reduced temperature, thereby increasing the refrigeration cycle efficiency.
8. A reseating type pressure relief valve shall be installed on each heat exchanger. If a non-reseating type is used, a backup reseating type shall be installed in series.

E. Refrigerant Flow Control:

1. To maintain optimal part load efficiency at high or low lift, the chiller shall utilize (2) Electronic Expansion Valves (EXVs) in the liquid line between the condenser and the evaporator. When equipped, the economizer, shall use a variable metering valve. To ensure good operating performance, the valve design will prevent refrigerant gas from the condenser from passing to the evaporator or economizer at full or part load.
2. By maintaining a liquid seal at the flow valve, bypassed hot gas from the condenser to the evaporator is eliminated.

F. Controls, Safeties, and Diagnostics:

1. Controls:
    a. The chiller shall be provided with a factory installed and wired microprocessor control center. The microprocessor can be configured for either English or SI units.
    b. All chiller and starter monitoring shall be displayed at the chiller control panel.
    c. The controls shall make use of non-volatile memory.
    d. The chiller control system shall have the ability to interface and communicate directly to the building control system.
    e. The default standard display screen shall simultaneously indicate the following minimum information:
        1) date and time of day
        2) 24-character primary system status message
        3) 24-character secondary status message
        4) chiller operating hours
        5) entering chilled water temperature
        6) leaving chilled water temperature
        7) evaporator refrigerant temperature
        8) entering condenser water temperature
        9) leaving condenser water temperature
        10) condenser refrigerant temperature
        11) percent motor rated load amps (RLA)
    f. In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control center including:
        1) evaporator pressure
        2) condenser pressure
        3) compressor discharge temperature
        4) motor winding temperature
        5) number of compressor starts
        6) control point settings

7) discrete output status of various devices
8) compressor motor starter status
9) optional spare input channels

g. Schedule Function:

The chiller controls shall be configurable for manual or automatic start-up and shutdown. In automatic operation mode, the controls shall be capable of automatically starting and stopping the chiller according to a stored user programmable occupancy schedule. The controls shall include built-in provisions for accepting:

1) A minimum of two 365-day occupancy schedules.
2) Minimum of 8 separate occupied/unoccupied periods per day.
3) Daylight savings start/end.
4) Minimum of 18 user-defined holidays.
5) Means of configuring an occupancy timed override.
6) Chiller start-up and shutdown via remote contact closure.

h. Service Function:

The controls shall provide a password protected service function which allows authorized individuals to view an alarm history file which shall contain the last 25 alarm/alert messages with time and date stamp. These messages shall be displayed in text form, not codes.

i. Network Window Function:

Each chiller control panel shall be capable of viewing multiple point values and statuses from other like controllers connected on a common network, including controller maintenance data. The operator shall be able to alter the remote controller's set points or time schedule and to force point values or statuses for those points that are operator forcible. The control panel shall also have access to the alarm history file of all like controllers connected on the network.

j. Pump Control:

Upon request to start the compressor, the control system shall start the chilled water pump, condenser water pumps and verify that flows have been established.

k. Ramp Loading:

A user-configurable ramp loading rate, effective during the chilled water temperature pulldown period, shall control the rate of guide vane opening to prevent a rapid increase in compressor power consumption. The controls shall allow configuration of the ramp loading rate in either degrees/minute of chilled water temperature pulldown or percent motor amps/minute. During the ramp loading period, a message shall be displayed informing the operator that the chiller is operating in ramp loading mode.

l. Chilled Water Reset:

The control center shall allow reset of the chilled water temperature set point based on any one of the following criteria:

1) Chilled water reset based on an external 4 to 20 mA signal.
2) Chilled water reset based on a remote temperature sensor (such as outdoor air).
3) Chilled water reset based on water temperature rise across the evaporator.

m. Demand Limit:

The control center shall limit amp draw of the compressor to the rated load amps or to a lower value based on one of the following criteria:

1) Demand limit based on a user input ranging from 40% to 100% of compressor rated load amps.
2) Demand limit based on external 4 to 20 mA signal.

n. Controlled Compressor Shutdown:

The controls shall be capable of being configured to soft stop the compressor. When the stop button is pressed or remote contacts open with this feature active, the guide vanes shall close to a configured amperage level and the machine shall then shut down. The display shall indicate "shutdown in progress."

2. Safeties:

a. Unit shall automatically shut down when any of the following conditions occur: (Each of these protective limits shall require manual reset and cause an alarm message to be displayed on the control panel screen, informing the operator of the shutdown cause.)

1) motor overcurrent
2) over voltage*
3) under voltage*
4) single cycle dropout*
5) high condenser pressure
6) high motor temperature
7) high compressor discharge temperature
8) prolonged surge
9) loss of evaporator water flow
10) loss of condenser water flow
11) starter fault

* Shall not require manual reset or cause an alarm if auto-restart after power failure is enabled.

b. The control system shall detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following parameters are outside their normal operating range:

1) high condenser pressure
2) high motor temperature
3) low evaporator refrigerant temperature
4) surge prevention control
5) high motor amps.

c. During the capacity override period, a pre-alarm (alert) message shall be displayed informing the operator which condition is causing the capacity override. Once the condition is again within acceptable limits, the override condition shall be terminated, and the chiller shall revert to normal chilled water control. If during either condition the protective limit is reached, the chiller shall shut down and a message shall be displayed informing the operator which condition caused the shutdown and alarm.

d. Internal built-in safeties shall protect the chiller from loss of water flow. Differential pressure switches shall not be allowed to be the only form of freeze protection.

3. Diagnostics and Service:

a. A self-diagnostic controls test shall be an integral part of the control system to allow quick identification of malfunctioning components.

b. Once the controls test has been initiated, all pressure and temperature sensors shall be checked to ensure they are within normal operating range. A pump test shall automatically energize the chilled water pump and condenser water pump. The control system shall confirm that water flow has been established and require operator confirmation before proceeding to the next test. A guide vane actuator test shall open and close the guide vanes to check for proper operation. The operator manually acknowledges proper guide vane operation prior to proceeding to the next test.

c. In addition to the automated controls test, the controls shall provide a manual test which permits selection and testing of individual control components and inputs. A thermistor test and transducer test shall display, and an actual reading shall be performed for each transducer and each thermistor installed on the chiller. All out-of-range sensors shall be identified.

G. Electrical Requirements:

1. Electrical contractor shall supply and install main electrical power line, disconnect switches, circuit breakers, and electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.

2. Electrical contractor shall wire the chilled water pump, condenser water pump, and tower fan control circuit to the chiller control circuit.

3. Electrical contractor shall supply and install electrical wiring and devices required to interface the chiller controls with the building control system if applicable.

4. Electrical power shall be supplied to the unit at the voltage, phase, and frequency listed in the equipment schedule.

H. Piping Requirements — Instrumentation and Safeties:

a. Mechanical contractor shall supply and install pressure gages in readily accessible locations in piping adjacent to the chiller such that they can be easily read from a standing position on the floor. Scale range shall be such that design values shall be indicated at approximately midscale.

b. Gages shall be installed in the entering and leaving water lines of the evaporator and condenser.

I. Isolator Pads:

Chiller manufacturer shall furnish neoprene isolator pads for mounting equipment on a level concrete surface.

J. Start-up:

1. The chiller manufacturer shall provide a factory trained representative, employed by the chiller manufacturer, to perform the start-up procedures as outlined in the Start-up, Operation and Maintenance manual provided by the chiller manufacturer.

2. Manufacturer shall supply the following literature:

a. Start-up, operation and maintenance instructions.

b. Installation instructions.

c. Field wiring diagrams.

d. One complete set of certified drawings.

K. Required Features:

1. Thermal Insulation:

   Unit manufacturer shall insulate the evaporator shell, economizer, low side compressor suction elbow, motor shell, and motor cooling lines. Insulation shall be 3/4 in. thick with a thermal conductivity not exceeding 0.28 (Btu in.)/hr ft2 F and shall conform to UL standard 94, classification 94 HBF.

2. Evaporator and Condenser Passes:

   Unit manufacturer shall provide the evaporator and condenser with 2 pass configuration on the water side.

3. BACnet Communication Option:

   Shall provide factory-installed communication capability with a BACnet IP network.

4. Unit-Mounted Variable Frequency Drive (VFD):

   a. Design:

      1) VFD shall be air cooled, microprocessor based, pulse width modulated (PWM) design. Water cooled designs are not acceptable.

      2) Output power devices shall be insulated gate bipolar transistors (IGBTs).

      3) Converter section with full-wave fixed diode bridge rectifier shall convert

      4) incoming fixed voltage/frequency to fixed DC voltage.

      5) DC link shall filter and smooth the converted DC voltage.

      6) Transistorized inverter and control regulator shall convert fixed DC voltage to a sinusoidal PWM waveform.

      7) Integrated controls shall coordinate motor speed and guide vane position to optimize chiller performance over a wide variety of operating conditions.

      8) Surge prevention and surge protection algorithms shall take action to prevent surge and move chiller operation away from surge.

   b. Enclosure:

      1) Pre-painted, unit-mounted cabinet protected against limited ingress of dust and water splashing shall include hinged doors and removable lifting lugs.

      2) Electrical system shall have a short circuit interrupt and withstand rating of at least 100,000 amps.

      3) Provisions to padlock main disconnect handle in the “Off” position shall be provided. Mechanical interlock to prevent opening cabinet door with disconnect in the “On” position or moving disconnect to the “ON” position while the door is open shall be provided.

4) Provisions shall be made for top entry of incoming line power cables.

c. Chiller Electrical Service (single point power):

1) Chiller shall have input circuit breaker with minimum 100,000 amp interrupt capacity.

2) Chiller shall have standard 15 amp branch oil pump circuit breaker to provide power for chiller oil pump.

3) Chiller shall have standard 3 kva control power transformer with circuit breaker to provide power for oil heater, VFD controls and chiller controls.

4) The branch oil pump circuit breaker and control power transformer shall be factory wired.

5) Input power shall be 380/480 vac, ±10 percent, 3 phase, 50/60 Hz, ±3 Hz.

e. Discrete Outputs:

115-v discrete contact outputs shall be provided for:

1) Circuit breaker shunt trip

2) Chilled water pump

3) Condenser water pump

4) Alarm status.

f. Analog Output:

An analog (4 to 20 mA) output for head pressure reference shall be provided. This signal shall be suitable to control a 2-way or 3-way water regulating valve in the condenser piping.

g. Protection — the following shall be supplied:

1) Under-voltage

2) Over voltage

3) Phase loss

4) Phase reversal

5) Ground fault

6) Phase unbalance protection

7) Single cycle voltage loss protection

8) Programmable auto restart after loss of power

9) Motor overload protection (NEMA Class 10)

10) Motor overtemperature protection.

h. VFD Testing:

VFD shall be factory mounted, wired and tested on the chiller prior to shipment.

6. Special Job Site Requirements:

1. In the event that the chillers cannot fit through a standard 72” X 80” mechanical door as a single unit, the chiller manufacturer shall be responsible for disassembling and reassembling the chiller in place.

SOUND

Acoustics: Manufacturer must provide both sound power and sound pressure data in decibels, per AHRI 370. A-weighted sound pressure at 30 feet should be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope.

If manufacturer cannot meet the noise levels, sound attenuation devices and/or barrier walls must be installed to meet this performance level.

Chiller shall ship with a muffler on each rotary screw compressor and very low noise condenser fans to meet the scheduled sound levels. If chiller does not meet sound levels, chiller manufacturer shall provide additional attenuation features.

Invisiound™ Superior acoustic treatment consisting of insulating sound material applied to the suction and discharge line.

Chiller shall be complete with acoustical sound attenuation covers for all screw compressors.

INSTALLATION

Install in accordance with manufacturer's requirements.

Level the chiller using the base rail as a reference. The chiller must be level within 1/2" in over the entire length and width. Use shims as necessary to level the chiller.

SERVICE AND START-UP

Startup - Provide all labor and materials to perform startup. Startup shall be performed by a factory-trained technician from the original equipment manufacturer (OEM). Technician shall confirm that equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty. This shall be done in strict accordance with manufacturer's specifications and requirements. Third-party service agencies are not permitted.

A start-up log shall be furnished by the factory approved start-up technician to document the chiller's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the chillers.

Chiller manufacturers shall maintain service capabilities no more than 40 miles from the jobsite. Provide local service agent with direct access to factory support on equipment

FLEXIBLE CONNECTIONS:

Furnish and install molded single arch spherical connector/expansion joints. The molded spherical body shall be manufactured; using multiple piles of nylon tire cord fabric bonded within the neoprene elastomer (to avoid exposure to atmosphere or media) and shall be reinforced with a spring steel wire. Floating/ratable flanges shall be zinc-coated plate steel and shall have drilled bolt holes in accordance with ANSI 150# standard. The rated design pressure of the molded body shall have a minimum 3:1 safety factor (burst to operating pressure) based on a maximum operating temperature of 220

degrees F. Flexible connections shall be as manufactured by Vibro-Acoustics Flexzorber model NNS, MetraFlex, Southern Hose, or prior approved equivalent.

INSTALLATION OF PIPING:
Furnish and install complete piping systems as shown on the plans. Valve equipment on both inlet and outlet. Pipe on all vent valves and relief valves to drains.

Furnish and install a drain valve in each of the supply and return mains at the low points in the system.

Furnish and install an adequate means of eliminating the air from the chilled water and hot water piping systems. Provide automatic float type air vents, Bell and Gosset No. 87 or Maid-O-Mist #75 at all points where air might be trapped. In addition, provide manual air vent valves at all high points of risers, etc. All automatic air vents shall have shut-off cock between vent and piping (minimum 1").

Provide hose connection, valves, air vents, etc. on all chilled water piping, so that the piping can be tested. All new piping shall be properly flushed prior to final connections to existing piping.

All pipes shall be true and straight, without sags or traps.

Furnish and install all butterfly valves, ball valves, check valves, balancing valves, hangers, floor, and ceiling plates, etc., to make the system complete.

Screw joints shall be made up with graphite and oil, or other approved compound for a water system.

PRESSURE AND TEMPERATURE STATIONS:
Supply and install in the supply and return piping T & P plug (1/4" MPT) fitting to receive either a temperature or pressure probe having 1/8" diameter stems. Fittings shall be solid brass with self-sealing valve core of Nordel, suitable for pressures to 1000 psig and temperatures at 275^{o}F. Fitting cap shall be installed to extend above insulation.

TESTING HYDRONIC PIPING SYSTEMS:
Chilled water piping shall be tested under 200 psi hydrostatic pressure for a minimum of 5 hours.

PRESSURE GAUGES:
Furnish and install pressure gauges where indicated on the plans. Gauges shall have 4-1/2" dial, corrosion resistant stainless steel case and ring, plastic lens, balanced adjustable black pointer, and accuracy within 1% of range.

Gauge shall have silver soldered phosphor bronze tube with brass socket suitable for chilled or hot water heating applications. Easy to read dial shall have white background with black numerals and graduations.

Gauges shall be as manufactured by Weksler Model EA-14, Conbraco Model No. 56 or equal.

PRESSURE GAUGES:
Furnish and install pressure differential gauges where indicated on plans and herein.

Gauges shall have a 4-1/2” dial, corrosion resistant 316 stainless steel case and ring, acrylic lens, 1/4”

NPT female end connections, piston-sensing element for an accuracy within +or- 2% of range, and easy to read dial shall have white background and black numerals and graduations.

Gauges shall be as manufactured by Dwyer PTGD, or prior approved equivalent.

Chilled Evaporator - Differential Pressure Flow Control/Monitoring – Model PTGD-SC04A-PY (4.5” dial, 316 S.S., 0-20 PSID, Glycerine fill).

GAUGE COCKS:
Furnish and install gauge cocks where indicated on the plans. Gauge cocks shall be solid brass suitable for pressures to 200psi.

Gauge cocks shall be as manufactured by Weksler Model A-10, Marsh Model J8046 or equal.

THERMOMETERS AND WELLS:
Furnish and install thermometers and wells as indicated on the plans. Thermometers shall be bi-metal, adjustable angle dial type. The dial shall be 5" (minimum) stainless steel housing with sealed glass lens, with white background and black numerals and graduations. Thermometer shall be complete with 3/4" separable wells for insulation in piping. Thermometer shall have recalibrating features. Provide stem length as recommended for pipe size. Provide range as recommended for application (0 degrees F to 100 degrees F).

Thermometer and wells shall be as manufactured by MILJOCO model B5099A, Weiss model 5RBMS, DWYER model BTA5, or prior approved equivalent.

EXECUTION:
All installation shall comply with N.F.P.A. 90A and shall be installed in accordance with all local and state codes.
All H.V.A.C equipment shall be installed and or piped to allow for complete servicing, access, and maintenance. This contractor shall verify all locations, routing, installation, and sizes with existing conditions on site prior to any equipment installation.

TEMPERATURE CONTROLS

SCOPE OF WORK
Project will consist of removing existing 500 Ton chiller and replace with new. All existing controls points shall be re-used and reinstalled. Contractor shall coordinate with manufacturer for all BacNet requirements.

ALL EXISTING CONTROLS SHALL REMAIN. MECHANICAL CONTRACTOR SHALL COORDINATE WITH OWNER FOR REMOVAL AND INSTALLATION OF ALL SENSORS AND WIRING AND MODIFY AS REQUIRED TO PLACE NEW CHILLER INTO OPERATION. OWNER TO COORDINATE WITH CONTROLS CONTRACTOR FOR ALL BACNET POINTS AS NEEDED AND PROGRAM INTO EXISTING GRAPHICS.

Select Building Controls: (FOR REFERENCE ONLY)
Darrell Boudreaux, Account Manager, Mobile: (337)525-2018,
Darrel_boudreaux@w-industries.com

TESTING, ADJUSTING, AND BALANCING

RELATED DOCUMENTS

All Mechanical specification sections, drawings, and general provisions of the contract apply to work of this section, as do other documents referred to in this section.

SCOPE OF WORK

The Contractor shall obtain the services of an independent Test and Balance (TAB) Company which specializes in the testing and balancing of heating, ventilating, and air conditioning (HVAC) systems to test, adjust and balance all HVAC systems in the building.

Preliminary testing of existing chilled water primary and secondary pumps is required prior to any demolition or changes to the existing systems. This is to provide a record baseline for use in final balancing.

The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting, and balancing the HVAC systems as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results. The testing, adjusting and balancing agency shall act as a reporting agency; that is, list and report each piece of equipment as to identification number, manufacturer, model number, serial number, proper location, specified performance, and report actual performance of all equipment as found during testing. The report is intended to be used during the life of the building as a ready reference indicating original conditions, equipment components, etc. The Test and balance Report shall be included in each set of the Operation and Maintenance Instruction Manuals.

Representatives of the Test and Balance Company shall visit the job site during installation of the HVAC equipment, piping and ductwork as required.

Upon completion of the HVAC system installation, the Test and Balance Company shall perform all required testing and balancing with the full cooperation of the Contractor and his Sub-contractors. The Contractor shall make changes and/or adjustments to the HVAC system components that are required by the Test and Balance Company to accomplish proper balancing. The TAB agency shall not supply or install any materials or balancing devices. All of this work is by the Contractor and shall be performed at no additional cost to the Owner.

The test and balance report complete with a summary page listing all deficiencies shall be submitted to the Owner for review. The test and balance report must be complete and must be accepted by the Owner prior to acceptance of the project. Any outstanding test and balance items shall be placed on the punch list and a monetary value shall be assigned to them.

After all deficiencies have been corrected and the final report accepted, the Test and Balance Company shall supply four (4) copies of the final and complete report for inclusion in the Operation and Maintenance Manuals.

The items requiring testing, adjusting, and balancing include (but are not restricted to) the following:

HYDRONIC SYSTEMS:

Pumps
System Mains and Branches
Centrifugal Chiller

DEFINITIONS, REFERENCES, STANDARDS

All work shall be in accordance with the latest edition of the Associated Air Balance Council (AABC) National Standards or the latest standards of the National Environmental Balancing Bureau (NEBB). If these contract documents set forth more stringent requirements than the AABC National Standards or the NEBB Standards, these contract documents shall prevail.

QUALIFICATIONS

Agency Qualifications: The TAB Agency shall be a current member of the AABC or the NEBB and have been established a minimum of five years and have completed projects of this size.

SUBMITTALS

Procedures and Agenda: The TAB agency shall submit the TAB procedures and agenda proposed to be used.

Sample Forms: The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards or the NEBB Standards.

TAB PREPARATION AND COORDINATION

Shop drawings, submittal data, up-to-date revisions, change orders, pump curves and other data required for planning, preparation, and execution of the TAB work shall be provided from the contractor when available and no later than 30 days after final approved submittal data.

System installation and equipment startup shall be complete prior to the TAB agency's being notified to begin.

The building control system (BCS) contractor shall provide and install the control system, including all sensors. These shall be calibrated for accurate control. If applicable, the BCS contractor shall install all necessary computers and computer programs and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

Laptop and Control programming shall be furnished by Temperature Control Contractor.

All test points, balancing devices, identification tags, etc., shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

REPORTS

Final TAB Report - The TAB agency shall submit the final TAB report for review by the Architect. On plans provided, all outlets, devices, HVAC equipment, etc., shall be identified (including manufacturer, model number, serial number, motor manufacturer, HP, drive type, fan and motor sheaves and belt number), along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" (or similar NEBB Guaranty) assuring

that the project systems were tested, adjusted, and balanced in accordance with the project specifications and AABC National Standards (or similar NEBB Standards). The Designer shall certify his approval on the Performance Guaranty.

Submit 4 copies of the Final TAB Report for inclusion in the Operation and Maintenance Manuals.

INSTRUMENTATION

All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards (or similar NEBB Standards).

EXECUTION

GENERAL

The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting, and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards (or similar NEBB Standards). Adjustment tolerances shall be + or - 10% unless otherwise stated.

Equipment settings, including valve indicators, pump speed control levers, and similar controls and devices shall be marked to show final settings.

All information necessary to complete a proper TAB project and report shall be per AABC or NEBB standards unless otherwise noted. The descriptions of work required, as listed in this section, are a guide to the minimum information needed.

TAB contractor shall cut insulation, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. Upon completion, patch insulation, and housings using materials identical to those removed. Seal insulation to reestablish integrity of the vapor barrier.

TAB work shall include additional inspection and adjustment of components during the season following the initial balance to include re-balance of any items influenced by seasonal changes or as directed by the Owner.

HYDRONIC SYSTEMS

The TAB agency shall, as applicable, verify that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. Examine water in system and determine if it has been treated and cleaned. As applicable, it shall check air vents and expansion or compression tank for proper operation. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards (or similar NEBB Standards):

For pumps:

1. Test and adjust chilled water pumps to meet design GPM requirements. Check pump rotation and verify impeller size. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead head calculations. List pump N.P.S.H. (as applies).

2. Chilled Water shall be balanced to allow full flow to AHU (Longest distance from Central Plant) with one chiller operating. Variable frequency drive shall be set to maintain chiller gpm as required for single chiller operation. When both chillers are energized and running, variable frequency drive shall be set to maintain chiller gpm as set.
3. Current and Voltage - Test and record each motor line voltage and amperage. Compare data with the nameplate limits to ensure motors are not in or above the service factor, are not excessively below FLA, or are not operating with a line voltage exceeding required tolerances. Make corrections as deemed necessary by Engineer.

For system mains and branches: Adjust water flow in pipes to within design GPM requirements. As applicable, at least one branch balancing valve shall be completely open.

For chillers:

1. Verify that chillers have been started by others and are in operation. Test and adjust chiller water flows to within 10% of design requirements by observing differential pressure gauge and setting balance valves.
2. Current and Voltage - Test and record each motor line voltage and amperage. Compare data with the nameplate limits to ensure motors are not in or above the service factor, are not excessively below FLA, or are not operating with a line voltage exceeding required tolerances. Make corrections as deemed necessary by Engineer.
3. Test and record entering and leaving temperature and pressure profiles of chillers.
4. Test and record pressure drop and flow across control valves at full flow.

ADDITIONAL TAB SERVICES

Job Site Inspections:
During construction, the TAB agency shall inspect the installation of pipe systems, temperature controls, and other component parts of the HVAC systems as required.

Verification of HVAC Controls:
The TAB agency shall be assisted by the building control systems Contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, control sequences, water resets etc.
2. Verify that all controlling instruments are calibrated and set for design operating conditions.

Temperature Testing:
To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals. The resulting temperatures shall not vary more than two degrees Fahrenheit from the control set point during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

TAB Report Verification:
At the time of final inspection, the TAB agency may be required to recheck, in the presence of the owner's representative, specific and random selections of data, air quantities, and air motion recorded

in the certified report. Points and areas for recheck shall be selected by the owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

Equipment Startup

The TAB agency shall be present for all equipment start-ups by the equipment manufacturer.

ELECTRICAL GENERAL CONDITIONS

DESCRIPTION

The General Conditions and all pertinent sections are a part of this specification, and the Contractor shall consult them in detail for instructions pertaining to his work. He shall consult all other sections of the specifications to determine if he is required to perform any work relative to that particular section.

SCOPE OF WORK

A. The work contemplated under this specification comprises the furnishing of all labor and materials required and necessary for the complete installation of electrical wiring in conduit for lighting control and power from the various panelboards to each ultimate outlet hereinafter specified and/or shown on the accompanying drawings. Said work shall be done in accordance with the latest edition of the National Electrical Code and all local codes and ordinances. The specifications are intended to describe a complete workable system and bidders shall report any discrepancies or omissions preventing such workability prior to the time their bids are submitted.

B. The work covered by this specification shall be as shown on the plans and called for herein, and shall be comprised generally of the following:
   1. Furnish and install light fixtures, wiring, etc.
   2. Furnish and install panelboards, electrical devices, wiring.
   3. Furnish and install Fire Alarm System.
   4. Furnish and install low voltage and Data Cabling System.

C. All equipment installed by this contractor shall be installed in strict accordance with instructions of the manufacturer.

D. He shall install his work to meet existing conditions as found at the building site.

E. The Electrical contractor is referred to the Architectural and Structural details for information in regard to the Architectural details. His work shall be done in strict accordance with local and state ordinances governing this class of work.

REJECTED WORK AND MATERIALS

Should contractor introduce any materials different from those called for and described in specifications or shown on plans, it must on notification from the engineers, be immediately removed from building or premises.

SHOP DRAWINGS

A. Before proceeding with work and/or within fifteen (15) days award of the General Contract for this work, the Electrical Contractor shall furnish to the Architect/Engineer, complete shop and working

drawings of such apparatus, equipment, controls, insulation, etc. to be provided in this project. These drawings shall give dimensions, weights, mounting data, performance curves, and other pertinent information. Shop drawings to be submitted as listed below.

1. Lighting Fixtures.
2. Panelboards, disconnects.
3. Data Cabling.
4. Fire Alarm
5. Conduit/Cabling.
6. Wiring Devices and Switches.

B. The contractor may be required to submit shop drawings on any other material he supplies in construction of this project. These drawings shall be submitted at time requested by Architect/Engineer.

ADDITIONS AND CHANGES

The accompanying drawings show approximate location of feeders, branch circuits, light and power circuits, etc. Complete and accurate details in regard to location of outlets, apparatus, etc. from location shown shall be made before roughing-in and without additional cost to the owner.

STANDARDS OF MATERIALS AND WORKMANSHIP

All materials shall be new and listed by UL as conforming to its standards. Work shall be executed in a workmanlike manner and present a neat, finished appearance when completed.

GUARANTEE

The Contractor for this work shall be required to keep the work installed by him in repair and perfect working order for one year from date of completion and final acceptance; said guarantee shall be based on defective materials and substandard workmanship. Contractor shall furnish, free of cost to owner, all materials and labor necessary to comply with this guarantee.

LAWS, PERMITS AND INSPECTIONS

This contractor shall at his own cost obtain all necessary permits, pay all legal fees and charges, and comply with all building and safety laws, ordinances and regulations relating to the building and the public health and safety, including NEC, NFPA, IBC and OSHA.

TESTS

After installation is complete and at such time as the Engineers may direct, Contractor shall conduct an operating test for approval. Equipment shall be demonstrated to operate in accordance with requirements of this specification. The test shall be performed in the presence of Engineers. Contractor shall furnish all instruments and personnel required for the test.

CUTTING AND PATCHING

Contractor shall do all cutting and patching where necessary at his own expense with approval of the Engineers as to cutting of any structural beams or joists, but all patching shall be done by crafts whose work is involved. After initial surfacing has been done, all further cutting, patching, and painting shall be done at this contractor's expense.

SAFETY PRECAUTIONS

Contractor shall furnish and place proper guards for prevention of accidents. He shall provide and

maintain any other necessary construction required to secure safety of life or property, including maintenance of sufficient lights during all night hours to secure such protection.

SUPERVISION

Contractor shall personally, or through an authorized and competent representative, constantly supervise the work done from beginning to completion and final acceptance. To the best of his ability he shall keep the same foreman and workmen throughout the project duration. During the progress of the work, it shall be subject to inspection by the representatives of the Engineers, and at these times, the contractor shall furnish the required information.

INSERTS AND OPENINGS

Contractor shall furnish and install all inserts and hangers required to support conduit, cables, wireways, disconnect switches, etc.

OPENINGS THROUGH WALLS AND FLOORS

Provide all slots, sleeved holes, and other openings necessary through walls and floors, and through any other parts of the structure. Where conduits pass through walls which are intended as rated fire walls, leave-outs, penetrations, or sleeves shall be sealed so as not to interfere with the rating of the wall.

BACKFILLING

Contractor shall be responsible to backfill any trenches for electrical runs under the building, paving, or any area of the site by backfilling the bottom of the trench-up to the top of the conduit with sand, then placing compacted fill in 4" layers using power tamping equipment.

RECORD DRAWINGS

A. The Contractor shall be provided with a set of prints of the original bidding documents by the Architect. The Contractor shall then have a set of sepia (reproducible plans) made.

B. If the Contractor elects to vary from the contract documents and secures prior approval from the architect for any phase of the work, he shall record in a neat and readable manner, ALL such variances on the print in red. These changes shall then be transferred to the permanent set (sepia) at the completion of the job. Both the sepia and the original print shall be returned to the Engineer for documentation.

C. All deviations from sizes, locations and from all other features of the installations shown in the Contract Documents shall be recorded.

D. In addition, it shall be possible using these drawings to correctly and easily locate, identify and establish sizes of all piping, directions, and the like, as well as other features of work which will be concealed underground and/or in the finished building. Locations of underground work shall be established by dimensions to columns, lines or walls, locating all turns, etc. and by properly referenced centerline.

E. For work concealed in the building, sufficient information shall be given so it can be located with reasonable accuracy and ease. In some cases this may be by dimension. In others, it may be sufficient to illustrate the work on the drawings in relation to the spaces in the building near which it was actually installed. Architect's/Engineer's decision in this matter will be final.

F. The following requirements apply to all “record” drawings:

1. They shall be maintained at the contractor's expense.

2. All such drawings shall be done carefully and neatly and, in a form, approved by the Engineer.

3. Additional drawings shall be provided as necessary for clarification.

4. They shall be kept up-to-date during the entire course of the work and shall be available upon request for examination by Engineer and when necessary, to establish clearances for other parts of the work.

5. "Record" drawings shall be returned to the Architect upon completion of the work and are subject to approval of the Engineer.

6. The Contractor shall refer to the Architectural section under "RECORD DRAWINGS" for further requirements and procedures.

BASIC ELECTRICAL MATERIALS AND METHODS

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY

A. This Section includes the following:
   1. Supporting devices for electrical components.
   2. Concrete equipment bases.
   3. Cutting and patching for electrical construction.
   4. Touchup painting.

SUBMITTALS

A. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

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.

COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

C. Coordinate electrical service connections to components furnished.

   1. Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.

   2. Comply with requirements of authorities having jurisdiction.

D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Specification Section "Access Doors."

E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches o.c., in webs.

D. Slotted-Steel Channel Supports: Comply with Specification Section "Metal Fabrications" for slotted channel framing.

   1. Channel Thickness: Selected to suit structural loading.

   2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

F. Pipe Sleeves: Schedule 40, galvanized steel, plain ends.

G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and

size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.

J. Powder-Driven Threaded Studs: Heat-treated steel.

TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

ELECTRICAL EQUIPMENT INSTALLATION

A. Temperature ratings of all equipment lugs and terminations shall be compatible with those of the wire or cable per NEC 110-14(C) and 110-40 as applicable.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

C. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.

2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.

3. New Concrete: Concrete inserts with machine screws and bolts.

4. Existing Concrete: Expansion bolts.

5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.

6. Steel: Welded threaded studs or spring-tension clamps on steel.

7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.

8. Light Steel: Sheet-metal screws.

9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

FIRESTOPPING

Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.

2. Building wire and connectors.

3. Supporting devices for electrical components.

4. Electrical identification.

5. Electricity-metering components.

6. Concrete bases.

7. Cutting and patching for electrical construction.

8. Touchup painting.

B. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.

2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.

3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.

4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.

5. Repair or replace malfunctioning metering equipment or correct test setup, then retest. Repeat each meter in installation until proper operation of entire system is verified.

REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Specification Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.