SECTION 230520

METERS AND RECORDERS

PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Purchase meters and recorders from firms of established reputation, who have been actively engaged in their manufacture and successful use for a period on not less than ten years such as Foxboro, Fischer and Porter, or Honeywell.

1.02 SUBMITTALS

A. Submit drawings and product data of the equipment and all appurtenance data.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. Magnetic Flow Meter:
   1. Size: Refer to drawings for flow meter size.
   2. Type: Electro-magnetic induction to produce a-c voltage signal proportional to flow. Measuring gallons (total) and gallons per minute.
   3. Accuracy: plus or minus 0.4 percent of the measured value.
   4. Connection and Housing material: #304 stainless steel with a PTFE liner, No obstructions to water flow.
   5. Electrodes: C-22 electrodes set flush with interior wall surface, 304 stainless steel grounding ring.
   6. Working Pressure: 125 psig.
   7. Ends: Flanged ASME Class 150.
   8. Enclosure: suitable for infrequent submergence up to 10 feet.
   9. Remote mounted display with mounting bracket and manufacturer's cable.
   10. 120V power connection with integral battery backup.
   11. Recorder: Modbus RS-485 communication with the building automation system (coordinate gateway controller to integrate into the existing building automation system).
   12. Junction box shall be stainless steel NEMA 4X.
   13. Basis of Design: Badger Meter ModMag M5000.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work in this Section as shown on the drawings, shop drawings and as approved by the Director's Representative.

B. Adjust equipment as required for proper operation.

END OF SECTION

SECTION 230523

VALVES

PART 1 GENERAL

1.01 ABBREVIATIONS

A. IBBM: Iron body, bronze mounted.

B. OS&Y: Outside screw and yoke.

C. WOG: Water, oil, gas.

D. WSP: Working steam pressure.

1.02 SUBMITTALS

A. Product Data: Catalog sheets, specifications and installation instructions for each valve type.

B. Valve Schedule: List type of valve, manufacturer's model number, and size for each service application.

PART 2 PRODUCTS

2.01 VALVES - GENERAL

A. Valve Standardization: Valves from one or more manufacturers may be used, however valves supplied for each specific valve type shall be the product of one manufacturer.

B. Valves shall be first quality, free from all imperfections and defects, with body markings indicating manufacturer and rating.

C. Valve parts of same manufacturer, size and type shall be interchangeable.

D. Manually operated gate, globe and angle valves shall be of rising stem type, unless otherwise specified.

E. Manually operated valves shall open in a counterclockwise direction by means of round ventilated type handwheels.
   1. Exception: Cross handle type handwheels are acceptable for valves up to 3 inches in size.

F. In open position, wedge and stem of gate valves shall clear the waterway completely.

G. Valves which use packing shall be capable of being packed when wide open and under full working pressure.

H. Size valves the same size as the piping in which they are installed, unless otherwise specified.

2.02 MATERIALS

A. Body:
1. Cast Iron: ASTM A 126 66, Class B, higher strength cast iron.
2. Bronze: For use up to 150 psig WSP, ASTM B 62 and over 150 psig to 300 psig WSP, ASTM B 61.
3. Cast Steel: ASTM A 216 Grade WCB.
4. Forged Steel: ASTM A 105 Grade 2.

B. Stem:
1. Cast Manganese Bronze: ASTM B 584.
2. Cast Silicon Brass: ASTM B 584.
3. Rolled Silicon Brass: ASTM B 98 Alloy D.
4. Rolled Aluminum Bronze: ASTM B 150 Alloy 1.
5. Rolled Manganese Bronze: ASTM B 138 Alloy A (half hard).
6. Naval Brass: ASTM B 21 Alloy A or Alloy C (hard).
7. Carbon Steel: As specified for particular type of valve.
8. Stainless Steel: As specified for particular type of valve.

C. Trim: As specified for particular type of valve.

2.03 GATE VALVES

A. Type A: 125 psig WSP, 200 psig WOG, bronze body, union bonnet, solid wedge disc, and threaded ends. Acceptable Valves: Crane428UB, Hammond IB617, Jenkins 47CU, Milwaukee 1152, Nibco T134, and Stockham B105.

B. Type C: 125 psig WSP, 200 psig WOG up to 12 inch size, and 150 psig WOG for 14 inch and 16 inch sizes; IBBM OS&Y, bolted bonnet, solid wedge disc, and threaded or flanged ends depending on size. Acceptable Valves: Crane 464-1/2 & 465-1/2, Hammond IR1140, Milwaukee F2885, Nibco T6170 & F6170, and Stockham G620 & G623

C. Type D: 125 psig WSP, 200 psig WOG, bronze body, threaded bonnet, solid wedge disc, and solder ends. Acceptable Valves: Crane 1330, Hammond IB635, Jenkins 991AJ, Milwaukee 149, Nibco S111, and Stockham B108.

2.04 GLOBE AND ANGLE VALVES

A. Type J: 125 WSP, 200 psig WOG, bronze body, threaded bonnet, and threaded ends. Acceptable Valves: Crane 1, Hammond IB440 & IB463, Jenkins 101J, Milwaukee 502, Nibco T211 & T311, and Stockham B16.

B. Type K: 125 psig WSP, 200 psig WOG, IBBM OS&Y, bolted bonnet, and threaded or flanged ends depending on size. Acceptable Valves: Crane 351 &

353, Hammond IR116, Jenkins 613C & 615C, Milwaukee F2981, Nibco F718B & F818B, and Stockham G512, & G515.

C. Type O: 125 psig, 200 psig WOG, bronze body, threaded bonnet, and solder ends. Acceptable Valves: Crane 1310, Hammond IB423, Jenkins 1200C, Milwaukee 1502, Nibco S211, and Stockham B17.

2.05 CHECK VALVES

A. Type S: 125 psig WSP, 200 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and threaded ends. Face discs for cold water service with teflon. Acceptable Valves: Crane 37, Hammond IB940, Jenkins 4092, Milwaukee 509, Nibco T413Y, and Stockham B319Y.

B. Type U: 125 psig WSP, 200 psig WOG, bronze body, brass or bronze trim, horizontal swing, renewable and regrindable disc, and solder ends. Face discs for cold water service with teflon. Acceptable Valves: Crane 1340, Hammond IB912, Jenkins 4093, Milwaukee 1509, Nibco S413Y, and Stockham 309Y.

D. Type V: 125 psig WSP, 200 psig WOG, IBBM, horizontal swing, bolted bonnet, regrindable and renewable seat ring and disc, and threaded or flanged ends depending on size. Discs on valves 4 inch size and larger may be cast iron with bronze face. Acceptable Valves: Crane 372, & 373, Hammond IR1124, Jenkins 623CJ & 624CJ, Milwaukee F2974, Nibco F918, and Stockham G927 & G931.

2.06 BUTTERFLY VALVES

A. Type BF: Iron body, flangeless wafer or lugged type, (lug for each bolt hole, drilled and tapped for cap screws), with replaceable reinforced resilient EPT (EPDM) seats, bronze or nickel plated ductile iron discs, phosphate coated steel or stainless steel stems, and raised necks able to accommodate 2 inches of insulation. Acceptable Manufacturers: Crane, Demco, De Zurik, Hammond, Keystone, Milwaukee, Nibco, Stockham, and Watts.
   1. Pressure Ratings:
      a. 12 inch size and Less: 200 psig WOG at 275 degrees F.

B. Operators:
   1. 6 inch size and Less: Manual actuator handles with external indication of disc position, and suitable means of locking actuator in any fixed position.
   2. 8 inch size and Up: Worm gear operator.

2.07 COMBINATION BALANCING AND SHUT-OFF VALVES (TRIPLE DUTY)

A. Heavy duty brass construction of angle or straightway pattern with 200 psig working water pressure at 250 degrees F, flanged connection, visible graduated dial indicator, memory stop, and wheel handle with full turn opening. Acceptable Manufacturers: Bell and Gossett, Armstrong, Dunham-Bush, and Spirax Sarco.

2.08 SAFETY AND RELIEF VALVES

A. General Requirements: Valves shall be as specified by ASME Code governing manufacture of such valves within scope of their particular usage and shall be tested, rated and listed by National Board of Boiler and Pressure Vessel Inspections and shall bear symbol of ASME and NBB and PVI, unless otherwise specified.

1. Valves for chilled water systems shall conform to the requirements of the ASME Code. Valves shall be of Safety Relief type, i.e., shall lift slowly to relieve normal thermal pressure build-up and "pop" to relieve excessive pressure due to "runaway" conditions, caused by the failure of any pressure control device. Valve bodies shall be brass, with EPDM diaphragm and seat.
2. End Connections: Unless otherwise specified, safety valves, relief valves and safety relief valves, in sizes 3/4 inch to 3 inches IPS inclusive, may be furnished with male or female pipe thread inlet and female pipe thread outlet; valves over 3 inches IPS must be furnished with 125 lb. or 250 lb. flanged inlet and may be equipped with female threaded or 125 lb. flanged outlet.

2.09 NEEDLE STOP VALVES

A. For Temperatures to 300 degrees F.: All brass or forged carbon steel construction, union bonnet, screwed ends, built for 1000 psi at 300 degrees F.

B. Acceptable Manufacturers: Marsh Instrument Company, Singer-American Meter Division, H.O. Trerice Co. and Weksler Instruments Corp.

2.10 GAGE COCKS

A. Gage Cocks: All brass construction, "T" or lever handles, screwed ends, built for 300 psig hydraulic pressure. Acceptable Manufacturers: Marsh Instrument Company, Mueller Instruments Co., H.O. Trerice Co. and Weksler Instruments Corp.

2.11 BALL VALVES

A. Type BV: 150 psig WSP, 600 psig WOG, 2-piece full port, bronze body, solid blow-out proof stem, teflon seats, chrome plated brass ball, teflon seals, corrosion resistant steel lever handles with vinyl grips and threaded or solder ends. Acceptable Manufacturers: Apollo, Hammond, Milwaukee, Nibco, and Watts.

1. Valve Option: Extended Stem.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install valves at locations noted on the drawings or specified per manufacturer's installation instructions.

3.02 DISCHARGE PIPING FROM LIQUID RELIEF VALVES

A. Connection vent piping to the discharge outlet of all relief valves and terminate over floor drain, bell outlet or other approved point of waste.

3.03 VALVE APPLICATION SCHEDULE

A. Schedule of valve applications for the different services is as follows:
   1. Chilled Water/Glycol 125 psig and less:
      a. 3 inches and Less: Screwed, A or D gates or BV balls, J or 0 globe or angles and S or U checks.
      b. 4 inches and Up: Flanged end, C gates or BF butterflies, K globe or angles and V checks.
   2. Make-Up Water 125 psig and less:
      a. 3 inches and Less: Solder end, BV balls, 0 globe or angles. Valves shall be NSF rated for potable water systems.

END OF SECTION

SECTION 230529

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Companion high density filler pieces for installation over the top 180 degree surface of pipe or tubing, at points of support where a combination clevis hanger, insulation shield and high density insulating saddle are installed.

1.02 SUBMITTALS

A. Shop Drawings:
   1. Details of trapeze hangers and upper hanger attachments for piping 4 inches in diameter and over. Include the number and size of pipe lines to be supported on each type of trapeze hanger.
   2. Details of pipe anchors.

B. Submit an Environmental Product Declaration (EPD) from the manufacturer for steel within this specification section, if available. A statement of the contractor's good faith effort to obtain the EPD shall be provided if not available.
   1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

C. Product Data: Catalog sheets, specifications and installation instructions for each item specified except fasteners.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with the applicable requirements of the ASME B31 Piping Codes.
   2. Unless otherwise shown or specified, comply with the requirements of the Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS) Standards SP-58, and SP-69.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

A. Combination clevis hanger, pipe insulation shield and vapor barrier jacketed high density insulating saddle with companion high density filler piece.
   1. Insulating saddles and filler pieces shall be of the same thickness and materials as the adjoining pipe insulation. Saddles shall cover the lower 180 degrees of the pipe or tubing, and companion filler pieces shall cover

the upper 180 degrees of the pipe or tubing. Physical sizes, gages, etc. of the components of insulated hangers shall be in accordance with the following schedule:

PIPE OR TUBING SIZE (Inches)	SHIELD LENGTH (Inches)	SHIELD GAGE	SADDLE LENGTH (Inches)	VAPOR BARRIER JACKET LENGTH (Inches)
Up to 2-1/2	4	16	6	10
3 to 6	4	14	6	10
8 to 14	10	12	12	16

B. Pipe Insulation Shields: Fabricated of steel, with a minimum arc of 180 degrees, unless otherwise indicated. Shields for use with hangers and supports, with the exception of combination clevis type hangers, shall be in accordance with the following schedule:

PIPE OR TUBING SIZE (Inches)	SHIELD LENGTH (Inches)	SHIELD GAGE
Up to 2-1/2	8	18
3 to 8	10	16
10 to 14	12	12

C. Pipe Hangers: Height adjustable standard duty clevis type, with cross bolt and nut.
   1. Pipe spreaders or spacers shall be used on cross bolts of clevis hangers, when supporting piping 10 inches in size and larger.

D. Adjustable Floor Rests and Base Flanges: Steel.

E. Hanger Rods: Mild, low carbon steel, fully threaded or threaded at each end, with two nuts at each end for positioning rod and hanger, and locking each in place.

F. Riser Clamps: Malleable iron or steel.

G. Rollers: Cast Iron.

2.02 ANCHORS AND ATTACHMENTS

A. Sleeve Anchors (Group II, Type 3, Class 3): Molly's Div./USM Corp. Parasleeve Series, Ramset's Dynabolt Series, or Red Head/Phillips AN, HN, or FS Series.

B. Wedge Anchors (Zinc Plated, Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly's Div./USM Corp. Parabolt PB Series, Ramset's Trubolt T Series, or Red Head/Phillips WS Series.

C. Self-Drilling Anchors (Group III, Type 1): Ramset's RD Series, or Red Head/Phillips S Series.

D. Non-Drilling Anchors (Group VIII, Type 1): Ramset's Dynaset DS Series, Hilti's HDI Series, or Red Head/Phillips J Series.

E. Stud Anchors (Group VIII, Type 2): Red Head/Phillips JS Series.

F. Beam Clamps: Forged steel beam clamp, with weldless eye nut (right hand thread), steel tie rod, nuts, and washers, Grinnell's Fig No. 292 (size for load, beam flange width, and rod size required).

G. Screw Type: Stainless steel impact wrench driven screw type anchor (requires pre-drilled concrete hole: Hilti KH-EZ screw anchor, Simpson Strong Tie Titen HD screw anchor.

2.03 VIBRATION ISOLATION FOR PIPING

A. Type: Combination rubber and spring type designed for insertion in a split hanger rod for isolating piping from the overhead construction.
   1. Approved isolators: Amber Booth Type BSSR, Korfund Type VX, Mason Industries, Type DNHS, Vibration Eliminator Co. Type SNRC and Vibration Mountings and Controls Type RSH.

B. To ensure that piping weight is properly distributed and not being supported by equipment flanges, the first three rubber and spring isolators on the inlet shall be of the "position indicating" type.
   1. Approved Isolators: Amber Booth Type PBSS, Korfund Type VXLS, Mason Industries Type PDNHS, Vibration Eliminator Co. Type PR2H and Vibration Mountings and Controls Type RSHP.

2.04 FASTENERS

A. Bolts, Nuts, Washers, Lags, and Screws: Medium carbon steel; size and type to suit application; galvanized for high humidity locations, and treated wood; plain finish for other interior locations. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work.

2.05 SHOP PAINTING AND PLATING

A. Hangers, supports, rods, inserts and accessories used for pipe supports, unless chromium plated, cadmium plated or galvanized shall be shop coated with metal primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper pipe or copper tubing.

B. Hanger supports for chromium plated pipe shall be chromium plated brass.

C. All pipe supports, hangers and accessories located outside must be hot dipped galvanized.

2.06 CHANNEL SUPPORT SYSTEM

A. Channel Material: 12 gage steel.

B. Finishes:
   1. Hot dipped galvanized.

C. Fittings/Accessories: Same material and finish as channel.

D. UL Listed Systems:
   1. Basis of Design: Unistrut Corp.'s P-1000 (1-5/8 x 1-5/8 inches), P-1001 (1-5/8 x 3-1/4 inches)
   2. B-Line Systems Inc.
   3. Grinell Corp.

PART 3 EXECUTION

3.01 INSTALLATION

A. Do not hang or support one pipe from another or from ductwork.
   1. Do not bend threaded rod.

B. Support all insulated horizontal piping conveying fluids below ambient temperature, by means of hangers or supports with insulation shields installed outside of the insulation.

C. Space hangers or supports for horizontal piping on maximum center distances as listed in the following hanger schedules, except as otherwise specified, or noted on the Drawings.
   1. For Steel, Alloy Steel, Threaded Brass Pipe and Fibrous Glass Reinforced Plastic Pipe (FRP):

PIPE SIZE (Inches)	MAXIMUM SPACING (Feet)
1 and under	8
1-1/4 and 1-1/2	9
2	10
2-1/2 and up	12

   2. For Copper Pipe and Copper Tubing:

PIPE OR TUBING SIZE (Inches)	MAXIMUM SPACING (Feet)
1-1/2 and under	6
2 and over	10

3. For Directional Changes: Install a hanger or support close to the point of change of direction of all pipe runs in either a horizontal or vertical plane.
4. For Concentrated Loads: Install additional hangers or supports, spaced as required and directed, at locations where concentrated loads such as in-line pumps, valves, fittings or accessories occur, to support the concentrated loads.
5. For Branch Piping Runs and Runouts Over 5 feet In Length: Install a minimum of one hanger, and additional hangers if required by the hanger spacing schedules.
6. Parallel Piping Runs: Where several pipe lines run parallel in the same plane and in close proximity to each other, trapeze hangers may be submitted for approval. Base hanger spacing for trapeze type hangers on the smallest size of pipe being supported. Design the entire hanger assembly based on a safety factor of five, for the ultimate strength of the material being used.

D. Size hanger rods in accordance with the following:

PIPE OR TUBING SIZE (Inches)	SINGLE ROD HANGER SIZE (Inches)		DOUBLE ROD HANGER SIZE (Inches)	
	PIPE	TUBING	PIPE	TUBING
1/2 to 2	3/8	1/4	3/8	1/4
2-1/2 and 3	1/2	3/8	3/8	1/4
4 and 5	5/8	1/2	1/2	3/8
6	3/4	1/2	5/8	1/2
8, 10 and 12	7/8	5/8	3/4	5/8

1. Secure hanger rods as follows: Install one nut under clevis, angle or steel member; one nut on top of clevis, angle or steel member; one nut inside insert or on top of upper hanger attachment and one nut and washer against insert or on lower side of upper hanger attachment. A total of four nuts are required for each rod, two at upper hanger attachment and two at hanger.

E. Vertical Piping:
1. Support vertical risers of piping systems, by means of heavy duty hangers installed close to base of pipe risers, and by riser clamps with extension arms at intermediate floors, with the distance between clamps not to exceed 25 feet, unless otherwise specified. Support pipe risers in

vertical shafts equivalent to the aforementioned. Install riser clamps above floor slabs, with the extension arms resting on floor slabs. Provide adequate clearances for risers that are subject to appreciable expansion and contraction, caused by operating temperature ranges.

2. Support extension arms of riser clamps, secured to risers to be insulated for cold service, 4 inches above floor slabs, to allow room for insulating and vapor sealing around riser clamps.

3.02 UPPER HANGER ATTACHMENTS

A. General:
   1. Secure upper hanger attachments to overhead structural steel, steel bar joists, or other suitable structural members.
   2. Do not attach hangers to steel decks that are not to receive concrete fill.
   3. Do not attach hangers to precast concrete plank decks less than 2-3/4 inches thick.
   4. Do not use flat bars or bent rods as upper hanger attachments.

B. Attachment to Existing Cast-In-Place Concrete:
   1. For piping up to a maximum of 4 inches in size, secure hangers to overhead construction with self-drilling type expansion shields and machine bolts.
   2. Secure hangers to wall or floor construction with single unit expansion shields or self-drilling type expansion shields and machine bolts.

3.03 COMBINATION CLEVIS HANGER, PIPE INSULATION SHIELD AND VAPOR BARRIER JACKETED HIGH DENSITY INSULATING SADDLES

A. Install a combination clevis hanger, pipe insulation shield and vapor barrier jacketed high density insulating saddles, at all points of support for piping or tubing to be insulated for cold service. Furnish companion high density vapor barrier jacketed saddle pieces, of the same material, thickness and length, for installation over the top 180 degree surface of pipe or tubing, at each point of support where an insulated clevis hanger is utilized.

3.04 PIPE INSULATION SHIELDS

A. Unless otherwise specified, install a pipe insulation shield, at all points of support. Center shields on all hangers and supports outside of high density insulation insert, and install in such a manner so as not to cut, or puncture jacket.

3.05 VIBRATION ISOLATION FOR PIPING

A. Install vibration isolation in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Piping: The isolator deflections shall be equal to or greater than the static deflection of the vibration isolators provided for the connected machinery as follows:
   1. Piping Connected to Vibration Isolated HVAC Equipment: For a distance of 50 feet or 50 pipe diameters, whichever is greater.

2. Chilled Temperature Piping: For risers from pumps and for the first 20 feet of the branch connection of the main supply and return piping at each floor.
3. Water Distribution Piping Application: Resiliently support piping with combination rubber and spring isolation hangers.
    a. Provide spring elements with 5/8-inch static deflection; install the hanger with spacing so that the first harmonic natural frequency is not less than 360 Hz. Provide double-deflection neoprene elements.
    b. For the first two isolation hangers from the rotating equipment of 3-1/2 inch and smaller piping systems, ensure a deflection equal to the equipment-isolation static deflection.
    c. For the first four piping isolation hanger supports from rotating equipment of 4-inch and larger piping systems, use resilient hanger-rod isolators at a fixed elevation regardless of load changes.
    d. Incorporate an adjustable preloading device to transfer the load to the spring element within the hanger mounting after the piping system has been filled with water.

C. Horizontal Piping Runs Within Mechanical Equipment Rooms: Provide combination rubber and spring type isolators, designed for insertion of a split hanger rod, for the following :
    1. Chilled water supply and return

END OF SECTION

SECTION 230549

CONCRETE PADS FOR EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. Except as shown or specified otherwise, the Work of this Section shall conform to the requirements of Specifications for Structural Concrete for Buildings ACI 301-99 of the American Concrete Institute.

1.02 SUBMITTALS

A. Submittals Package: Submit product data for design mix and materials for concrete specified below at the same time as a package.

B. Submit an Environmental Product Declaration (EPD) from the manufacturer for concrete within this specification section, if available. A statement of the contractor's good faith effort to obtain the EPD shall be provided if not available.
   1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

C. Samples:
   1. Fabric Reinforcement: 8 inches square.
   2. Bar Supports: Full size.

D. Quality Control Submittals:
   1. Certificates: Bar reinforcement manufacturer's certification that bar material conforms with ASTM A 615 and specified grade.

1.03 STORAGE

A. Store materials as required to insure the preservation of their quality and fitness for the Work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Anchor Bolts: Standard bolts, ASTM A 307, with lock washers and nuts.

B. Steel Plates: ASTM A 36.

C. Sleeves: Steel Pipe, Schedule 40, black, ASTM A 53.

D. Steel Shims and Fillers: ASTM A 569.

E. Reinforcement: Furnish the following unless otherwise indicated on the Drawings:
   1. Fabric Reinforcement: ASTM A 185 welded wire fabric, 6 x 6 - W2.9 x W2.9 fabricated into flat sheets unless otherwise indicated.
   2. Bar Reinforcement: ASTM A 615, Grade 60, deformed.
   3. Metal Bar Supports: Galvanized or AISI Type 430 stainless steel, and without plastic tips.
   4. Tie Wire: Black annealed wire, 16 gage minimum.

F. Fly Ash: ASTM C 618, including Table 1A (except for footnote A), Class F except that loss on ignition shall not exceed 4.0 percent.

G. Bonding Agent (Adhesive): Epoxy-resin-base bonding system, Type II, complying with ASTM C 881. Grade and class as required by conditions of use.

H. Cement Grout: Portland cement and clean natural sand mixed at a ratio of 1.0 part cement to 3.0 parts sand, with only the minimum amount of water required for placement and hydration.

I. Dowels: ASTM A 36 steel bars 1/2 inch in diameter by 5 inches long, unless otherwise indicated on the Drawings.

2.02 PROPORTIONING OF CONCRETE MIXES

A. Compressive Strength: Minimum 4000 psi.

B. Weight: Normal.

C. Durability: Concrete shall be air-entrained. Design air content shall be 6 percent by volume, with an allowable tolerance of plus or minus 1.5 percent for total air content. Entrained air shall be provided by use of an approved air-entraining admixture. Air-entrained cement shall not be used.

D. Slump: Between 2 inches and 4 inches.

E. Admixtures: Do not use admixtures in concrete unless specified or approved in writing by the Director.

F. Selection of Proportions: Concrete proportions shall be established on the basis of previous field experience or laboratory trial batches, unless otherwise approved in writing by the Director. Proportion mix with a minimum cement content of 611 pounds per cubic yard for 4000 psi concrete.
   1. Optional Material: Fly ash may be substituted for (Portland) cement in normal weight concrete up to a maximum of 15 percent by weight of the required minimum (Portland) cement. If fly ash is incorporated in a concrete design mix, make necessary adjustments to the design mix to compensate for the use of fly ash as a partial replacement for (Portland) cement.

a. Adjustments shall include the required increase in air-entraining admixture to provide the specified air content.

2.03 FABRICATION OF ANCHOR BOLT ASSEMBLIES

A. Bolts: Diameter 1/8 inch less than the bolt holes in the equipment supports and length equal to the depth of the pad minus 1 inch plus the additional length required to provide full thread through nuts after shims, equipment, and washers are in place.

B. Sleeves: Diameter 1/2 inch larger than the bolt diameter and length as required to extend from the head of the bolt to the top of the pad.

C. Plates: 3 x 3 x 1/4 inch steel plate.

D. Weld a plate to the head end of a bolt. Center the bolt in a sleeve and tack-weld the sleeve to the plate.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Concrete materials, reinforcement, forms, and earth which will be in contact with fresh concrete shall be free from frost at the time of concrete placement.

3.02 BONDING TO EXISTING CONCRETE SLABS

A. Prior to placing concrete, thoroughly roughen and clean existing concrete slab. Saturate existing concrete surface with clean water. Immediately prior to depositing concrete for pad, apply a coat of cement grout over the existing damp concrete or allow existing concrete to dry and apply bonding agent (adhesive) over the existing concrete in accordance with manufacturer's printed instructions.

3.03 INSTALLING ANCHOR BOLTS AND SLEEVES

A. Install anchor bolts (with sleeves) for all bolt holes in equipment supports.

B. Accurately position and securely support anchor bolts and sleeves prior to placing concrete. Support head of bolt 1 inch above bottom of pad. Temporarily close open end of sleeves to prevent entry of concrete.

C. Grout anchor bolts in sleeves with cement grout or approved shrink-resistant grout after final positioning.

3.04 REINFORCING

A. Except where other reinforcement is shown on the Drawings, install welded wire fabric at mid-depth of each pad, extending to 1 inch from perimeter of pad.

3.05 FINISHES

A. Formed Surfaces: Provide a smooth form finish, with angled external corners, on all concrete surfaces exposed to view.

B. Unformed Surfaces: Provide a troweled finish on top surface of pads.

END OF SECTION

SECTION 230552

FLEXIBLE VIBRATION ELIMINATORS

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each type flexible vibration eliminator.

PART 2 PRODUCTS

2.01 METAL FLEXIBLE VIBRATION ELIMINATORS

A. Design for a working pressure of 125 psig, when used in systems operating at pressures up to 125 psig, and for higher working pressures to correspond with the pressure in the piping for pressures over 125 psig.
   1. Furnish end fittings to correspond to the end connections of the piping in which installed.

B. Stainless Steel Units: Fabricate of seamless flexible Type 321 steel tubing, with a stainless steel wire braided outer jacketing of the same material as the tubing, welded to steel end fittings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install eliminators plumb in vertical piping and horizontally true in horizontal runs.

B. Do not use eliminators to compensate for misalignment between equipment and piping.

END OF SECTION

SECTION 230553

PIPE AND VALVE IDENTIFICATION

PART 1 GENERAL

1.01 REFERENCES

A. ANSI A13.1 - Scheme for Identification of Piping Systems.

1.02 SUBMITTALS

A. Product Data: Catalog sheets, specifications and installation instructions for each item specified.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. W.H. Brady Co., Milwaukee, WI.

B. Emed Co., Buffalo, NY.

C. Panduit Corp., Tinley Park, IL.

D. Seton Nameplate Corp., New Haven, CT.

2.02 PIPE MARKERS AND ACCESSORIES

A. Snap-on Marker: One piece wrap around type constructed of precoiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, 3/4 inch adhesive strip on inside edge, and 360 degree visibility.

B. Strap-On Marker: Strip type constructed of precoiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, factory applied grommets, and pair of stainless steel spring fasteners.

C. Stick-On Marker: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating, and integral flow arrows for applications where flow arrow banding tape is not being used.

D. Pipe Marker Legend and Color Field Sizes:

OUTSIDE DIAMETER OF PIPE OR INSULATION (Inches)	LETTER SIZE (Inches)	LENGTH OF COLOR FIELD (Inches)
3/4 to 1-1/4	1/2	8

OUTSIDE DIAMETER OF PIPE OR INSULATION (Inches)	LETTER SIZE (Inches)	LENGTH OF COLOR FIELD (Inches)
1-1/2 to 2	3/4	8
2-1/2 to 6	1-1/4	12
8 to 10	2-1/2	24
Over 10	3-1/2	32

E. Banding Tapes: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating.
   1. Plain Tape: Unprinted type; color to match pipe marker background.
   2. Flow Arrow Tape: Printed type with integral flow arrows; color to match pipe marker background.

F. Pipe Size Labels: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating, vertical reading pipe size in inches, and legend size matching adjacent pipe marker.

2.03 PIPE SERVICE IDENTIFICATION TAGS

A. Type: No. 19 B & S gage brass, with 1/4 inch high pipe service abbreviated legend on one line, over 1/2 inch high pipe size legend in inches, both deep stamped and black filled; and 3/16 inch top hole for fastener.

B. Size: 2 inch square tag.

C. Fasteners: Brass "S" hook or brass jack chain of size as required for pipe to which tag is attached.

2.04 VALVE SERVICE IDENTIFICATION TAGS

A. Type: No. 19 B & S gage brass, with 1/4 inch high valve service abbreviated lettering on one line over 1/2 inch high valve service chart number, both deep stamped and black filled; and with 3/16 inch top hole for fastener.

B. Sizes:
   1. HVAC Use: 1-1/2 inch dia round.

C. Fasteners: Brass "S" hook or brass jack chain of size as required for valve stem or handle to which tag is attached.

2.05 VALVE SERVICE IDENTIFICATION CHART FRAMES

A. Type: Satin finished extruded aluminum frame with rigid clear plastic glazing, size to fit 8-1/2 x 11 inches valve chart.

PART 3 EXECUTION

3.01 PREPARATION

A. Complete testing, insulation and finish painting work prior to completing the Work of this Section.

B. Clean pipe surfaces with cleaning solvents prior to installing piping identification.

C. Remove dust from insulation surfaces with clean cloths prior to installing piping identification.

3.02 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Stick-On Pipe Markers:
   1. Install minimum of 2 markers at each specified location, 90 degrees apart on visible side of pipe.
   2. Encircle ends of pipe markers around pipe or insulation with banding tape with one inch lap. Use plain banding tape on markers with integral flow arrows, and flow arrow banding tape on markers without integral flow arrows.

C. Pipe Size Labels: Install labels adjacent to each pipe marker and upstream from flow arrow. Install a minimum of 2 pipe size labels at each specified location, 90 degrees apart on visible side of pipe.

D. Pipe Service Identification Tags: Attach tags to piping being identified with "S" hooks or jack chains.

3.03 PIPING IDENTIFICATION SCHEDULE

A. Piping Identification Types:
   1. Piping or Insulation under 3/4 inch od: Pipe identification tags.
   2. Piping or Insulation 3/4 inch to 5-7/8 inch od: Snap-on marker or stick-on marker.
   3. Piping or Insulation 6 inch od and Larger: Strap-on marker or stick-on marker.

B. Identify exposed piping, bare or insulated, as to content, size of pipe and direction of flow, with the following exceptions:
   1. Piping in finished spaces.

C. Locate piping identification to be visible from exposed points of observation.
   1. Locate piping identification at valve locations; at points where piping enters and leaves a partition, wall, floor or ceiling, and at intervals of 20 feet on straight runs.

2. Where 2 or more pipes run in parallel, place printed legend and other markers in same relative location.

D. Provide pipe markers on all piping installed under this contract. In addition to piping installed under this contract, provide pipe markers on all existing piping located within the boiler room.

3.04 VALVE IDENTIFICATION SCHEDULE

A. Valve Service Identification Tags:
1. Tag control valves, except valves at equipment, with a brass tag fastened to the valve handle or stem, marked to indicate service and numbered in sequence.

B. Valve Service Identification Charts:
1. Provide 2 framed valve charts for each piping system specified to be provided with valve identification tags. Type charts on 8-1/2 x 11 inches heavy white bond paper, indicating valve number, service and location.
2. Hang framed charts at locations as directed.

C. Provide valve tags on all valves installed under this contract. In addition to valves installed under this contract, provide valve tags on all existing valves located within the boiler room. Include the existing valves located within boiler room on the valve identification chart.

END OF SECTION

SECTION 230554

DUCT AND EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Mechanical Painting: Section 099103.

1.02 DELIVERY, STORAGE AND HANDLING

A. Deliver paint to the Site in original, new unopened containers, bearing manufacturers' printed labels.

B. Store materials at the site where directed. Keep storage space clean and accessible to the Director's Representative at all times.

PART 2 PRODUCTS

2.01 MATERIALS

A. Paint: Type IAL-3 specified in Section 099103.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection: Cover and protect surfaces to be painted, adjacent surfaces not to be painted, and removed furnishings and equipment from existing paint removals, airborne sanding particles, cleaning fluids and paint spills using suitable drop cloths, barriers and other protective devices.

1. Schedule and coordinate surface preparations so as not to interfere with work of other trades or allow airborne sanding dust particle to fall on freshly painted surfaces. Do not perform the Work of this Section until testing, insulation and finish painting Work have been completed.
2. Provide adequate natural or mechanical ventilation to allow surfaces to be prepared and painted in accordance with product manufacturer's instructions and applicable regulations.
3. Provide and maintain "Wet Paint" signs, temporary barriers and other protective devices necessary to protect prepared and freshly painted surfaces from damages until Work has been accepted.

B. Clean and prepare surfaces to be painted in accordance with specifications, paint manufacturer's approved product data sheets and printed label instructions. In the event of conflicting instructions or directions, the more stringent requirements shall apply.

1. Cleaners: Use only approved products manufactured or recommended by finish paint manufacturer. Unless otherwise recommended by cleaner manufacturer, thoroughly rinse with clean water to remove surface contaminants and cleaner residue.

3.02 DUCT IDENTIFICATION

A. Identify exposed ductwork, bare or insulated, directly connected to air handling apparatus, in the following all spaces, by means of painted stenciled legends.

B. Locate stenciled legends to be readily visible from any point of observation. Stencil identification along center line of duct, close to equipment. Where view is unobstructed from two directions, apply two sets of stenciling (both sides), visible from each direction.

C. Letter Size: 1-1/2 inches in height.

D. Samples of Ductwork Identification:
   1. Combustion Air Supply.

E. Colors: Paint stenciled letters black. Where the background color is dark, paint background white before stenciling.

3.03 EQUIPMENT IDENTIFICATION

A. Identify mechanical equipment, bare or insulated, installed in all spaces, by means of painted stenciled legends.

B. Paint stenciled legends black, a minimum of 1-1/2 inches in height, located to be readily visible from a reasonable point of view. Place identification along center line of equipment, if possible.

C. Samples of Equipment Identification:
   1. Boiler B 1.
   2. Water Heater WH 1.
   3. Expansion Tank ET 1.
   4. Air Separator AS 1.

3.04 APPLICATION OF PAINT

A. Stencil Painting: Apply with a brush or aerosol type spray can.

3.05 CLEANING

A. Clean adjacent surfaces of paint spatters resulting from the Work of this Section.

END OF SECTION

SECTION 230593

CLEANING AND TESTING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Balancing of Systems: Section 230594.

1.02 SUBMITTALS

A. Quality Control Submittals
   1. Test Reports (Field Tests):
      a. Propylene Glycol System Test: Submit test results in a format acceptable to the Director's Representative.
      b. Submit data for each system tested, and/or disinfected; include date performed, description, and test results for each system.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.
   2. Perform field testing of piping systems in complete accordance with the local utilities and other agencies having jurisdiction and as specified.

1.04 PROJECT CONDITIONS

A. Protection: During test Work, protect controls, gages and accessories which are not designed to withstand test pressures. Do not utilize permanently installed gages for field testing of systems.

1.05 SEQUENCING AND SCHEDULING

A. Transmit written notification of proposed date and time of operational tests to the Director's Representative at least 5 days in advance of such tests.

B. Perform cleaning and testing Work in the presence of the Director's Representative.

C. Pressure test piping systems inside buildings, at the roughing-in stage of installation, before piping is enclosed by construction Work, and at other times as directed. Perform test operations in sections as required and directed, to progress the Work in a satisfactory manner and not delay the general construction of the building. Valve or cap-off sections of piping to be tested, utilizing valves required to be installed in the permanent piping systems, or temporary valves or caps as required to perform the Work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Test Equipment and Instruments: Type and kind as required for the particular system under test.

B. Test Media (water): As specified for the particular piping or system under test.

C. Cleaning Agent (chemical solution): As specified for the particular piping, apparatus or system being cleaned.

D. Propylene Glycol: Permanent type anti-freeze solution as manufactured by Dow Chemical Co. or Union Carbide.
   1. Percentage of Propylene Glycol: 30 percent.

PART 3 EXECUTION

3.01 PRELIMINARY WORK

A. Thoroughly clean pipe and tubing prior to installation. During installation, prevent foreign matter from entering systems. Prevent if possible and remove stoppages or obstructions from piping and systems.

3.02 PRESSURE TESTING OF PIPING

A. Piping shall be tight under test and shall not show loss in pressure or visible leaks, during test operations or after the minimum duration of time as specified. Remove piping which is not tight under test; remake joints and repeat test until no leaks occur.

B. General:
   1. Pressure test piping systems inside buildings, at the roughing-in stage of installation, before piping is enclosed by construction Work, and at other times as directed.
   2. Perform test operations in sections as required and directed, to progress the Work in a satisfactory manner and not delay the general construction of the building.
   3. Valve or cap-off sections of piping to be tested, utilizing valves required to be installed in the permanent piping systems, or temporary valves or caps as required to perform the Work.
   4. Isolate existing piping from pressure testing.
   5. Pressure test only new piping unless otherwise specified or directed by Director's Representative.

C. Water Systems:
   1. Circulating water systems, including propylene glycol solution systems and cold water make-up piping connections to heating, ventilating, air conditioning and refrigeration systems, unless otherwise specified:

a. Before final connections are made perform hydrostatic test at 1-1/2 times the maximum working pressure, but not less than 125 psig, for 4 hours.
b. After final connections are made perform hydrostatic retest at a pressure equal to maximum operating system design pressure, but not less than 30 psig, for 4 hours.

3.03 TESTING OF EQUIPMENT, APPARATUS AND APPURTENANCES

A. Chillers: Perform hydrostatic test at pressure indicated by the approved manufacturer, after installation, with piping connections shut-off.

B. Relief Valves: Increase pressure in equipment or apparatus to relief valve setting, to test opening of valves at required relief pressures.

3.04 HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS - CLEANING AND OPERATIONAL TESTING

A. Circulating Chilled Water Systems in Buildings:
1. Cleaning:
a. Flush systems and apparatus, upon completion of pressure test(s).
b. Completely open valves and flush each system with clean water, prior to chemical cleaning.
c. Repeatedly flush at short intervals until twice the system water capacity has been flushed through.
d. Chemically clean systems immediately following flushing operations.
e. Circulate a solution consisting of trisodium phosphate, in a proportion of one pound of chemical to every 50 gallons of water in the system.
f. Completely fill system with cleaning solution; vent as required, and place in operation, with automatic controls operating and valves fully open.
g. Allow system to reach design operating temperature or an operating temperature designated by the Director's Representative.
h. Circulate the solution through the system for a minimum of 4 consecutive hours; immediately drain system and flush with clean water until the pH at the farthest drain matches the clean water input.
i. Provide temporary pipe and /or hose required to drain system.
j. Keep strainers unplugged during cleaning operations. Remove and clean strainer screens prior to operational test.
k. Refill system with clean water and correct pH to 7.
l. Do not flush steam piping thru steam coils. Provide temporary steam supply and condensate piping to bypass steam coils.
m. Upon completion of flushing, remove temporary piping and reconnect steam coil.
2. Operational Test:

a. Run system in an automatic mode for a minimum of 120 consecutive hours.
b. During this time, make final adjustments, including the setting of the balancing valves.

B. Propylene Glycol Systems:
1. Clean as specified for circulating water systems.
2. Perform operational test as specified for circulating water systems with propylene glycol solution in system.

END OF SECTION

SECTION 230594

BALANCING OF SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Systems Cleaning, Pressure and Operational Testing: Section 230593.

1.02 SUBMITTALS

A. Quality Control Submittals:
   1. Testing, Adjustment and Balancing Reports:
      a. Hydronic Systems: Submit results to the Director's Representative.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Provide the services of a certified independent agency for the testing, adjustment and balancing of all air distribution and hydronic distribution systems complete with all connected apparatus and equipment. The agency shall be certified by the Associated Air Balance Council Bureau - AABC, Los Angeles, Cal. 90026 or by National Environmental Balancing Bureau - NEBB, Arlington, Va. 22209.
   2. The Work shall be performed by skilled mechanical technicians under the direct supervision of certified personnel in the employ of the independent agency. The supervisor shall be personally certified by the national council or bureau, as approved by the Director.

1.04 SEQUENCING AND SCHEDULING

A. Scheduling:
   1. Perform environmental systems testing and balancing after cleaning, miscellaneous testing, adjustment and operational testing Work has been completed.
   2. Test and balance system during a period of time when outside temperature conditions will impose a significant load on the system; i.e., summer months for air conditioning system. Balance and adjust systems accordingly.
   3. Send written notification to the Director a minimum of five days prior to the performance of testing and balancing Work. Perform testing and balancing Work in the presence of the Director's Representative.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. General Information: Test instruments are included in this specification for information only. Balancing of air and hydronic systems shall be performed by qualified personnel utilizing company owned test instruments, which will remain the property of the company. Use test instruments which are in first class operating condition, with individual calibration histories to guarantee their accuracy. Test instruments shall be of type and kind as required by the type of system installed. Trade names and manufacturer's names are mentioned in this section for descriptive purposes only; instruments of equivalent range and capabilities may be utilized.

B. Hydronic Balancing Instruments:
1. Calibrated Test Gages: Ranges 0 to 30 lbs., 0 to 60 lbs., 0 to 200 lbs.
2. Calibrated Test Gages (Compound Type): Ranges from -30 inches to 30 lbs. and -30 inches to 60 lbs.
3. U Tube Manometer: 36 inches.

C. Hydronic Systems Balancing Instruments:
1. Thermometers: 12 inches mercury column type and dial type, with a range of -40 to +120 degrees F. and 0 to 220 degrees F. Total of four thermometers.
2. Universal Hand Tachometer: Herman H. Sticht Type UH.
3. Stop Watch.
4. Stroboscope.
5. Contact Pyrometer: Thermocouple type.
6. Volt-Ohm-Ammeter Test Kit, High Current Type: Sperry "Ohmprobe".
7. Volt-Ammeter: With leads for connecting to lugs.

PART 3 EXECUTION

3.01 PRELIMINARY WORK

A. Circulating Water/Glycol Systems: Prior to balancing the system, bleed all air vents so as to completely flood the system; check pumps for proper rotation; clean strainers and set balancing and system stop valves in the full-open position.

3.02 BALANCING OF CIRCULATING WATER/GLYCOL SYSTEM

A. Equipment Schedules and Report Sheets: Prepare itemized equipment schedules, listing all cooling elements and equipment in the system to be balanced. List in order on equipment schedules, by pump or zone according to the design, all cooling elements and all zone balancing valves or balancing devices. Break down schedules into zones to circuits, starting from the zone or circuit pump and terminating with the last item of equipment or transfer element in the respective zone or circuit. Include on schedule sheets, column titles listing the location, type of element or apparatus, design conditions and water balance readings. Prepare individual pump report sheets for each individual system or zone pump.

B. Balancing:

1. Place system in full automatic operation, with automatic controls set in accordance with design conditions, and allow water to reach design temperature.
2. Test pumps and balance flow. Record the following on pump report sheets:
   a. Suction and discharge pressure.
   b. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
   c. Pressure drop across pump in feet of water and total gpm pump is handling under full flow conditions.
3. Set zone or circuit balancing valve at each pump, to handle the design GPM.
4. When the design incorporates the use of air handling units containing coils, check and adjust each unit to insure the proper volume of air is passing through the coils, while the balancing procedure is in progress.
5. Check pumps for flow, after the system has been balanced.
6. Record test readings, calculations and results.

3.03 FIELD QUALITY CONTROL

A. Inspection: Prior to the environmental testing and balancing of hydronic distribution systems, the certified supervisor in the employ of the testing and balancing agency shall inspect the installations and notify the Director's Representative of any Work which must be performed or modified prior to initiating testing and balancing procedures.

B. Performance: Test and balance environmental hydronic and air distribution systems, including all connected equipment and apparatus, so as to conform to the design conditions. Perform the Work of this section in accordance with the published standards of the balancing council or bureau, which is certifying the member firm. Record all test readings, calculations and results.

END OF SECTION

SECTION 230719

INSULATION

PART 1 GENERAL

1.01 ABBREVIATIONS

A. FS: Federal Specification.

B. K: Thermal Conductivity, i.e., maximum Btu per inch thickness per hour per square foot.

C. pcf: Pounds per cubic foot.

D. PVC: Polyvinylchloride.

1.02 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog sheets, specifications and installation instructions for insulation materials and jacket materials.
   2. Materials Schedule: Itemize insulation materials and thicknesses for each specified application in Insulation Material Schedules in Part 3 of this Section. Where optional materials are specified, indicate option selected.

B. Quality Control Submittals:
   1. Installers Qualification Data:
      a. Name of each person who will be performing the Work, and their employer's name, business address and telephone number.
      b. Furnish names and addresses of the required number of similar projects that each person has worked on which meet the qualifications.

1.03 QUALITY ASSURANCE

A. Qualifications: The persons installing the Work of this Section and their Supervisor shall be personally experienced in mechanical insulation work and shall have been regularly employed by a company installing mechanical insulation for a minimum of 5 years.

B. Regulatory Requirements:
   1. Insulation installed inside buildings, including duct lining materials, laminated jackets, mastics, sealants and adhesives shall have a Fire Spread/Smoke Developed Rating of 25/50 or less based on ASTM E 84.

PART 2 PRODUCTS

2.01 INSULATION

A. Fibrous Glass (Mineral Fiber) Insulation: Composed principally of fibers manufactured from rock, slag, or glass, with or without binders, and asbestos free.
   1. Preformed Pipe Insulation: Minimum density 3 pcf; ASTM C 547:
      a. Class 1 (Suitable for Temperatures Up to 450 degrees F): K of 0.26 at 75 degrees F.
      b. Class 2 (Suitable for Temperatures 451 to 650 degrees F): K of 0.46 at 300 degrees F.
      c. Class 3 (Suitable for Temperatures 651 to 1200 degrees F): K of 0.56 at 300 degrees F.
   2. Premolded Fitting Insulation: Minimum density 4.0 pcf, K of 0.26 at 75 degrees F; ASTM C 547, Class 1.
   3. Insulation Inserts for PVC Fitting Jackets: Minimum density 1.5 pcf, K of 0.28 at 75 degrees F; ASTM C 553, Type III.
      a. Suitable for temperatures up to 450 degrees F.
   4. Block or Board Insulation: Minimum density 3.0 pcf and 6.0 pcf as specified; ASTM C 612:
      a. Type IA or IB (Suitable for Temperatures Up to 450 degrees F): K of 0.26 at 75 degrees F.
      b. Type II (Suitable for Temperatures 451 to 850 degrees F): K of 0.44 at 300 degrees F.
      c. Type III (Suitable for Temperatures 851 to 1000 degrees F): K of 0.44 at 300 degrees F.
      d. Type IV (Suitable for Temperatures 1001 to 1200 degrees F): K of 0.37 at 300 degrees F.
      e. Type V (Suitable for Temperatures 1201 to 1800 degrees F): K of 0.42 at 300 degrees F.

B. Flexible Elastomeric Foam Insulation:
   1. FM tested and approved, meeting the following:
      a. Maximum Water Vapor Transmission: 0.10 perm - inch based on ASTM E 96, Procedure A.
      b. K of 0.27 at 75 degrees F based on ASTM C 518 or C 177.
      c. Fire Spread/Smoke Developed Rating: 25/50 or less based on ASTM E 84.
   2. Pipe Insulation: ASTM C 534, Type I.
   3. Polyethylene and polyolefin insulation is not acceptable.

C. High Density Jacketed Insulation Inserts for Hangers and Supports:
   1. For Use with Fibrous Glass Insulation:
      a. Cold Service Piping:
         1) Polyurethane Foam: Minimum density 4 pcf, K of 0.13 at 75 degrees F, minimum compressive strength of 125 psi.
   2. For Use with Flexible Elastomeric Foam Insulation:
      a. Piping: Hardwood dowels and blocks, length or thickness equal to insulation thickness, other dimensions as specified or required.

D. Cements:

1. Fibrous Glass Thermal Insulating Cement: Asbestos free; ASTM C 195.
2. Fibrous Glass Hydraulic Setting Thermal Insulating and Finishing Cement: ASTM C 449/C 449M.

2.02 JACKETS

A. Laminated Vapor Barrier Jackets for Piping: Factory applied by insulation manufacturer, conforming to ASTM C 1136, Types I and II.
   1. Type I: Reinforced white kraft and aluminum foil laminate with kraft facing out.
      a. Pipe Jackets: Furnished with integral 1-1/2 inch self sealing longitudinal lap, and separate 3 inch wide adhesive backed butt strips.
   2. Type II: Reinforced aluminum foil and kraft laminate with foil facing out.

B. Premolded PVC Piping and Fitting Jackets:
   1. Constructed of high impact, UV resistant PVC.
      a. ASTM D 1784, Class 14253-C.
      b. Working Temperature: 0-150 degrees F.

C. Metal Jacketing:
   1. Aluminum: ASTM B 209, Alloys 1100, 30003, 3105 or 5005, Temper H14, 0.016 inch thick.
      a. Factory Pre-formed Sectional Pipe Jacketing:
         1) Smooth outer finish with integral bonded laminated polyethylene film - kraft paper moisture barrier underside.
         2) Pittsburg or modified Pittsburg longitudinal lock seams.
         3) 2 inch overlapping circumferential joints with integral locking clips, or butt joints sealed with 2 inch wide mastic backed aluminum snap bands.
      b. Fastening Devices:
         1) Strapping: Type 18-8 stainless steel, 0.020 inch thick, 1/2 and 3/4 inch wide as specified.
         2) Wing Seals: Type 18-8 stainless steel, 0.032 inch thick.
         3) Sheet Metal Screws: Panhead, Type A, hardened aluminum, and stainless steel.

2.03 ADHESIVES, MASTICS, AND SEALERS

A. Lagging Adhesive (Canvas Jackets): Childers' CP-50AMV1, Epolux's Cadalag 336, Foster's 30-36.

B. Vapor Lap Seal Adhesive (Fibrous Glass Insulation): Childers' CP-82, Epolux's Cadoprene 400, Foster's 85-60 or 85-20.

C. Vapor Barrier Mastic (Fibrous Glass Insulation): Permeance shall be .03 perms or less at 45 mils dry per ASTM E 96. Childers' CP-34, Epolux's Cadalar 670, Foster's 30-65 .

D. Adhesive (Flexible Elastomeric Foam): Armstrong's 520, Childers' CP-82, Epolux's Cadoprene 488, Foster's 85-75. 5 gallon cans only.

E. Adhesive (Fiberglass duct liner): Childers' Chil Quik CP-127, Foster Vapor Fas 85-60. Must comply with ASTM C 916, Type II

F. Weather Barrier Breather Mastic (Reinforcing Membrane): Childers' VI-CRYL CP-10/11, Foster's Weatherite 46-50.

G. Sealant (Metal Pipe Jacket): Non hardening elastomeric sealants. Foster Elastolar 95-44, Childers Chil Byl CP-76, Pittsburgh Corning 727.

H. Reinforcing Membrane: Childers' Chil Glas #10, Foster Mast a Fab, Pittsburgh Corning PC 79

2.04 MISCELLANEOUS MATERIALS

A. Pressure Sensitive Tape for Sealing Laminated Jackets:
   1. Acceptable Manufacturers: Alpha Associates, Ideal Tape, Morgan Adhesive.
   2. Type: Same construction as jacket.

B. Wire, Bands, and Wire Mesh:
   1. Binding and Lacing Wire: Nickel copper alloy or copper clad steel, gage as specified.
   2. Bands: Galvanized steel, 1/2 inch wide x 0.015 inch thick, with 0.032 inch thick galvanized wing seals.
   3. Wire Mesh: Woven 20 gage steel wire with 1 inch hexagonal openings, galvanized after weaving.

2.05 INSULATED BOX COVERS FOR PUMPS

A. Insulated Pump Box Covers for Pumps:
   1. Insulated pump box covers consisting of a minimum of 2" thick flexible EPDM insulation molded to the pump, enclosed by an aluminum riveted, ridged shell to maintain box shape, strength and durability. Seal all joints with EPDM adhesive and mastic. Insulated Pump Box Covers shall be two halves tightly latched together with latch style buckles for ease of removal for pump maintenance. Pump box shall fully enclose pump housing and support base where the pump is supported by a pump base. Pump motor shall not be enclosed by pump box. Extend exposed rubber beyond metal for a tight seal against pipe insulation. Basis of Design: KIM Industries Pump Box.

PART 3 EXECUTION

3.01 PREPARATION

A. Perform the following before starting insulation Work:
   1. Install hangers, supports and appurtenances in their permanent locations.

2. Complete testing of piping, ductwork, and equipment.
3. Clean and dry surfaces to be insulated.

3.02 INSTALLATION, GENERAL

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions unless otherwise specified.

B. Piping Insulation: Provide continuous insulation and jacketing when passing thru interior wall, floor, and ceiling construction.
   1. At Through Penetration Firestops: Coordinate insulation densities with the requirements of approved firestop system being installed. See Section 078400.
      a. Insulation densities required by approved firestop system may vary with the densities specified in this Section. When this occurs use the higher density insulation.

C. Do not intermix different insulation materials on individual runs of piping.

3.03 INSTALLATION AT HANGERS AND SUPPORTS

A. Reset and realign hangers and supports if they are displaced while installing insulation.

B. Install high density jacketed insulation inserts at hangers and supports for insulated ductwork, piping, and equipment.

C. Insulation Inserts For Use with Fibrous Glass Insulation:
   1. Piping: Where clevis hangers are used, install insulation shields and high density jacketed insulation inserts between shield and pipe.
      a. Where insulation is subject to compression at points over 180 degrees apart, e.g. riser clamps, U-bolts, trapezes, etc.; fully encircle pipe with 2 protection shields and 2 high density jacketed fibrous glass insulation inserts within supporting members.
         1) Exception: Locations where pipe covering protection saddles are specified for hot service piping, 6 inch and larger.

D. Insulation Inserts For Use with Flexible Elastomeric Foam Insulation:
   1. Piping:
      a. Where clevis hangers are used, install insulation shields with hardwood filler pieces, same thickness as adjoining insulation, inserted in undersized die cut or slotted holes in insulation at support points.
      b. Contour hardwood blocks to match the curvature of pipe, and shield.
      c. Coat dowels and blocks with insulation adhesive, and insert while still wet.
      d. Vapor seal outer surfaces of dowels and blocks with adhesive after insertion.

e. Install filler pieces as follows:

PIPE/TUBING SIZE	FILLER PIECES	POSITION
Thru 1-1/2"	2 dowel plugs	6 o'clock; in tandem
2" thru 4"	1 block 2 dowel plugs	6 o'clock, and 4 & 8 o'clock respectively
6" thru 8"	2 blocks 4 dowel plugs	6 o'clock; in tandem and 4 & 8 o'clock; in tandem

3.04 INSTALLATION OF FIBROUS GLASS COLD SERVICE INSULATION

A. Install insulation materials with a field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket, unless otherwise specified.

B. Piping:
1. Butt insulation joints together, continuously seal minimum 1-1/2 inch wide self sealing longitudinal jacket laps and 3 inch wide butt adhesive backed strips.
   a. Substitution: 3 inch wide pressure sensitive sealing tape, of same material as jacket, may be used in lieu of butt strips.
2. Bed insulation in a 2 inch wide band of vapor barrier mastic, and vapor seal exposed ends of insulation with vapor barrier mastic at each butt joint between pipe insulation and equipment, fittings or flanges at the following intervals:
   a. Horizontal Pipe Runs: 21 ft.
   b. Vertical Pipe Runs: 9 ft.

C. Fittings, Valves, Flanges and Irregular Surfaces:
1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as pipe insulation.
2. Secure insulation in place with 16 gage wire, with ends twisted and turned down into insulation.
3. Butt insulation against pipe insulation and bond with joint sealer.
4. Insulate valves up to and including bonnets, without interfering with packing nuts.
5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
6. When insulating cement has dried, seal fitting, valve and flange insulation, by imbedding a layer of reinforcing membrane or 4 oz. canvas jacket between 2 flood coats of vapor barrier mastic, each 1/8 inch thick wet.
7. Lap reinforcing membrane or canvas on itself and adjoining pipe insulation at least 2 inches.
8. Trowel, brush or rubber glove outside coat over entire insulated surface.
9. Exceptions:
   a. In Mechanical Equipment Rooms, Steam Service Rooms, Machine Rooms, Boiler Rooms, Penthouses, Finished Rooms and Finished Spaces: Cover fittings, valves and flanges insulated with fibrous glass with an additional 6 oz canvas

jacket, lapped on adjoining insulation and pasted with lagging adhesive.

b. Type C and D Piping Systems: Valves, fittings and flanges may be insulated with premolded PVC fitting jackets, with fibrous glass insulation inserts.

1) Additional insulation inserts are required for services with operating temperatures under 45 degrees F or where insulation thickness exceeds 1-1/2 inches. The surface temperature of PVC fitting jacket must not go below 45 degrees F.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC FOAM INSULATION

A. Where possible, slip insulation over the pipe, and seal butt joints with adhesive.
   1. Where the slip-on technique is not possible, slit the insulation and install.
   2. Re-seal with adhesive, making sure the mating surfaces are completely joined.

B. Insulate fittings and valves with miter cut sections. Use templates provided by the manufacturer, and assemble the cut sections in accordance with the manufacturer's printed instructions.
   1. Insulate threaded fittings and valves with sleeved fitting covers. Over lap and seal the covers to the adjoining pipe insulation with adhesive.

C. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier of the system.

D. Insulated Covers for Pumps:
   1. Do not extend pump insulation beyond or interfere with stuffing boxes, or interfere with adjustment and servicing of parts requiring regular maintenance or operating attention.

E. Piping Exposed Exterior to a Building, Totally Exposed to the Elements:
   1. Apply flexible elastomeric foam insulation to piping with adhesive.
   2. Apply reinforcing membrane around piping insulation with adhesive or mastic.
   3. Adhesive Applied System: Apply 2 coats of finish. See Section 099103.
   4. Mastic Applied System: Apply another coat of mastic over reinforcing membrane.
   5. Provide sheet metal jacketing on exterior of insulation.

3.06 INSTALLATION OF SHEET METAL JACKETING ON PIPING

A. Secure jacketing to insulated piping with preformed aluminum snap straps and stainless steel strapping installed with special banding wrench.

B. Jacket exposed insulated fittings, valves and flanges with mitred sections of aluminum jacketing.
   1. Seal joints with sealant and secure with preformed aluminum bands.

2. Substitution: Factory fabricated, preformed, sectional aluminum fitting covers may be used in lieu of mitred sections of aluminum jacketing for covering fittings, valves and flanges.

3.07 FIELD QUALITY CONTROL

A. Field Samples: The Director's Representative, may at their discretion, take field samples of installed insulation for the purpose of checking materials and application. Reinsulate sample cut areas.

3.08 PIPING AND EQUIPMENT INSULATION SCHEDULE

A. Insulate all cold service piping, equipment, and appurtenances except where otherwise specified.

B. Schedule of Items Not to be Insulated:
1. Do not insulate the following cold service items:
   a. Actual heat transfer surfaces.
2. Do not insulate items installed under other Contracts.
3. Do not insulate mechanical equipment with a factory applied insulated steel jacket.

3.09 COLD SERVICE INSULATION MATERIAL SCHEDULE

TYPE	SERVICE AND TEMPERATURES	INSULATION MATERIAL	JACKET MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
C	Chilled Water and other fluids (except make-up water) 40 F to 80 F.	Interior: Fibrous Glass Exterior: Flex Elastomeric Foam	Interior: PVC Exterior: Aluminum	Interior 1-1/2 & less Interior Over 1-1/2 Exterior Over 1-1/2	1 1-1/2 2
D	Domestic cold water, and as specified. 33 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	Interior: PVC	All Sizes	1/2

A. **NOTES:**
1. Equipment Insulation: Insulation thicknesses above also apply for flat, curved and irregular equipment surfaces.
   a. Insulate equipment with fibrous glass board insulation with minimum density 6 pcf.

b. Insulate base mounted and unitary type pumps and other equipment specified, installed in chilled water systems, with 3/4 inch thick sheet flexible elastomeric foam.

c. Exceptions: Minimum insulation thickness for Type A service shall be a minimum of 1 inch thick for flat, curved and equipment irregular surfaces.

2. Type D Insulation Materials: In addition to the services shown on the schedule above, use Type D materials and thicknesses for the following:

a. Condensate Drain Piping:

1) Piping connected to drain pans under cooling coils within unit enclosure, except where over drain pans.

2) Horizontal condensate drain piping outside unit enclosures.

3) Vertical condensate drain piping of less than one story immediately following horizontal run.

3.10 SCHEDULE OF METAL JACKETING FOR INSULATED PIPE

A. General:

1. Jacket exposed insulated interior piping with preformed sectional PVC pipe jacketing.

B. Piping Exterior to Building: Jacket insulated piping with aluminum jacketing.

1. Lap longitudinal and circumferential joints a minimum of 2 inches.
2. Secure jacketing in place with 1/2 inch x 0.020 inch thick aluminum bands secured with aluminum wing type seals, on maximum 12 inch centers.
3. Cover insulated fittings, valves, and offsets with mitered sections of jacketing. Seal joints with metal pipe jacket sealant, and secure with aluminum strapping and wing seals.
4. Factory fabricated, preformed fitting covers of same material as jacketing may be used instead of mitered jacketing.
5. Install jacketing so as to avoid trapping condensation and precipitation.

END OF SECTION

SECTION 230924

MODIFICATIONS TO DIRECT DIGITAL BUILDING CONTROL SYSTEM

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Basic Electrical Materials and Methods for Direct Digital Building Control System: Section 260502.

1.02 DESCRIPTION OF EXISTING SYSTEM

A. The existing system is a Honeywell International Inc. ComfortPoint Open.
   1. Honeywell Contact:
      a. Victor Ayoola, (718) 374-1862, Victor.Ayoola@Honeywell.com

1.03 MODIFICATIONS TO EXISTING SYSTEM

A. Building 144 Removals Work: Remove controls, devices, wiring associated with the chillers and distribution pumps. Remove control panels unless they are to be re-used.

B. Building 144 Work: Integrate the Chiller Plant into the existing DDC system including: (2) chillers, (2) pumps, (1) flow meter, associated sensors/devices and ancillary modified/provided equipment indicated on the drawings. Update the graphics screen accordingly.

C. Direct Digital Building Control System (Building Automation System - BAS): The existing control system shall be modified to provide automatic operation of the chiller plant to maintain stable temperature control of the chilled glycol-water solution supplied to the building. Control system modifications shall integrate into the existing Honeywell control system. The intent is to add to the existing controls system information, graphics screens and settings available to system operators; upgrade but do not remove existing features.

   1. Provide the services of the existing facility Honeywell authorized service technician to integrate the control work provided by the contractor into the existing facility control system. The contractor shall be responsible for providing a head-end controller capable of being programmed to operate the chiller plant on a standalone basis, and with the capability to tie into and communicate with the existing facility control system. The facility Honeywell authorized service technician, hired by the HVAC contractor, shall be responsible for control panel wire terminations at existing control panels as require for system devices, control system integration, existing BMS system programming changes including creating/updating graphic screens to support the new sequences of operations, commissioning of controls provided in this project, and refresher training secession for controls provided in this project.

1.04 OVERVIEW

A. All controls components, devices, digital controllers, sensors, actuators, hardware, software, programming, graphics, wiring and conduit installed in this contract, specified in this section and shown on drawings shall integrate seamlessly to the existing building automation system.

B. The contractor shall deliver a predominately wired, networked, distributed control system including all labor, controls components, controls equipment, transformers and services as required to tie the provided equipment and associated controls into the existing Honeywell Building Automation System (BAS), to perform the functions described in this Section and as stated in the Sequence of Operations on the drawings.

C. It is the BAS manufacturer's responsibility to provide all the design, engineering, field coordination, hardware and software required to ensure all equipment sequence of operations are met as specified, and the designated BAS operators have the capability of managing the building mechanical system.

1.05 SUBMITTALS

A. Waiver of Submittals: The "Waiver of Certain Submittal Requirements" in Section 013300 does not apply to this Section.

B. Submittals Package: Submit the shop drawings, product data, and quality control submittals specified below at the same time as a package.

C. Shop Drawings:
1. Composite wiring and/or schematic diagrams of the modifications as proposed to be installed (standard diagrams will not be acceptable).

D. Product Data:
1. Catalog sheets, specifications and installation instructions.
2. Bill of materials.
3. Detailed description of system operation.

E. Quality Control Submittals:
1. Company Field Advisor Data: Include:
   a. Name, business address and telephone number of Company Field Advisor secured for the required services.
   b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
   c. Services and each product for which authorization is given by the Company, listed specifically for this project.

F. Contract Closeout Submittals:
1. System acceptance test report.
2. Certificate: Affidavit, signed by the Company Field Advisor and notarized, certifying that the system meets the contract requirements and is operating properly.
3. Operation and Maintenance Data:
   a. Deliver 2 copies, covering the installed products, to the Director's Representative. Include:

1) Operation and maintenance data for each product.
2) Complete point to point wiring diagrams of entire system as installed. Number all conductors and show all terminations and splices. (Numbers shall correspond to markers installed on each conductor.)

1.06 QUALITY ASSURANCE

A. Company Field Advisor: Secure the services of a Company Field Advisor from the Company of the existing system for a minimum of 40 working hours for the following:
   1. Render advice and witness test of existing system.
   2. Render advice regarding modifications to the system.
   3. Assist in reprogramming of the system.
   4. Witness final system test and then certify with an affidavit that the modifications were installed in accordance with the contract documents and are operating properly.

1.07 OPERATORS WORKSTATION GRAPHICS

A. Graphic pages update: Update existing graphic pages to reflect all new systems, revisions, updated equipment arrangements, and point revisions listed in this section and as indicated on drawings.

1.08 MODBUS & BACNET SOFTWARE CONFIGURATION

A. Virtual Point Software Interface: Provide all work necessary to configure BAS software for interconnections to equipment with modbus and/or BACnet communications.
   1. Research all equipment interface addressing codes for input/ output points indicated, and as customarily provided, for listed equipment.
   2. All modbus & BACnet virtual points shall be completely operational at project completion.
   3. Where gateways or other interface communications equipment is provided with supplied equipment, coordinate with supply vendors to insure complete operation of all required communications links, prior to completion of work.
   4. If communications links are found to be non-functional, report problems to the Directors Representative.

B. 'Read' Virtual Points: Provide all work necessary to configure BAS software to 'read' designated virtual points via modbus and/or BACnet communications.
   1. Indicate virtual points on graphic display, with virtual identifications. Note some points will look like duplicated data points, provide detailed labels on graphic display.

C. 'Write' Virtual Points: Provide all work necessary to configure BAS software to 'write' designated virtual points via modbus and/or BACnet communications.
   1. 'Write' virtual points will usually be set point adjustments or mode change commands.

2. Password protection; provide password protection to allow users permission to change parameters via 'write' point. Coordinate password protections with the Directors Representative.

D. Coordination: Coordinate Virtual Point requirements with equipment suppliers associated with modbus and/or BACnet communications.
   1. Follow equipment suppliers recommendations for read write points beyond those indicated in input/ output points.

PART 2 PRODUCTS

2.01 CONTROL COMPONENTS

A. Existing Workstations: Upgrade existing workstation software with the manufacturers' latest software version that supports interoperability with devices provided with the system modifications. Establish alarm notification functions as previous to construction. Update existing graphics to show all equipment; configure updated displays to provide same data and settings as similar equipment prior to construction.

B. System Controller Expansion Module:
   1. Microprocessor based, with operating system (OS) and energy management system (EMS) programs, data file and control programs. This shall be an expansion of the existing system controller.
   2. No battery required. Include internal clock with minimum of 3 days of back-up power via capacitor. All programs are backed up by non-volatile memory.
   3. Minimum of 400 MB of FLASH memory and 256 MB SDRAM
   4. Supports BACnet communication Protocols. Provide gateway as necessary to communicate with equipment speaking other controls language.
   5. The module shall include accessory devices such as relay, power supplies, etc., and shall be factory mounted, wired and housed in a steel enclosure with a hinged door panel. Enclosure shall be powder coated finish, minimum size 20in x 24in x 6.5in.
   6. Module shall be equipped with LEDs for indication of power and operational status, status of each input and output, and diagnostic LED indicators.
   7. Integral RS-485 MS/TP communications.

C. Router and Gateways:
   1. Provide certified Router and/or Gateway devices which connect two or more physical BACnet compatible equipment as required.
   2. Routers or Gateways if required, shall be a microprocessor based communication device designed to provide seamless, two-way translation between two or more standard or non-standard network layer protocols.
   3. UL Listing: UL 916 required as a minimum.

D. Communications Software:

1. BACnet or Ethernet shall be used for communication between System Controller (SC), Expansion Modules, and between operator interfaces. Each system controller shall have a full master peer-to-peer communications module to support all global data sharing, hierarchical control, and global control strategies specified.

E. Data Communications

1. Operator's workstation and system controllers shall directly reside on the primary peer communication bus such that communications may be executed directly between workstation and SCs, and directly between SCs on a peer to peer basis, via ethernet cable, and routers as needed.
2. Protect communication lines against incorrect wiring, static transients and induced magnetic interference.
   a. Provide static, transient, and short circuit protection on all inputs and outputs.
   b. AC couple, or optically isolate bus connected devices so that any single device failure will not disrupt or halt bus communication.

F. Data and Control (D/C) Summary

1. Each analog point shall have unique SC resident dual high and dual low limit alarm thresholds set in engineering units. Where specified, floating (a band above and below a set point) alarm limits shall be provided.
2. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track its associated command output within a programmable time interval, a "command failed" alarm shall be reported.
3. Where calculated points (such as pressure) are shown, they shall appear in their respective logical groups. The respective unconditioned raw data (such as logarithmic differential pressure) points shall also be grouped into a special group for display and observation independent of the logical groups.

G. Miscellaneous Electric/Electronic and Mechanical Devices

1. Current Sensing Relays
   a. Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for the application. The setpoint of the contact operation shall be field adjustable.
2. Output Relays
   a. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contacts, enclosed in dustproof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.
3. Transformers: Provide all necessary 120V step down transformers and enclosures to power control panels, control components and steam valve actuators.

4. Hydronic Temperature Sensor:

a. Precision 1k ohm nickel may be used in temperature sensing applications below 200 degrees F, as identified on the project drawings or where allowed in this specification. Provide with thermowell, size necessary for the pipe being installed within.

b. Sensor accuracy over the application range shall be 0.36 degrees F or less between the range of 32 degrees F to 150 degrees F. Sensor manufacturer shall utilize 100 percent screening to verify accuracy. Stability error of the sensor over five years shall not exceed 0.25 degrees F cumulative.

c. Sensor element and leads shall be encapsulated. Bead thermistors shall not be allowed. A/D conversion resolution error shall be kept to 0.1 degrees F. Total error for a sensor circuit shall not exceed 0.5 degrees F, which includes sensor error and Control Unit A/D conversion resolution error.

d. Provide sensor and Control Unit manufacturer documentation including Contractor's engineering calculations, which support the proposed sensor input circuit will have a total error of 0.5 degrees F or less.

5. Hydronic Pressure Sensor and Differential Pressure Sensor:

a. Provide with pressure sensing element for insertion in insulated piping, provide flanges or sockets of the extension neck type to accommodate insulation thickness.

H. Chilled Water Control Valves:

1. Chiller Control Valve/Actuator:

a. 6" Globe Control Valve: ANSI 125, Cv of 344, globe valve, cast iron body, stainless steel stem, brass valve plug, EPDM stem seal, 316 stainless steel seat, ANSI Class III leakage rate, flanged ends. Valve actuator shall be on/off, 120V, spring return open. Provide 120-volt rated relay to control valve position. Provide with globe valve weathershield to allow for control valve outdoor installation (Belimo ZS-GV-002). Basis of Design: Belimo G6150C + AVKB120-3.

2. By-Pass Control Valve/Actuator:

a. 4" Globe Control Valve: ANSI 125, Cv of 170, globe valve, cast iron body, brass valve plug, EPDM stem seal, 316 stainless steel seat, ANSI Class III leakage rate, flanged ends. Valve actuator shall be modulating, 24V, spring return close. Utilize 4-20 mA control signal. Provide 24-volt step down transformer. Basis of Design: Belimo G6100C + AVKB24-MFT.

I. Digital Energy Meter:

1. Basis of Design: Siemens Model MD-BMED Energy Meter, with Siemens current transformer

2. Meter shall provide real-time enectric energy measurement:
   a. Voltage: 80 to 600V
   b. Choice of 3-phase or single phase from same unit
   c. Parameter update rate of 0.5 seconds
   d. Outputs: 2 pulse, configurable
   e. Waveform Sampling: 12kHz voltage and current
   f. UL listed Standard 61010-1, cUL certified to CAN/CSA Standard C22.2 No.61010-1 and CE Low Voltage and EMC Directives
   g. Testing: ANSI C12.20-2010
   h. Accuracy: ANSI C12.20-2010 Class 0.2. Where differences exist between the requirements of this Standard and C12.1 and C12.10, the requirements of this Standard shall prevail.
   i. Resolution: 0.01 Amp, 0.1 Volt, 0.01 watt, 0.01 VAR, 0.01 VA, 0.01 Power Factor depending on scalar setting
   j. Power types: Single Phase, Three Phase-Four Wire (WYE), Three Phase-Three Wire (Delta)
   k. 3 voltage channels: 80 to 346V AC Line-to-Neutral, 600V Line-to-Line, CAT III
   l. Maximum current input: 666 mVac (200% of current transducer rating)
   m. Measurement rating: True RMS using high-speed digital signal processing (DSP)
   n. Waveform sampling: 12 kHz voltage and current
3. Current Transformer
   a. Meters shall be provided with CTs as a system such that the CTs are tested and known to be compatible with the meter.
   b. All current transformers shall be internally shunted for intrinsically safe operation on energized conductors.
   c. Output: 333 mV at rated current
   d. Up to 5000A service
   e. The meter shall accept Rogowski type CTs - flexible rope type CTs to wrap around multiple conductors or bus bars.
   f. The meter shall have embedded Rogowski Coil CT amplifier/integrator circuitry, so there is no need to provide external power to the CTs.
   g. The meter shall accept mix and match split-core and Rogowski-style CT's on the same meter.
4. Power: Power for the meter shall be sourced from the metered lines.
   a. Meters powered from the metered lines are allowed to be mounted inside the power panel as long as the meter is rated for the maximum voltage of the panel.
   b. Separate low voltage power wires shall not be allowed inside of a high voltage (>240V) enclosure. Meters that require separate power supplies shall be mounted outside of the high switch panels with provisions to separate the metered lines and the meter power input wires.
   c. Provide 0.5A fuse protection on the power to the meter.
5. Installation:
   a. Provide a means for the installer to check that the wiring is correct without using the setup software or using the meter's

built-in setup configuration. The MD Model uses LEDs to let the installer know that the wiring is correct or not.

b. The meter shall automatically adjust for CT orientation-greatly reducing setup time and all but eliminating installation errors.

6. Communication:

a. Provide an RS-485 communication connection. The unit's default communication shall be BACnet MS/TP communication.

b. The Meter shall be BACnet Testing Labs (BTL) certified as a smart sensor (B-SS) device.

c. Baud rate: 78,500

d. The meter shall provide ¼ unit loads on the RS485 so that up to 127 meters may be connected to a single BACnet client for monitoring and recording power usage at multiple locations within a single site. Meters with ½ units loads shall be limited to 64 meters on a subnetwork.

e. Modbus shall be an option only if the manufacturer of the meter provides a BACnet gateway to translate to the BAS native communication protocol.

f. If Ethernet networking is an option on the meter, then the BACnet implementation shall be BACnet/IP. Modbus over Ethernet shall be an option only if the meter provides a BACnet gateway to translate to the BAS native communication protocol.

7. Diagnostics

a. Minimum Data Monitoring:

1) Total Net True Energy (kWh)
2) Instantaneous Total True Power (kW)
3) Peak Demand (adjustable window) (kW)
4) Maximum Instantaneous Power (kW)
5) Minimum Instantaneous Power (kW)
6) Total Net Reactive Energy (kVARh)
7) Total Reactive Power (kVAR)
8) Total Apparent Energy (kVAh)
9) Total Apparent Power (kVA)
10) System Displacement Power Factor (dPF)
11) System Apparent Power Factor (aPF)
12) Total Current in all phases (Amps)
13) Average Line-Line Voltage (Volts)
14) Average Line-Neutral Voltage (Volts)
15) Individual Phase-Phase Voltages
16) Line Frequency (Hz)
17) Individual Phases True Energy (kWh)
18) Individual Phases True Power (kW)
19) Individual Phases Reactive Energy (kVARh)
20) Individual Phases Apparent Energy (kVAh)
21) Individual Phases Reactive Power (kVAR)
22) Individual Phases Apparent Power (kVA)
23) Individual Phases Apparent Power Factor (aPF)
24) Individual Phases Displacement Power Factor (dPF)
25) Individual Phases Current (Amps)
26) Individual Phases Line to Neutral Voltages (Volts)
27) Individual Phases Line to Line Voltages (Volts)
28) Multiple Meters External Data Synchronization

8. Software
   a. Provide Windows compatible software with USB cable to configure the meter and integrate the data in the meter.

2.02 MARKERS AND NAMEPLATES

A. Markers: Premarked self-adhesive; W.H. Brady Co.'s B940, Thomas and Betts Co.'s E-Z Code WSL self-laminating, Ideal Industries' Mylar/Cloth wire markers, or Markwick Corp.'s permanent wire markers.

B. Nameplates: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.
   1. Phenolic: Two color laminated engraver's stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).
   2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.
   3. Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

2.03 WIRING

A. See Section 260502.

2.04 ACCESSORIES

A. Include accessories required for the modifications to perform the functions specified and indicated on the drawings.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Test of Existing System:
   1. Prior to modifying the system, test portions of the existing system to ascertain their operating condition. Specifically, test:
      a. Active points which will be modified.
      b. Primary operators station (POS) and distributed control processor (DCP) functions associated with the modifications.
   2. Prepare a written report for the Director's Representative indicating the repairs required, if any, to make the existing system function properly.
   3. Repairs to the existing system are not included in the Work unless requested by Order on Contract.

3.02 INTERRUPTIONS TO EXISTING SYSTEM

A. Maintain the existing system in its present condition to the extent possible while installing new Work.

B. Prior to making changes relative to the existing system, notify the Director's Representative and have procedures approved.

3.03 INSTALLATION

A. Install the Work in accordance with the Company's printed instructions unless otherwise indicated.

B. Reprogram the system to include new sensor and control points and update existing system program to include changes and additions requested by facility
   1. Obtain from the facility personnel through the Director's Representative, a list of desired system program changes, additions, etc.

C. Identification, Labeling, Marking:
   1. Identification of Circuits: Identify wires, cables, and tubing by system and function in interconnection cabinets, POSs and DCPs to which they connect with premarked, self-adhesive, wraparound type markers. Designations shall correspond with point to point wiring diagrams.

3.04 FIELD QUALITY CONTROL

A. Preliminary System Test:
   1. Preparation: Have the Company Field Advisor adjust the completed system and then operate it long enough to assure that it is performing properly.
   2. Run a preliminary test for the purpose of:
      a. Determining whether the system is in a suitable condition to conduct an acceptance test.
      b. Checking and adjusting equipment.

B. System Acceptance Test:
   1. Preparation: Notify the Director's Representative at least 3 working days prior to the test so arrangements can be made to have a Facility Representative witness the test.
   2. Make the following tests:
      a. Test system operational functions associated with the modifications.
      b. Test each monitor and control device connected or added under this project.
   3. Supply all equipment necessary for system adjustment and testing.
   4. Submit written report of test results signed by Company Field Advisor and the Director's Representative. Mount a copy of the written report in a plexiglas enclosed frame assembly adjacent to the POS.

3.05 POINT DESCRIPTION, PROGRAM LIST AND SEQUENCES

A. See Drawings.

END OF SECTION

SECTION 232000

HVAC PIPING

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data:
   1. Catalog sheets and specifications indicating manufacturer name, type, applicable reference standard, schedule, or class for specified pipe and fittings.
   2. Material Schedule: Itemize pipe and fitting materials for each specified application in Pipe and Fittings Schedule in Part 3 of this Section. Where optional materials are specified indicate option selected.

B. Submit an Environmental Product Declaration (EPD) from the manufacturer for steel within this specification section, if available. A statement of the contractor's good faith effort to obtain the EPD shall be provided if not available.
   1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

C. Quality Control Submittals:
   1. Installers Qualification Data:
      a. Welder Qualification Data: Copies of certification; include names, home addresses.
      b. Welding Procedures:
         1) Copy of QW-482 "Suggested Format for Welding Procedure Specification (WPS)" for all welders for all weld types.
         2) Copy of QW-483 "Suggested Format for Procedure Qualification Record (PQR)" as specified in Welding Quality Assurance below for all weld types.
      c. Welders' Certificates:
         1) Copy of QW-484 "Suggested Format for Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQ)" for all welders for all weld types.
   2. Quality Control Submittals (for Hydraulic Press Joints, if used): Copy of hydraulic press fitting manufacturer's printed field inspection procedures for hydraulic press joints in copper tubing.
   3. Welding Procedure Submittals: Submit the following:
      a. Welding Procedure Specifications: Provide for each weld type.
         1) Recommended to use ASME Form E00006, QW-482 "Suggested Format for Welding Procedure Specification (WPS)".
      b. Procedure Qualification Records: Provide for each weld type.

1) Recommended to use ASME Form E00007, QW-483 "Suggested Format for Procedure Qualification Record (PQR)".

4. Contract Closeout Submittals:
   a. Copy of Final Hydrostatic Testing Record Log.

1.02 QUALITY ASSURANCE

A. Qualifications of Welding Procedures, Welders and Welding Operators: Comply with the following:
   1. American Welding Society Standard AWS B 2.1.

B. Welding Procedures:
   1. Record in detail, and qualify the Welding Procedure Specifications for every welding procedure that is proposed to be used for the Project.
   2. Develop procedures for all metals included in the work.
   3. Qualify the procedures for making transition welds between different materials, or between plates or pipes of different wall thickness.
   4. Qualification for each welding procedure shall conform to the requirements of ASME B31.1, and as specified herein.
   5. Describe the method for each system including the number of beads, the volts, the amperes, and the welding rod for various pipe thicknesses and materials.
   6. The welding procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings.
   7. Preheat, interpass temperature control, and postheat treatment of welds shall be as required by approved welding procedures, unless otherwise indicated or specified.
   8. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds.
   9. Welding procedures shall be identified individually and shall be clearly referenced to the type of welding required for this project.
   10. These procedures shall be the same as those used for all pipe welder qualification tests, all shop welds, and all field welds.
   11. Provide procedure qualification records for all proposed Welding Procedure Specifications (WPS).

C. Welder Qualification:
   1. WPQs:
      a. Provide welder qualifications for each welder for each weld type.
      b. Recommended to use ASME Form E00008, QW-484 "Suggested Format for Manufacturer's Record of Welder or Welding Procedure Qualification Tests (WPQ)."
   2. Perform WPQs under the witness of an independent agency.
      a. The witness shall be a representative of an independent testing agency, Authorized Inspector, or consultant, any of which must be approved by the National Certified Pipe Welding Bureau.
      b. The qualifying test segment must be a 2 inch nominal pipe size with wall thickness within range of the WPS.
      c. Tests position shall be "6G" per ASME Section IX.
   3. Evidence of Continuity: Welder qualifications must be current.

a. If the qualification test is more than 6 months old, provide record of welding continuity for each welder.
b. Record of welding continuity shall show that the welder in question has performed welding to the procedure in question without a 6 month continuous span of inactivity since the date that the welder qualification test was passed for the submitted welding procedure.
c. Record of welding continuity shall include, at a minimum, the welder's employer name and address, the date the welder qualification test was passed, and the dates indicating welding continuity including welding procedure for each date.

D. Weld Records:
1. For all welding within the scope of ASME B31.1, submit for approval an administrative procedure for recording, locating, monitoring, and maintaining the quality of all welds to be performed on the project.
a. The weld record shall include but not be limited to drawings and schedules identifying location of each weld by individual number, identification of welder who performed each weld by individual welder's name, stamp number, date and WPS used.
2. After achieving qualification, but before being assigned work, each qualified person shall be assigned an identifying number by the Contractor to be used to identify all of their welds.
a. A list of qualified persons with their respective numbers shall be submitted and maintained accurately with deletions and additions reported promptly.
3. Upon completing a joint, the welder shall mark the pipe not more than 6 inches from the weld with the identifying number and the last two digits of the year in which the work was performed.
a. Make identification marks with a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Director's Representative that do not deform the metal.
b. Place identification marks for seam welds adjacent to the welds at 3-foot intervals.
c. Identification by die stamps or electric etchers is not acceptable.
d. Provide required markers. Substitution of a map of welds with welders' names is not acceptable.
4. Maintain a constantly updated log available to the Director's Representative at all times.

E. Piping, Fittings, etc installed within the make-up water system shall be NSF rated for use in potable water systems.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Pipe Storage:
1. Upon the receipt of each shipment of pipe on the job, maintain the pipe marking, and store pipe in accordance with ASTM material specifications, and method of manufacture (seamless, etc.) of each length of pipe.
2. Pipe markings shall be clearly readable at the time of pipe installation.

3. If at the time of its installation, any length of pipe not readily identifiable will be subject to rejection, or arbitrary downgrading by the Director's Representative to the lowest grade which has been received on the job to that date.
4. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, bell and-spigot, and clay pipe.
    a. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

PART 2 PRODUCTS

2.01 STEEL PIPE AND FITTINGS

A. Standard Weight Schedule 40 or Extra Heavy Weight Schedule 80, Black or Galvanized Steel: ASTM A 53, Grade B, Type E or S, or ASTM A 135.

B. Bending, Coiling, Flanging and Other Special Services: ASTM A 53, Grade A, Type E or S, or ASTM A 135.

C. Flanges, Welding Neck Type, Same Pressure Rating as Adjoining Pipe: ASME B16.5.

D. Weld Fittings, Carbon Steel:
1. Butt Welding Type: ASME B16.9.
    a. Allied Piping Products Co., Inc.'s Branchlets, Type 1 or 2.
    b. Bonney Forge Corp.'s Weldolets.
2. Socket Welding Type: ASME B16.11.
    a. Allied Piping Products Co., Inc.'s Branchlets, Type 1 or 2.
    b. Bonney Forge Corp.'s Thredolets or Sockolets.

E. Malleable Iron, Steam Pattern Threaded Fittings:
1. 150 lb Class: ASME B16.3.
2. 300 lb Class: ASME B16.3.

F. Cast Iron Fittings:
1. Drainage Pattern, Threaded: ASME B16.12.
2. Steam Pattern, Threaded: ASME B16.4.
    a. Standard Weight: Class 125.
3. Flanged Fittings and Threaded Flanges: ASME B16.1.
    a. Standard Weight: Class 125.

G. Unions: Malleable iron, 250 lb class, brass to iron or brass to brass seats.

H. Couplings: Same material and pressure rating as adjoining pipe, conforming to standards for fittings in such pipe. Use taper tapped threaded type in screwed pipe systems operating in excess of 15 psig.

I. Nipples: Same material and strength as adjoining pipe, except nipples having a length of less than one inch between threads shall be extra heavy.

2.02 COPPER AND BRASS PIPE, TUBING AND FITTINGS

A. Copper Tube, Types K, L and M: ASTM B 88. Piping to be used in make-up water system shall be NSF rated for use in potable water systems.

B. Wrot Copper Tube Fittings, Solder Joint: ASME B16.22. Fittings to be used in make-up water system shall be NSF rated for use in potable water systems.

C. Cast Copper Alloy Tube Fittings, Solder Joint: ASME B16.18. Fittings to be used in make-up water system shall be NSF rated for use in potable water systems.

D. Chrome Plated Grade A Red Brass Threaded Pipe, Standard Weight: ASTM B 43.
   1. Plating: 0.02 mil chromium over 0.2 mil nickel plating, high polish finish.

E. Chrome Plated Cast Brass Threaded Pipe Fittings, 125 lb Class: ASME B16.15.
   1. Plating: 0.02 mil chromium over 0.2 mil nickel plating, high polish finish.

F. Flanges: Conform to the Standards for fittings used in systems.
   1. Brazing Flanges: ASME B16.24, hubs modified for brazing ends.

G. Unions: Cast bronze, 150 lb Class, bronze to bronze seats, threaded or solder joint.

2.03 HYDRAULIC PRESS FITTINGS FOR COPPER TUBING

A. Acceptable Fittings:
   1. ProPress by Viega, 301 N. Main, Wichita, KS 67202, (877) 843-4262, www.viega.com.

B. Operating Conditions:
   1. Maximum Operating Pressure: 200 psi.
   2. Operating Temperature Range: 0-250 degrees F.
   3. Maximum Test Pressure: 600 psi.
   4. Maximum Vacuum: 29.2 inches hg @ 68 degrees F.

C. Features:
   1. Fittings: Copper and copper alloy conforming to material requirements of ASME B16.18 or ASME B16.22.
      a. Stainless Steel Grip Ring: Adds strength to the joint without collapsing the interior passageway.
   2. No flame for soldering required for installation of fittings and valves.
   3. Unpressed connections identified during pressure testing when water flows past sealing element.
   4. Sealing Elements: Factory installed, EPDM.
   5. Fittings that have been pressed can be rotated. If rotated more than 5 degrees, the fitting must be repressed to restore its resistance to rotational movement.

6. Extended fitting end lead allows for twice the retention grip surface, and assists with proper tube alignment.
7. Soldered adapter fittings are not allowed.
8. Shall be NSF rated for use in potable water system.

2.04 JOINING AND SEALANT MATERIALS

A. Thread Sealant:
1. LA-CO Industries', Slic-Tite Paste with Teflon.
2. Loctite Corp.'s No. 565 Thread Sealant.
3. Thread sealants for potable water (make-up water) shall be NSF approved.

B. Solder: Solid wire type conforming to the following:
1. Type 3: Lead-free tin-silver solder (ASTM B 32 Alloy Grade E, AC, or HB); Engelhard Corp.'s Silvabrite 100, Federated Fry Metals' Aqua Clean, or J.W. Harris Co. Inc.'s Stay-Safe Bridgit. NSF rated for potable water systems.

C. Soldering Flux for Soldered Joints: All-State Welding Products Inc.'s Duzall, Engelhard Corp.'s General Purpose Liquid or Paste, Federated Fry Metals' Water Flow 2000, or J.W. Harris Co. Inc.'s Stay-Clean.

D. Electrodes and Welding Rods:
1. Electrodes for Use in Arc Welding: Heavily coated, not larger than 3/16 inch diameter exclusive of coating, unless otherwise approved.
2. Welding Rods: Free flowing when fused, so as to avoid excessive puddling.
3. Electrodes for Welding Stainless Steels: Coated and used with reverse polarity.
4. Filler material shall conform to the appropriate AWS-ASTM specification.

E. Flange Gasket Material:
1. For Use With Cold Water or Chilled Water: 1/16 inch thick rubber.

F. Flange Bolts, Washers and Nuts
1. Bolts: High strength, ASTM A 193 B7.
2. Washers: ASTM F436 Structural Type 1 hardened steel flat hot dipped galvanized.
3. Nuts: ASTM A194 2H.

G. Anti-Seize Lubricant: Bostik Inc.'s Never Seez or Dow Corning Corp.'s Molykote 1000.

2.05 PACKING MATERIALS FOR BUILDING CONSTRUCTION PENETRATIONS

A. Oiled Oakum: Manufactured by Nupak of New Orleans, Inc., 931 Daniel St., Kenner, LA 70062, (504)466-1484.

2.06 DIELECTRIC CONNECTORS

A. Dielectric Fitting: Bronze ball valve with end connections and pressure rating to match associated piping.
   1. Nipples with inert non-corrosive thermoplastic linings are not acceptable.

B. Flange Electrical Insulation Kit: Consisting of dielectric sleeves and washers, and dielectric gasket.
   1. Water Applications:
      a. Chilled Water/Glycol: Rated 150 psi at 250 degrees F: ANSI Class 300, full faced durlon gasket with bolt holes, double durlon washers, and durabla sleeves; Model 300 by APS, Lafayette, LA 70596, (337) 233-6116.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install piping at approximate locations indicated, and at maximum height.

B. Install piping clear of door swings, and above sash heads.

C. Make allowances for expansion and contraction.

D. Allow for a minimum of one inch free air space around pipe or pipe covering, unless otherwise specified.

E. Install vertical piping plumb.

F. Use fittings for offsets and direction changes, except for Type K soft annealed copper tube.

G. Cut pipe and tubing ends square; ream before joining.

H. Threading: Use American Standard Taper Pipe Thread Dies.
   1. Thread brass pipe with special threading dies.

I. Make final connections to equipment with unions, flanges, or mechanical type joint couplings.

3.02 WATER AND PROPYLENE GLYCOL PIPING SYSTEMS

A. Pitch:
   1. Pitch horizontal piping 1/8 inch per 10 feet. Pitch supply piping up in direction of flow and return piping downward in direction of flow.
   2. Pitch single pipe systems up in direction of flow 1/8 inch per 10 feet.

B. Air Vents: Install air vents at locations indicated on the drawings, and at each high point in system. Use manually operated air vents rated for use in glycol systems, unless otherwise indicated.

C. Drains:
   1. Install piping to be completely drainable. Provide drains at low points, consisting of a 1/2 inch valve with a hose bibb connection, and at the following locations and equipment:
      a. In each section of piping separated by valves.
      b. For each riser, where riser or runout to riser has a valve installed.

D. Runouts: Connect runouts to upfeed risers to top of mains, and runouts to downfeed risers to bottom of mains.

3.03 PIPE JOINT MAKE-UP

A. Threaded Joint: Make up joint with a pipe thread compound applied in accordance with the manufacturer's printed application instructions for the intended service.
   1. Chrome Plated Brass Piping: Tighten joint with strap or Parmalee wrench; do not mar pipe finish. Install piping so that no threads are visible.

B. Soldered Joint: Thoroughly clean tube end and inside of fitting with emery cloth, sand cloth, or wire brush. Apply flux to the pre-cleaned surfaces. Install fitting, heat to soldering temperature, and join the metals with type solder specified. Remove residue.

C. Flanged Pipe Joint:
   1. Install threaded companion flanges on steel pipe; flanges on galvanized pipe are not required to be galvanized.
   2. Provide a gasket for each joint.
      a. Hot Water Pipe Gasket: Coat with a thin film of oil before making up joint.
      b. Compressed, Control, and Instrument Air Pipe Gasket: Coat with a thin film of oil before making up joint.
   3. Flange Bolt Installation:
      a. Clean and coat nuts, bolt threads and washers with anti-seize lubricant before making up joint.
      b. With each bolt; one hardened steel washer is required under the nut.
      c. With each stud; one hardened steel washer is required under the nut at each end.
      d. Torque Requirements: Stress bolts to 30,000 psi.
      e. Check torque with a calibrated breaking action torque wrench on the final torque round.
      f. Bolts shall be cold and hot torqued.
      g. Torque Pattern: Cross or star pattern with at least four passes. Limit each pass to 30 percent of full torque increases.
      h. Hot torque: Re-torque the flange bolts with the system at normal, and operating temperature for minimum of 12 to 15 hours.
   4. Coat bolt threads and nuts with anti-seize lubricant before making up joint.

D. Welded Pipe Joint:

1. General:
   a. Weld pipe joints only when ambient temperature is above 0 degree F where possible.
   b. Bevel pipe ends at a 37.5 degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   c. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inches to 20 inches.
   d. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass.
   e. Eliminate valleys at center and edges of each weld.
   f. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   g. Do not weld-out piping system imperfections by tack-welding procedures. Refabricate as required to comply with requirements.
   h. If piping component ends are bored, such boring shall not result in the finished wall thickness after welding less than the minimum design thickness.
   i. Align the inside diameters of piping components to be butt-welded as accurately as is practicable within existing commercial tolerances on diameters, wall thickness and out of roundness.
   j. Preserve alignment during welding. The internal misalignment of the ends to be joined shall not exceed 0.05 inch.
2. Welding Processes:
   a. All welding on metal piping systems shall be performed using qualified welding procedures and qualified welders and welding operators in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.
   b. All welding shall be performed by a process that is compatible with the work being welded and the working conditions. Shielded metal-arc welding (SMAW) shall not be used on work less than 3/16 inch thick.
   c. Welding shall be performed by using only one of the following processes:
      1) Shielded Metal Arc Welding (SMAW), also know as "Stick" Welding.
      2) Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc Welding.
      3) Submerged Arc Welding (SAW).
   d. Where a specific welding process is called for in the piping group, it shall govern.
   e. All stainless steel work less than 3/16 inch thick shall be welded by the gas tungsten-arc (GTAW) process with the back side purged with argon. Work thicker than 3/16 inch shall have a root pass by the GTAW Process with the back purged with argon and the balance of the weld may be completed by SMAW Process or any other suitable process.
3. Welding Grooves:

a. Bevel the ends of steel pipe and fittings to be erected with butt welded joints to form welding grooves in accordance with ANSI B16.25, except where otherwise noted herein, or on the Contract Drawings.
b. Bevel welding grooves for butt welded joints in pipe of unequal wall thickness in accordance with ASME Code for Pressure Piping B31.1 - latest edition, latest revision and section that is applicable.

4. Backing Rings: Backing rings or consumable inserts are not acceptable.
5. Cleaning of Welding: Completely remove all slag or flux remaining on the bead of welding before laying down the next successive bead and at the completion of the weld.
   a. Wire brush all completed welds a minimum of 2 inches on both sides and coated with one coat of high temperature (minimum rated 500 deg. F) primer prior to being insulated.
6. Preheating of Welded Joints: Pipe adjacent to joints before and during welding shall be preheated by any suitable method in accordance with the qualified welding procedure, and in all cases shall be in accordance with ASME B31.1, Paragraph 131.
7. Weld Quality:
   a. All welds shall have full penetration and complete fusion with a minimum of weld metal protruding on the inside of the pipe.
   b. The finished weld contour shall be uniform, with the toe or edge of the weld merging smoothly into the base material.
   c. Butt welds shall have a slight reinforcement build-up gradually from the toe or edge toward the center of the weld.
   d. The limitation on butt weld reinforcement shall be in accordance with ASME B31.1, Table 127.4.2 and shall apply separately to both inside and outside surfaces of the joint.
   e. Fillet welds may be slightly concave on the furnished surface.
8. Identification of Welders:
   a. Upon completing a joint, the welder shall mark the pipe not more than 6 inches from the weld with the identifying number and the last two digits of the year in which the work was performed.
   b. Make Identification marks with a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Director's Representative that do not deform the metal.
   c. Place identification marks for seam welds adjacent to the welds at 3-foot intervals.
   d. Identification by die stamps or electric etchers is not acceptable.
   e. Provide required markers. Substitution of a map of welds with welders' names is not acceptable.
9. Postheat Treatment of Welded Joints In Carbon and Ferritic Alloy Steel Pipe:
   a. Postheat treatment of welded joints in carbon and ferritic alloy steel piping shall be in accordance with ASME B31.1, as specified in the piping group, or on the Contract Drawings, except the cooling rate for stress relieving shall not exceed 200 degrees F per hour down to 600 degrees F.

1) In each case, the temperature given is a minimum and where a higher temperature is called for in the welding procedure, the welding procedure shall govern.

b. Perform stress relieving by one of the following methods:

1) Electrical resistance or induction coil heating is the preferred method for field use.

a) Record the temperature by pyrometer from the start of the heating operation until 600 degrees F. is reached during cooling.

2) The gas, natural or liquid petroleum, torch stress relieving procedure may be used only where approved by Director's Representative.

a) Maintain temperature record from the start of the heating operation until 600 degrees F. is reached during cooling.

b) Place two measuring thermocouples 180 degrees apart at the centerline of the weld and two measuring thermocouples each placed 90 degrees away from the centerline thermocouples at a distance from the centerline of the weld equal to three times the wall thickness.

3 Furnace postheat treatment may be employed when desirable to treat several welded or formed assemblies simultaneously.

a) Temperature range, heating conditions, holding time, and cooling conditions shall be as outlined above but shall satisfy the requirements for the thickest section, etc. of the load.

b) When this method is used, adequately support pipe and pipe assemblies to minimize distortion.

10. Socket Welding Joints:

a. Where socket welding valves or fittings are used, space pipe with a minimum of 1/16 inch clearance between the end of the pipe and the socket so that no stresses will be imparted to the weld due to "bottoming" of the pipe in the socket.

b. The fit between the socket and the pipe shall conform to applicable standards for socket weld fittings and in no case shall the inside diameter of the socket exceed the outside diameter of the pipe by more than 0.075 inches.

E. Mechanical Joint: Make up joint in conformance with the manufacturer's printed installation instructions, with particular reference to tightening of bolts.

F. Hydraulic Pressed Joint: Follow manufacturer's printed installation instructions.

G. Dissimilar Pipe Joint:

1. Joining Bell and Spigot and Threaded Pipe: Install a half coupling on the pipe or tube end to form a spigot, and caulk into the cast iron bell.

2. Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.
3. Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.
4. Joining Galvanized Steel Pipe and Brass Pipe or Copper Tubing: Make up joint with a dielectric connector.

3.04 PIPE AND FITTING SCHEDULE

A. Abbreviations: The following abbreviations are applicable to the Pipe and Fitting Schedule:

BS	Black steel.
CI	Cast iron.
SE	Screwed end.
ST	Steel.
SW	Standard weight.
WE	Weld end.

B. Where options are given, choose only one option for each piping service. No deviations from selected option will be allowed.

C. Schedule of Pipe and Fittings for the different piping services is as follows:
1. Chilled Water/Glycol 125 psig and less:
   a. 3 inch and less: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings.
   b. 4 inch and Up: SW BS pipe, with WE SW ST fittings.
2. Make-Up Water 125 psig and less:
   a. 3 inch and less: Type L hard drawn copper tubing with wrot copper or cast copper alloy solder fittings, and Type 3 solder, or hydraulic press joints. NSF Rated for potable domestic water systems.
3. Drain Piping:
   a. Drain Piping: SW BS pipe, with SE SW CI fittings, or WE SW ST fittings.

END OF SECTION

SECTION 232001

STRAINERS

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, specifications, and installation instructions for each type strainer.

PART 2 PRODUCTS

2.01 STRAINERS

A. Body:
   1. Type:
      a. Y Type.
   2. Materials: Any of the following:
      a. ASTM A 126 Grade B cast iron.
      b. ASTM A 216 WCB cast steel.
      c. ASTM B 62 cast bronze may be used in systems operating at a maximum of 125 psig steam or 175 psig water.

B. Pressure Ratings:
   1. 125 psig WSP, 175 psig WOG.

C. End Connections:
   1. Threaded ends for use in threaded piping 3 inch size and smaller.
   2. Flanged ends in piping 4 inch size and larger.
   3. Solder ends or threaded ends with solder adapters in copper tubing.

D. Screens: Fabricate from 18-8 stainless steel or monel metal.
   1. Perforation Sizes:
      a. Water Piping:
         1) 3 inch and Smaller: 1/16 inch perforations.
         2) Over 3 inch: 1/8 inch perforations.
   2. Minimum Free Screen/Basket Area: Double the internal cross sectional area of the inlet pipe.

E. Caps and Covers:
   1. Strainers 3 inch size and Smaller: Any of the following:
      a. Faced and gasketed screen retaining cap.
      b. Straight thread bushing with a blow-out proof gasket.
      c. Internally milled tapered gasketed bushing.
   2. Strainers 4 inch size and Larger: Bolted gasketed screen cover.
   3. Gasket Material: Graphited non-asbestos mineral or ceramic fiber.

PART 3 EXECUTION

3.01 INSTALLATION

A. Strainers: Provide with a full size drain valve with integral hose bibb connection, and chained cap, rated for 450 degrees F.

B. Install strainers, indicated or specified to be installed in the suction or discharge piping connections to pumps as shown on the drawings.

END OF SECTION

SECTION 232002

BACKFLOW PREVENTERS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Air Gap Fittings: Section 232004.

1.02 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog sheets, specifications, and installation instructions for each type backflow preventer and test kit.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with the State Department of Health Sanitary Code for Cross Connection Control, and the other standards listed in Part 2 of this section.
   2. Where conflicts occur between the referenced standards, the most stringent requirements shall apply.

1.04 MAINTENANCE

A. Special Tools (as furnished or recommended by the backflow preventer manufacturer). Deliver to the Director's Representative:
   1. Test Kit A: Portable, packaged in a substantially built, compartmented carrying case, containing hose, gauge, and fittings required for testing backflow preventer for proper operation, and printed procedure for conducting test.

PART 2 PRODUCTS

2.01 BACKFLOW PREVENTERS

A. Type A: Reduced Pressure Zone Principle device, with atmospheric vent, conforming to ASSE Standard 1013, AWWA C-511, NSF Rated, USC specifications manual for Cross Connection Control, and listed as acceptable in the State Department of Health, Environmental Health Manual.
   1. Performance: 150 psig, and 130 degrees F maximum working conditions.
   2. Assembly: Strainer and ball valve on inlet side, ball valve on outlet side, and four test cocks, all as furnished or recommended by the backflow preventer manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions.

B. Atmospheric Vent: Pipe vent to spill over closest point of drainage, as directed, maintaining a minimum 12 inch air gap above the drain.
   1. Install air gap fitting when shown, or if atmospheric vent must be connected to drainage line. See Section 232004.

3.02 FIELD QUALITY CONTROL

A. Operation Test: Test kit as specified under Part 1 of this section may be used. Conduct test in the presence of the Director's Representative.
   1. Type A Backflow Preventer: Test the device with the test kit in accordance with the manufacturer's test procedures.

B. Re-testing: Repair or replace any device failing the operation test, and repeat the test.

END OF SECTION

SECTION 232003

THERMOMETERS AND GAUGES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Valves: Section 230523.

1.02 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, specifications and installation instructions for each item specified.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Where Federal, NSF, ASME or other standards are indicated or required, products shall meet or exceed the standards established for material, quality, manufacture and performance.

PART 2 PRODUCTS

2.01 MANUFACTURERS/COMPANIES

A. Dresser Instruments.

B. Marsh Bellofram.

C. Moeller Instrument Co.

D. Taylor Precision Products.

E. H.O. Trerice Co.

F. Weksler Instruments Corp.

2.02 THERMOMETERS

A. General Design Features:
   1. Scale Ranges: 1-1/2 times actual working temperature required for the particular application, as approved.
      a. Maximum of two degrees between graduations and ten degrees between numerals.
      b. When scale ranges are in excess of 100 degrees, maximum range between numerals may be 20 degrees, or as otherwise approved for the particular application.
   2. Direct Reading Thermometers: Bimetallic actuated, dial type, straight pattern, angle pattern, or adjustable angle pattern as required.
   3. Thermometers for Sensing Liquid Temperature: Furnish with separable sockets.

a. Sockets for Use in Insulated Piping, Insulated Tanks or Similar Equipment: Extension lagging neck type, of length as required to compensate for insulation thickness, and proper immersion..

2.03 THERMOMETERS FOR MEASURING LIQUID TEMPERATURE

A. Bimetallic Actuated Thermometers: Comply with ASME B40.3, Accuracy Grade A.
   1. Construction: Type 304 stainless steel, all welded construction, with clear acrylic plastic or shatterproof glass crystal.
   2. Dial: White enamel background with bold black figures and graduations.
   3. Head Size:
      a. Installation in Piping: 3inch diameter.
      b. Installation in Tanks and Similar Equipment: 5 inch diameter.
   4. Stem: Length as required for proper immersion, and to compensate for insulation thickness, with threaded connection for socket.
   5. External Calibration Device.
   6. Separable Socket:
      a. Water Service: Brass or bronze.
      b. Steam Service: Stainless steel.

2.04 PRESSURE AND COMPOUND GAUGES

A. Type: Adjustable dial type with micrometer type pointer, or external calibration device, bronze bourdon tube, and bronze bushed rotary movement.

B. Dial: White enameled background, and bold black graduations, numerals and pointer; 3-1/2 inch diameter.
   1. Scale Range:
      a. Standard Gauges: Double normal operating pressure.

C. Case: Cast aluminum, brass, or black finished phenolic.

D. Accuracy: Guaranteed of within 1 percent in middle third of dial range.

2.05 IMPULSE DAMPERS

A. Impulse Dampers: H.O. Trerice Co. Model 870.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install thermometers and pressure gauges where indicated on the drawings.

B. Thermometers:
   1. Install in accordance with the manufacturer's printed installation instructions.
   2. Install direct reading thermometers, when the application requires installation 6 feet or less above the floor or bottom of space in which installed.

C. Pressure Gauges:

1. Install in accordance with the manufacturer's printed installation instructions.
2. For Measuring Liquid Pressure: Install gauges complete with stop cocks and drain cocks.

D. Impulse Dampers:
1. Install impulse dampers in the piping connections to gauges installed in suction and discharge piping connections to close coupled and base mounted circulating pumps driven by motors 10 HP and over.

END OF SECTION

SECTION 232004

AIR GAP FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. Comply with the applicable requirements of ASME A112.36.2M - Cleanouts, and ASME A112.1.2 - Drainage Funnels and Air Gaps.

1.02 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each item specified except fasteners.

PART 2 PRODUCTS

2.01 AIR GAP FITTING

A. Coated cast iron body with air gaps, set screw or threaded inlet, and outlet connection to match piping option selected.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

END OF SECTION

SECTION 232006

HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each item specified.

B. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

A. Hydronic Expansion Tank (non-domestic use): Pre-pressurized, welded steel (ASME Boiler and Pressure Vessel Code Section VIII, Division I) with heavy duty butyl rubber bladder, air charging valve, and plugged drain.
   1. Maximum Working Pressure: 125 psig.
   2. Maximum Operating Temperature: 240 degrees F.

2.02 AIR VENTS

A. Type D: Automatic High Capacity Float Operated Vent; Sarco Model 13W, or ITT Bell and Gossett Model 107.
   1. Construction: Cast iron body with bolted and gasketed cover, and stainless steel float mechanism, and 3/8 inch drain connection.
   2. Maximum Working Pressure: 150 psig.
   3. Maximum Operating Temperature: 250 degrees F.

2.03 MAKE-UP GLYCOL SYSTEM

A. Type: Packaged tank and pump make-up water system.
   1. 50 gallon polyethylene tank.
   2. Steel tank stand.
   3. Bronze rotary gear pump delivering 1.5 gpm @ 100 psi.
   4. Integral control panel mounted to stand including: NEMA 4X enclosure, power cord with plug, low level audible and visual alarm, alarm silence switch, main power indicator, main power switch, pump hand-off-auto switch, pump "on" indicator light. Control panel shall be factory wired.
   5. Valving/Controls: Isolation valves, wye-strainer, union connections, pressure switch controls, pressure relief valve set at 100 psi.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions.

END OF SECTION

SECTION 232113

COMBINATION BALANCING VALVE AND FLOW METERS

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, performance charts, test data, specifications and installation instructions for each item specified.

B. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative.

1.02 MAINTENANCE

A. Special Tools: Deliver to the Director's Representative at the site.
   1. One portable readout meter for use with combination balancing valve and flow meter
   2. One calibrating and cross reference chart designed for mid range of required flows, or one valve calculator.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Bell & Gossett Div. of ITT, 8200 N. Austin Ave., Morton Grove, IL 60053, (847) 966-3700

2.02 COMBINATION BALANCING VALVE AND FLOW METER

A. Flanged End Ball Style Types (4 inch size and Up): Bell & Gossett Series CB Circuit Setter.
   1. Features:
      a. Body and Bonnet: Cast iron (flanged end type) or ductile iron (grooved end type).
      b. Disc: Bronze with EPDM insert.
      c. Stem: Stainless steel.
      d. Packing: Replaceable, teflon-graphite (asbestos free).
      e. Gasket: Synthetic fiber-nitrile binder (asbestos free).
      f. Seal Ring: EPDM.
      g. Bushing: Zinc plated steel.
      h. Calibrated nameplate and memory stop indicator.
   2. Maximum Working Pressure: 175 psig.
   3. Maximum Operating Temperature: 250 degrees F.

B. Portable readout meter with hoses, shutoff valve and vent valve, and carrying case

(Model RO-5).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions.

END OF SECTION

SECTION 232123

PUMPS

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data: Catalog sheets and installation instructions for each type or size pump.

B. Schedule: Pump schedule showing pump specifications and application.

C. Quality Control Submittals:
   1. Performance curves for each pump, showing gpm, brake HP and efficiency from free delivery to shut-off. Chart curves on manufacturer's factory tests shall be conducted in accordance with the recommended procedures of the Hydraulic Institute, and certified thereto by the manufacturer.
   2. Certificates: Affidavit required under QUALITY ASSURANCE Article.
   3. Company Field Advisor Data:
      a. Name, business address and telephone number of Company Field Advisor secured for the required services.
      b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
      c. Services and each product for which authorization is given by the Company, listed specifically for this project.

D. Contract Close Out Submittals:
   1. Operation, Maintenance Data, and Parts Lists: Deliver 2 copies, for each type of pump or pumping apparatus, to the Director's Representative.

1.02 QUALITY ASSURANCE

A. Company Field Advisor: Secure the services of a Company Field Advisor from pump manufacturer for a minimum of 16 onsite working hours for the following:
   a. Render advice regarding installation and final adjustment of the system.
   b. Render advice on the suitability of each item for this particular application.
   c. Witness final system acceptance test, then certify with an affidavit that the system is installed in accordance with the Contract Documents and is operating properly.
   d. Train facility personnel on the operation and or maintenance of the system (Minimum of two 2-hour sessions).
   e. Explain available service programs to facility supervisory personnel for their consideration.

1.03 MAINTENANCE

A. Spare Parts: Deliver one spare set of mechanical seals for each size and type of pump equipped with mechanical seals, to the Director's Representative, who will sign receipt for same. Furnish seals of type as required for the particular pump application and the chemical water treatment being utilized. Suitably box and label spare seals as to their usage.

PART 2 PRODUCTS

2.01 PUMP MANUFACTURER

A. Basis of Design Product:
   1. Base mounted double suction split case pump: Weinman Pumps, Model 3L-6.
      a. Weinman Pump Contact Information
         i. John Ferendzo, Rolfe Industries, 518-265-0144

B. The following specification is a performance type specification. Comparable product by other manufacturers may be submitted. If the Contractor elects to use other than the basis of design products, equipment is still required to meet the performance, quality, dimensions, weights, electrical requirements and installation requirements of the specification.

C. The contract documents are prepared on the basis of one manufacturer as the "basis of design". Other manufacturers are acceptable and may be submitted. If the Contractor elects to use other than the basis of design, submittals shall include project specific detailed drawings of the proposed installation inclusive of:
   1. Maintenance, service removal and operational clearances.
   2. Proposed installation of equipment.
   3. All pertinent revisions to the design arrangement.
   4. Revised piping routing and additional supports.

D. If the submitted equipment is larger than basis of design equipment or the inlet/discharge do not line up with existing piping the Contractor shall, prior to submittal, verify the equipment will physically fit on the existing concrete equipment pad provided without interference to adjacent equipment, electrical panels or entry ways. A rigging and installation drawing shall be submitted with the initial submittal showing installation pathway and final installation of equipment. Submittal shall clearly indicate no interferences with adjacent equipment or required clearances.

E. If the submitted equipment is other than basis of design equipment the Contractor shall assume responsibility for, and coordination of, all changes in the work at no cost increase in any contract. Additional responsibilities of the Contractor includes but is not limited to:
   1. Revised electrical feeds
   2. Revised circuit breakers
   3. Revised or additional control devices and sequences
   4. Modifications to supporting structure (concrete equipment pad)
   5. Additional supporting structure and framing.
   6. Revised pipe routing and additional pipe supports.

2.02 PUMPS - GENERAL

A. Design pumps to operate continuously without overheating bearings or motors at every condition of operation on the pump curve, or produce noise audible outside the room or space in which installed.

B. Equip pumps complete with electric motor and drive assembly, unless otherwise indicated. Design pump casings for the indicated working pressure and factory test at 1-1/2 times the designed pressure.

C. Pumps of the same type, shall be the product of a single manufacturer, with pump parts of the same size and type interchangeable.

D. Equip base mounted pumps with OSHA compliant metal guards over the moving drive assembly. Fabricate from expanded galvanized metal or galvanized sheet metal. Secure guards as required and approved.

2.03 CIRCULATING WATER PUMPS

A. Base Mounted Double Suction Split Case Pump: Horizontal, volute, single stage, end suction centrifugal pump with mechanical seals, and casing and frame of cast iron. Basis of Design: Weinman Model: 3L-6.
   1. Design casing for 125 psig working pressure, with vent cock in top and drain plug in bottom, P/T gauge connections, with flanged inlet and outlet connections.
   2. Equip with enclosed type cast bronze impeller, keyed to shaft and secured with self-locking bronze impeller nut.
   3. Shaft shall be 416 stainless steel with lock collars, designed to SAE-1045 steel, and shall have renewable 416 stainless steel sleeves.
   4. Direct connect pump to electric motor with a flexible coupling, with OSHA type coupling guard.
   5. Mount pump and driving motor on common cast iron base or heavy steel base plate, with suitable lugs for anchor bolting.
   6. Equip chilled water, secondary water and primary water pumps, driven by motors 5 HP and larger with drip lip type base. Pitch drip lip to pump end with tapped, and plugged drain connection at low point.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install base mounted pumping apparatus on existing concrete pump foundations as noted on drawings or specified. Level, align and true the equipment utilizing steel shims. Bolt to construction and grout, when grouting holes are provided in bases.

3.02 FIELD QUALITY CONTROL

A. Preliminary System Tests:

1. Preparation: Have the Company Field Advisor adjust the completed system and then operate it long enough to assure that it is performing properly.
2. Run a preliminary test for the purpose of:
    a. Determining whether the system is in a suitable condition to conduct the acceptance test.
    b. Checking control equipment.
    c. Training Facility personnel.

B. System Acceptance Test:
1. Preparation: Notify the Director's Representative at least 3 working days prior to the test so arrangements can be made to have a Facility Representative witness the test.
2. Make the following tests:
    a. Individually test each pump at all operating conditions including variable speed conditions and parallel operation (if applicable). Individually test control devices.

END OF SECTION

SECTION 232514

WATER TREATMENT - AIR CONDITIONING SYSTEMS

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data: Catalog sheets, brochures, performance charts, standard schematic drawings, specifications and installation instructions for the complete system.

B. Quality Control Submittals:
   1. Test Reports: Furnish and deliver to the Director's Representative at the site, written copies of test results conducted each week on all systems treated under the Work of this contract. In addition, the water conditioning company shall furnish copies of test results obtained by them, during the periodic visits specified, during the performance of the Work of this contract and the period of the guarantee.

C. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Printed instructions, framed under rigid plastic, on procedures, test required and dosages to be used for each chemical treatment system.
   2. Warranty: Copy of specified warranty.

1.02 QUALITY ASSURANCE

A. Consultant Water Conditioning Company:
   1. Engage the services of an independent professional water conditioning company for testing and chemical treatment of heating and air conditioning water systems installed under the Work of this contract, as approved by the Director.
   2. Upon the request of the Director, the water conditioning company shall submit a list of at least 3 installations of similar capacity in New York State, which have been successfully tested for a period of 5 consecutive years, immediately preceding the award of this contract.
   3. The water conditioning company shall make an analysis of the year round raw water supply to the building and recommend the chemical dosages to be used and shall periodically check, at least 6 times a year, on the effectiveness of the treatment, prior to final payment on this contract.
   4. The water conditioning company shall train operating personnel, selected by the State, in the procedures and tests required to maintain chemical control, and shall during the period of the guarantee make at least 6 periodic visits to check the effectiveness and adequacy of the chemical treatment.

1.03 WARRANTY

A. The Consultant Water Conditioning Company and the Contractor shall warranty in writing, that the water systems and any component parts thereof, will experience no more than minimal scale formation, corrosion, pitting, algae and slime growth, for a period of one year from the date of final certificate on this project, when treated in strict accordance with the Consultant Water Conditioning Company's recommendations.

1.04 MAINTENANCE

A. Extra Materials: Before final payment, deliver to the Director's Representative at the Site, a one year supply of water treatment chemicals for each system installed under this contract. The one year supply of chemicals will be used by the State's Operating Personnel, for the treatment of the water systems, during the period of the Warranty.

PART 2 PRODUCTS

2.01 COMPANIES

A. Sound Water Treatment Center, Inc., 504 W. Boston Post Rd., Mamaroneck, NY 10543, (914) 738-2227.

B. Bond Chemical Co, 1154 W. Smith Rd., Medina, OH 44256-2443, (330) 723-6005.

C. Betz Dearborn, Inc., 4636 Somerton Rd., Trevose, PA 19053-6783, (215) 355-3300.

2.02 EQUIPMENT FOR SYSTEMS REQUIRING TREATMENT

A. Equipment:
1. Air Cooled Chillers and Pumps.

B. Systems:
1. Chilled Glycol/Water Systems.

C. Refer to drawings for capacities of equipment and systems, and the entering and leaving temperatures of water for equipment and systems.

2.03 EQUIPMENT FOR TREATMENT OF SECONDARY WATER SYSTEMS

A. By-pass feeder, with a capacity of five gallons, designed for a working pressure of 200 psi.

2.04 TEST EQUIPMENT

A. Metal test cabinet, complete with sufficient glassware and reagents to make each of the following determinations once a day, for the period of the contract and the guarantee:
1. pH by color comparator.

2. Chromate by color comparator and titration.
3. Nitrite by color comparator and titration.
4. Total dissolved solids by concentration hydrometer.
5. Chlorides by titration.
6. Phenolphtalain and methyl orange alkalinity by titration.

2.05 CHEMICALS

A. Secondary Water Systems: Nitrite.

B. Propylene Glycol: Permanent type anti-freeze solution as manufactured by Dow Chemical Co. or Union Carbide.
1. Percentage of Propylene Glycol: 30 percent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install chemical treatment systems, complete with feeders, valves and piping, as indicated on the drawings, and as required for the treatment of systems.

B. Install test cabinet complete with required glassware and reagents, at location as directed.

3.02 FIELD QUALITY CONTROL

A. It is the intent of these specifications to provide complete systems of chemical treatment to protect water systems from scale formations, corrosion, algae and slime growth.

B. As a guide to the adequacy of the chemical treatment, maintain the following chemical residuals:
1. Secondary water systems - Nitrite at 300-500 ppm, at a pH range of 8.5 to 9.5.
2. The Consultant Water Conditioning Company may submit recommendations for changes in the aforementioned chemicals or concentrations to the Director for approval. Do not make any changes in treatment concentrations, chemicals or methods without the written permission of the Director.

C. Until final payment is made on this project, chemically treat all water systems for scale formation, corrosion control, algae and slime growth, all as directed by the Consultant Water Conditioning Company.

END OF SECTION

SECTION 233113

METAL DUCTWORK

PART 1 GENERAL

1.01 REFERENCES

A. American Conference of Governmental Industrial Hygienists (ACGIH).

B. National Fire Protection Association (NFPA).

C. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

1.02 SUBMITTALS

A. Shop Drawings:
   1. Layouts for areas in which it may be necessary to deviate substantially from layout shown on the Drawings. Show major relocation of ductwork and major changes in size of ducts. Minor transitions in ductwork, if required due to job conditions, need not be submitted as long as the duct area is maintained.
   2. Layouts of mechanical equipment rooms and penthouses.
   3. Details of intermediate structural steel members required to span main structural steel for the support of ductwork.
   4. Method of attachment of duct hangers to building construction.
   5. Coordinate shop drawings with related contracts prior to submission.

B. Submit an Environmental Product Declaration (EPD) from the manufacturer for steel this specification section, if available. A statement of the contractor's good faith effort to obtain the EPD shall be provided if not available.
   1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

C. Product Data: Material, gage, type of joints, sealing materials, and reinforcing for each duct size range, including sketches or SMACNA plate numbers for joints, method of fabrication and reinforcing. Include ACGIH figure numbers for hoods if applicable.

1.03 QUALITY ASSURANCE

A. SMACNA: Gages of materials, fabrication, reinforcement, sealing requirements, installation, and method of supporting ductwork shall be in accordance with the following SMACNA manuals, unless otherwise shown or specified:
   1. HVAC Duct Construction Standards.

B. Conform to the applicable requirements of NFPA 90A, 90B, 91, 96, and 101.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet Metal:
   1. Galvannealed Steel: ASTM A653, Class LFQ (lock forming quality), coating designation G-90.

B. Duct Hangers:
   1. Strap Hangers: Same material as ducts, except that hangers for stainless steel ducts in unfinished spaces may be galvanized steel.
   2. Rod Type Hangers: Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with 2 removable nuts each end for positioning and locking rod in place. Unless stainless steel, galvanized or cadmium plated; shop coat with metal primer.

C. Miscellaneous Fasteners and Upper Hanger Attachments:
   1. Sheet Metal Screws, Machine Bolts and Nuts: Same material as duct, unless otherwise specified.
   2. Concrete Inserts: Steel or malleable iron, galvanized; continuously slotted or individual inserts conforming with MSS SP-58, Types 18 & 19, Class A-B.
   3. C Clamps: Fee & Mason Co.'s 255L with locking nut, and 255S with retaining strap.
   4. Metal Deck Ceiling Bolts: B-Line Systems, Inc.'s Fig. B3019.
   5. Welding Studs: Erico Fastening Systems, capacitor discharge, low carbon steel, copper flashed.
   6. Structural (carbon) Steel Shapes and Steel Plates: ASTM A36, shop primed.
   7. Stainless Steel Shapes and Plates: ASTM A276 and ASTM A666.
   8. Machine Bolt Expansion Anchors:
      a. Non-caulking single unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 1.
      b. Non-caulking double unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 2.
      c. Self-drilling type: FS FF-S-325, Group III, Types 1 and 2.

2.02 FABRICATION - GENERAL

A. Fabricate ductwork from galvannealed sheet metal to allow for painting of exposed ductwork.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install ductwork to allow maximum headroom. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.

B. Pitch horizontal ducts connected to hoods downward toward hood not less than 1 inch in 10 feet.

C. Provide necessary transformation pieces, and flexible fabric connections for ductwork connected to air handling equipment or air inlet and outlet devices.

3.02 SEALING SEAMS, JOINTS, AND PENETRATIONS

A. Seal ductwork in accordance with the SMACNA Manual except for the following:
   1. Ductwork Specified to be Insulated: Conform with Seal Class A for all pressure classes.

B. Duct Sealants: Water based, non-fibrated: Foster 32-19, Childers CP-146, Duro Dyne SAS.

3.03 HANGERS FOR DUCTS, UNDER 2 INCHES W.G.

A. Install hangers for ducts as specified in the SMACNA Manual, with the following exceptions:
   1. Rectangular ducts up to 42 inches wide, not having welded or soldered seams, and supported from overhead construction; extend strap hangers down over each side of the duct and turn under bottom of duct a minimum of 2 inches. Secure hanger to duct with 3 full thread sheet metal screws, one in the bottom and 2 in the side of the duct.
   2. Rectangular ducts 43 inches wide and over, and all sizes of duct with welded or soldered seams, and supported from overhead construction; use trapeze hangers.
   3. Prime coat plain steel rods threaded at the site immediately after installation with metal primer.

3.04 UPPER HANGER ATTACHMENTS

A. General:
   1. Secure upper hanger attachments to structural steel or steel bar joists wherever possible.
   2. Do not use drive-on beam clamps, flat bars or bent rods, as upper hanger attachments.
   3. Do not attach hangers to steel decks which are not to receive concrete fill.
   4. Do not attach hangers to precast concrete planks less than 2-3/4 inches thick.
   5. Avoid damage to reinforcing members in concrete construction.
   6. Metallic fasteners installed with electrically operated or powder driven tools may be used as upper hanger attachments, in accordance with the SMACNA Manual, with the following exceptions:

a. Do not use powder driven drive pins or expansion nails.
b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
c. Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
d. Do not use powder driven fasteners in precast concrete.

B. Attachment to Existing Cast-In Place Concrete:
1. Secure hangers to overhead construction with self drilling type expansion anchors and machine bolts.
2. Secure hanger attachments required to be supported from wall or floor construction with single unit expansion anchors or self drilling type expansion anchors and machine bolts.

3.05 DUCT RISER SUPPORTS, UNDER 2 INCHES W.G.

A. Support vertical round ducts by means of double-ended split steel pipe riser clamps bearing on floor slabs or adjacent structural members, at every other floor through which the riser passes.

B. Unless otherwise specified or shown on the drawings, support vertical rectangular ducts by means of two steel angles, secured to duct and resting on floor slab or adjacent structural steel member, at every other floor through which the duct passes. Size supports as follows:

MAX. SIDE DIMENSION (inches)	SUPPORT ANGLE (inches)	SECURE TO DUCT WITH	MIN BEARING AT EACH END (inches)
36	1 x 1 x 1/8	Screws	2
48	1-1/2 x 1-1/2 x 1/8	Bolts	3
60	2 x 2 x 1/8	Bolts	3
61 - up	2-1/2 x 2-1/2 x 3/16	Bolts	4

END OF SECTION

SECTION 236416

AIR-COOLED, ROTARY SCREW WATER CHILLER

PART 1 GENERAL

1.01 REFERENCES

A. AHRI 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle

B. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment

C. ASHRAE 15 - Safety Code for Mechanical Refrigeration

D. ASHRAE 90.1 - Energy Efficient Design of New Buildings

E. ASME - Boiler and Pressure Vessel Code SEC VIII, Division 1

F. UL 1995 - Central Cooling Air Conditioners

G. ASTM B117 - Standard Method of Salt Spray (Fog) Testing

H. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

I. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products

J. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments

K. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.

L. ISO 9001

1.02 SYSTEM DESCRIPTION

A. Section includes design, performance criteria, refrigerants, controls, and installation requirements for air-cooled rotary screw packaged chillers.

1.03 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, standard diagrams, ARI certification performance charts, rated capacities, standard schematic drawings, specifications and installation instructions for chiller package and accessories.
   a. Submit dimensional plan and elevation view drawings, weights and loadings, required clearances, location and size of all field connections, electrical requirements and wiring diagrams.
   b. Submit manufacturer's installation instructions.
   c. Submit noise data at the conditions listed on the Drawings

B. Quality Control Submittals:
   1. Certificates: Affidavit required under Quality Assurance Article.
   2. Company Field Advisor Data:
      a. Name, business address and telephone number of Company Field Advisor secured for the required services.
      b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
      c. Services and each product for which authorization is given by the Company, listed specifically for this project.

C. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative.
   2. Test Reports:
      a. Chiller Package Acceptance Test Report.
   3. Warranty certificates including warranty extension.

1.04 QUALITY ASSURANCE

A. Chiller Manufacturer: Chiller shall be manufactured and constructed in an ISO 9001 classified facility.

B. Regulatory Requirements:
   1. Design, fabricate, inspect, test and label chiller package in accordance with applicable ASME and ANSI codes, and ARI and ASHRAE standards.
   2. Electrical components shall be UL or ETL listed.
   3. Comply with ARI 550/590 for chiller capacity and power rating and/or certification.
   4. Comply with NEMA standards for motors and motor controllers.
   5. Comply with OSHA requirements for acceptable sound pressure level.

C. Certification: Affidavit by the Company Field Advisor, certifying that the chiller package meets the contract requirements and is operating properly.

D. Company Field Advisor: Secure the services of a Company Field Advisor for a minimum of 40 working hours for the following:
   a. Render advice regarding installation, final adjustment and alignment of the chiller package.
   b. Perform final system acceptance tests, then certify with an affidavit that the chiller package is installed in accordance with the Contract Documents and is operating properly.
   c. Train facility personnel on the operation and or maintenance of the chiller package. (Minimum of two 4 hour sessions).
   d. Explain available service programs to facility supervisory personnel for their consideration.

1.05 DELIVERY, STORAGE AND HANDLING

A. Handle chiller package in accordance with manufacturer's written instructions.

B. Ship chiller package with all refrigerant piping and control wiring factory installed.

C. Ship chiller package with permanently attached metal plates that indicate:
   1. Name of manufacturer.
   2. Chiller model number.
   3. Compressor type and refrigerant used.
   4. Year of manufacture.

1.06 MAINTENANCE SUPPORT AVAILABILITY

A. Chiller manufacturer shall have a fully equipped authorized service organization capable of guaranteeing response within 8 hours to service calls available 24 hours a day, 7 days a week

1.07 WARRANTY

A. Provide the manufacturers standard and extended warranty on equipment parts and labor for each chiller through December 31st, 2025.

PART 2 PRODUCTS

2.01 CHILLER MANUFACTURER

A. Basis of Design Product:
   1. Chiller: Trane Technologies, RTAF high efficiency air-cooled screw chiller rated at 150 nominal tonnage.
      a. Trane Technologies Contact Information
         i. Brad Juneau, Trane Technologies, (518) 788-2138

B. The following specification is a performance type specification. Comparable product by other manufacturers may be submitted. If the Contractor elects to use other than the basis of design products, equipment is still required to meet the performance, quality, dimensions, weights, electrical requirements and installation requirements of the specification.

C. The contract documents are prepared on the basis of one manufacturer as the "basis of design". Other manufacturers are acceptable and may be submitted. If the Contractor elects to use other than the basis of design, submittals shall include project specific detailed drawings of the proposed installation inclusive of:
   1. Maintenance, service removal and operational clearances.
   2. Proposed installation of equipment.
   3. All pertinent revisions to the design arrangement.
   4. Revised piping routing and additional supports.

D. If the submitted equipment is larger than basis of design equipment the Contractor shall, prior to submittal, verify the equipment will physically fit on the existing concrete equipment pad provided without interference to adjacent

equipment, electrical panels or entry ways. A rigging and installation drawing shall be submitted with the initial submittal showing installation pathway and final installation of equipment. Submittal shall clearly indicate no interferences with adjacent equipment or required clearances.

E. If the submitted equipment is other than basis of design equipment the Contractor shall assume responsibility for, and coordination of, all changes in the work at no cost increase in any contract. Additional responsibilities of the Contractor includes but is not limited to:
   1. Revised electrical feeds
   2. Revised circuit breakers
   3. Revised or additional control devices and sequences
   4. Modifications to supporting structure (concrete equipment pad)
   5. Additional supporting structure and framing.
   6. Revised pipe routing and additional pipe supports.

2.02 CHILLER OPERATION

A. Chiller shall be capable of operating with a leaving solution temperature range 40°F to 68°F (4.4 to 20°C) without glycol.

B. Chiller shall be capable of starting up with 95°F (35°C) entering fluid temperature to the evaporator. Maximum water temperature that can be circulated with the Chiller not operating is 108°F (52°C)

C. Chiller shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive mode. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.

D. Rapid Restart™ after power restoration. The Chiller shall be capable of starting in 45 seconds.

2.03 COMPRESSORS

A. Chiller shall utilize semi-hermetic, variable speed drive, helical rotary screw compressors.

B. Compressor motor shall be suction gas cooled.

C. Oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.

D. Compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.

E. Compressor with automatic capacity reduction equipment consisting of capacity control via variable speed drive and/or slide valve. Compressor shall start unloaded for soft start on motors.

F. Chiller shall be capable of operation down to 15% load without hot gas bypass.

2.04 EVAPORATOR

A. The evaporator shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 200 psig. Waterside working pressure shall be 150 psig.

B. Insulate the evaporator with a minimum of 0.75 inch (K=0.28) UV rated insulation. If the insulation is field installed, the additional money to cover material and installation costs in the field shall be provide at no cost to the State.

C. Evaporator heaters shall be factory installed and shall protect chiller down to -4°F (-20°C). Contractor shall wire separate power to energize heat tape and protect evaporator while chiller is disconnected from the main power.

D. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets.

E. Chiller shall provide the ability to remove evaporator tubes from either end of the heat exchanger.

F. Evaporator shall have cleanable tubes.

G. Provide water drain connection, vent and fittings. Factory installed leaving water temperature control and low temperature cutout sensors.

H. Water connections shall be grooved pipe.

I. Proof of flow shall be provided by the equipment manufacturer's flow switch, mechanically installed and electrically wired, at the factory.

2.05 FANS

A. Fans shall by dynamically balanced and direct driven.

B. All condenser fan TEAO motors have permanently lubricated ball bearings and external overload protection.

C. All condenser fans shall have drives to provide variable speed for optimized efficiency.

2.06 CONDENSER

A. Construct condenser coils of microchannel all aluminum brazed fin construction. The condenser coils shall have an integral sub-cooling circuit and shall be designed for at least 350 psig working pressure. Leak tested at 1.5 times working pressure. Coils can be cleaned with high pressure water.

B. Condenser coils shall be transverse design.

2.07 ENCLOSURE/CHILLER CONSTRUCTION

A. Chiller panels, base rails and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays.

B. Mount starters and Terminal Blocks in a UL 1995 rated weatherproof panel provided with full opening access doors. Circuit breaker shall be a lockable, through-the-door type with an operating handle and clearly visible from outside of chiller indicating if power is on or off.

C. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B117.

D. Chiller manufacturer shall provide rubber in shear vibration isolator bases for the chiller to be mounted on, quantity per the approved chiller manufacturer's requirements.

2.08 CHILLER MOUNTED VARIABLE SPEED DRIVE (VSD)

A. The chiller shall be furnished with an air cooled variable speed drive (VSD).

B. The VSD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96 at all loads for VSD. All other starters shall have a minimum displacement power factor of 0.85.

C. Power semi-conductor and capacitor cooling shall be from a liquid or air cooled heatsink.

D. Unit shall have a single point power connection.

E. A molded case standard interrupting capacity circuit breaker shall be factory pre-wired with terminal block power connections and equipped with a lockable external operator handle, making it available to disconnect the chiller from main power.

F. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

G. Unit wiring shall run in liquid-tight conduit.

H. Field wired 15 amp, 115-volt GFCI convenience outlet shall be factory mounted on the exterior of the control panel.

2.09 REFRIGERANT CIRCUIT

A. chiller shall have 2 refrigeration circuits, each with one or two (manifolded) compressor(s) on each circuit.

B. Provide for refrigerant circuit:
   1. Liquid line shutoff valve
   2. Suction service valve
   3. Discharge service valve

4. Filter (replaceable core type)
5. Liquid line sight glass.
6. Electronic expansion valve sized for maximum operating pressure
7. Charging valve
8. Discharge and oil line check valves
9. High side pressure relief valve
10. Integrated oil loss sensor

C. Full operating charge of R-513A and oil.

2.10 CONTROLS

A. A color, touch sensitive liquid crystal display (LCD) shall be unit mounted and a minimum of 7" diagonal. Animated graphical representations of chiller subsystem operation shall be provided at the user interface.

B. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, and motor information as well as associated diagnostics.

C. The chiller control panel shall provide password protection of all setpoints.

D. The controller shall have the ability to display all primary sub-system operational parameters on dedicated trending graphs. The operator shall be able to create up to 6 additional custom trend graphs, choosing up to 10 unique parameters for each graph to trend log data parameters simultaneously over an adjustable period and frequency polling.

E. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer.

F. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:
1. Run time.
2. Number of starts.
3. Current chiller operating mode.
4. Chilled water set point and set point source.
5. Electrical current limit set point and set point source.
6. Entering and leaving evaporator water temperatures.
7. Saturated evaporator and condenser refrigerant temperatures.
8. Evaporator and condenser refrigerant pressure.
9. Oil tank pressure.
10. Differential oil pressure.
11. Compressor motor current per phase.
12. Compressor motor percent RLA.
13. Compressor motor voltage per phase.
14. Phase reversal/unbalance/single phasing and over/under voltage protection.
15. Low chilled water temperature protection.

16. High and low refrigerant pressure protection.
17. Load limit thermostat to limit compressor loading on high return water temperature.
18. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize chiller efficiency.
19. Display diagnostics.
20. Oil pressure control based off of maintaining system differential pressure.
21. Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.
22. Oil loss indication.

G. Mount weatherproof control panel on chiller, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer.

H. The chiller controller shall utilize a microprocessor that will automatically take action to prevent chiller shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

I. Provide the following safety controls with indicating lights or diagnostic readouts.
1. Low chilled water temperature protection.
2. High refrigerant pressure.
3. Low oil flow protection.
4. Loss of Oil diagnostic
5. Loss of chilled water flow.
6. Contact for remote emergency shutdown.
7. Motor current overload.
8. Phase reversal/unbalance/single phasing.
9. Over/under voltage.
10. Failure of water temperature sensor used by controller.
11. Compressor status (on or off).

J. Provide the following operating controls:
1. A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
2. Chilled water pump output relay that closes when the chiller is given a signal to start.
3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
4. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.

5. Compressor current sensing unloader chiller that unloads compressors to help prevent current overload nuisance trip outs.
6. Low ambient lockout control with adjustable setpoint.
7. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing chiller efficiency.

K. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
1. Leaving chilled water setpoint adjustment from LCD input
2. Entering and leaving chilled water temperature output
3. Percent RLA output for each compressor
4. Pressure output of condenser
5. Pressure output of evaporator
6. Ambient temperature output
7. Voltage output
8. Current limit setpoint adjustment from LCD input.

L. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

M. Digital Communications to BAS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.

2.11 SOUND

A. Acoustics: Manufacturer shall provide both sound power and sound pressure data in decibels. Sound pressure data per AHRI 370 must be provided in 8 octave band format at full load. In addition, A-weighted sound pressure at 30 feet shall be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope. Values shall be equal to or below those listed on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the chiller package in accordance with the manufacturer's printed installation instructions.

B. Locate chiller package in the available space allowing sufficient clearance for evaporator removal, cleaning and servicing of installed equipment.

3.02 FIELD QUALITY CONTROL

A. Preliminary System Tests:

1. Preparation: Have the Company Field Advisor adjust the completed chiller package and then operate it long enough to assure that it is performing properly.
2. Run a preliminary test for the purpose of:
    a. Determining whether the system is in a suitable condition to conduct the acceptance test.
    b. Checking the adjusting equipment.
    c. Training Facility personnel.

B. System Acceptance Test:
1. System Acceptance Test shall only be performed by the chiller manufacturer's company field adviser.
2. Preparation: Notify the Director's Representative at least 3 working days prior to the test so arrangements can be made to have a Facility Representative witness the test.
3. Make the following tests:
    a. Individually test alarm indicating functions of the chiller.
    b. Individually test system setpoints and protective limits of the chiller.
4. Supply equipment necessary for system adjustment and testing.
5. Submit a typewritten report of the test results, signed by the Company Field Advisor and the Director's Representative. Enclose a copy of the report in a metal frame covered with plastic sheet glazing, mount it on the chiller package in a conspicuous location.

END OF SECTION