

TABLE OF CONTENTS

<u>Section</u>	<u>Description</u>	<u>No. of Pages</u>
DIVISION 22	PLUMBING	
Section 22-01-00	Common Work Results for Plumbing	8
Section 22-07-00	Plumbing Insulation	8
Section 22-07-00	HVAC Insulation	14
Section 22-10-00	Facility Water Distribution	9
DIVISION 23	MECHANICAL	
Section 23-05-00	Common Work Results for HVAC.....	8
Section 23-05-23	HVAC Piping Systems	20
Section 23-05-53	Identification for HVAC Piping and Equipment	10
Section 23-30-00	Air Distribution.....	12
Section 23-70-00	HVAC Equipment.....	21
Section 23-90-00	Building Automation and Control System	8
DIVISION 26	ELECTRICAL	
Section 26-00-00	Electrical General Requirement.....	7
Section 26-05-00	Electrical Distribution System	17



[Signature]
6/12/2025

DIVISION 22- PLUMBING

SECTION 22-01-00 – COMMON WORK RESULTS FOR PLUMBING

1.0 G E N E R A L

1.1 The Conditions of the Contract apply to this Section.

1.2 Examine all plans and specifications, visit the site(s) of the proposed project, and become fully informed as to the extent and character of the work required.

1.3 **REQUIRED STANDARDS**

- a. Laws and Regulations of the State of Texas.
- b. County of Nueces, City of Corpus Christi, codes and ordinances.

1.4 **COORDINATION**

1.4.1 Coordinate work under this Division to avoid conflicts and to attain satisfactory and complementary systems.

1.4.2 Coordinate work under this Division with work under other Divisions to avoid conflicts and to allow for adequate installation, maintenance, and operating space. Obtain the Engineer's approval for penetrations of other parts of the Work prior to effecting them.

1.4.3 In resolving pipe, duct and conduit coordination, meet all requirements and be guided by these general orders of precedence:

- a. Accommodate gravity flow lines with required slopes before other lines.
- b. Accommodate lines with specific slope requirements (i.e., steam) before other lines.
- c. Accommodate work with a required reference elevation before other work.
- d. Accommodate mains before branches.
- e. Accommodate pipe and duct before conduit.
- f. Accommodate large lines before small lines.
- g. Accommodate pipe before duct.
- h. Accommodate high-pressure and high-velocity duct before low-pressure and low-velocity duct.
- i. Accommodate data cable trays equally with ductwork and coordinate each with Division 26.

1.5 **DEFINITIONS**

1.5.1 Specific meanings used in Division 22 (variant forms are inferred):

- a. Work: This project, or the referenced part.
- b. Provide:

1. Furnish and install, complete with necessary appurtenances.
 2. "Provide" is implied throughout this Division unless language is specific.
- c. Required: Required by the Contract Documents.
 - d. Necessary: Necessary in order to obtain a finished system in satisfactory operating condition, and meeting all requirements.
 - e. Furnish: Procure and deliver, ready for installation, necessary and/or required.
 - f. Install: Receive, place securely, ready for connection to work specified elsewhere, and bring into satisfactory operating condition, as necessary and/or required.
 - g. Connect: Connect properly to mechanical work. This includes non-physical "connections" such as indirect waste drains.

1.6 SCOPE OF WORK

1.6.1 The work under this Division includes providing complete HVAC CONDENSATE DRAIN AND MAKE UP WATER systems for the project, internal to of the building or structure.

1.6.2 All items of labor, material or equipment not required in detail by the specifications or plans, but incidental to, or necessary for the complete installation and proper operation of all phases of work described herein, or reasonably implied in connection therewith, shall be furnished as if called for in detail by the Contract Documents.

1.7 WORKMANSHIP

All labor shall be performed in a workmanlike manner by mechanics skilled in their particular trades. All installations shall be complete in both effectiveness and appearance whether finally enclosed or left exposed. The Engineer reserves the right to direct the removal or replacement of any item which in his opinion shall not present a reasonable neat or workmanlike appearance, providing that same can be properly installed in an orderly way.

1.8 MANUFACTURER'S INSTRUCTIONS

Obtain written recommendations and installation and start-up instructions from material vendors and comply, unless otherwise required. Bring discrepancies between these instructions and project requirements to the attention of the Engineer and resolve prior to construction. Provide signed inspection report by manufacturer's representative at system start-up to verify construction and warrantability.

1.9 PERMITS AND FEES

1.9.1 Permits: Obtain special permits necessary for this portion of the Work.

1.9.2 Fees: Pay any fees associated with permits and required inspections, connections to this part of the work.

1.10 LICENSES

- a. Work under this Division shall be performed by organizations and individuals holding a current license to perform such type of work by the authority having jurisdiction. "License" in this sense means any process, regardless of its appellation, which is normally mandated by the authority in order to perform such type of work within its jurisdiction. The stipulation of this paragraph applies even if the work is located physically on property owned or controlled by a higher authority. E.G., to work within the city limits of Corpus Christi, Texas, on a Federal project, State of Texas and City of Corpus Christi licenses which would be mandated to work on a private project shall be required even though the City and State may have no jurisdiction over the higher government.
- b. In the event that the licensed organization loses its license or is unable to obtain one, or the licensed individual performing the work becomes unlicensed or departs the organization, notify Engineer immediately in writing.

1.11 UTILITY COORDINATION – Refer to Div. 33 and Civil Engineering Plans.

1.12 LISTING AND LABELLING

Materials that require listing shall be listed and labeled for the particular service if a listing is available. Obtain and comply with the terms of listing. Listed materials include:

- a. NSF: Potable water and sanitary waste systems components.
- b. UL: Electrical materials.
- c. AMCA: Air moving devices and related accessory items.
- d. ARI: HVAC equipment.
- e. FM or UL: Hazardous fluid and fire protection system components.
- f. FIA, FM or AGA: Fuel gas system components.

1.13 MATERIALS AND EQUIPMENT

- a. All materials and equipment shall be new. Products shall be currently manufactured.
- b. All materials and equipment shall be clearly marked, stamped or labeled for identification. Do not obscure nameplates.

1.14 SUBMITTALS AND REVIEW

1.14.1 Contractor shall furnish to the Engineer, within a reasonable time after award of contract, and prior to commencing any work, complete brochures in quadruplicate of all materials and equipment that the contractor proposes to furnish on the project. Data shall include descriptive literature, performance data, diagrams, capacity information, etc., to substantiate that proposed equipment will meet all of the requirements of the plans and specifications.

1.14.2 All data must be checked and any required changes noted thereon by the contractor, signed and dated prior to furnishing same to the Engineer for approval. Contractor's

attention is directed that it is mandatory that he thoroughly review data prior to furnishing same to assure that equipment is in accordance with plans and specifications and to assure prompt return of the data.

1.14.3 Deviations: Specifically call to the attention of the Engineer every proposed deviation from the Contract Document requirements. Failure to identify deviations as such constitutes a representation that all requirements are met.

1.14.4 Review of submittals shall not be construed as releasing the Contractor from responsibility, but rather as a means to facilitate coordination of the work and the proper selection and installation of the products. All work shall be subject to final acceptance by the Engineer at the completion of the project.

1.14.5 If above information is not provided complete as specified above and within the allocated time, all equipment shall be furnished exactly as specified without any substitutions.

1.15 SUBSTITUTIONS

1.15.1 Refer to the Conditions of the Contract.

1.15.2 Where one vendor is indicated for a product, [provide that product] [it is to establish a level of quality and performance; provide a product equal to that product in all respects from a vendor of equivalent performance] [alternative vendors will be considered after the contract award, at an appropriate change in contract price. Otherwise, provide the indicated product].

1.15.3 Where multiple vendors are indicated for a product, any of those vendors meeting the requirements may be submitted.

1.15.4 Some product specifications in this Division are of the Acceptable Manufacturer type. Vendors listed as Acceptable Manufacturers are acceptable as vendors. However, the product submitted is subject to review as being fully equivalent in detail to the basis of design.

1.15.5 Where multiple vendors are listed with product model numbers, each model and vendor is acceptable, provided all requirements are met. Model numbers are indicated to the extent believed necessary to identify a type and are not necessarily complete.

1.16 DRAWINGS AND SPECIFICATIONS

1.16.1 These specifications are accompanied by Drawings. The Drawings and Specifications are complementary each to the other, and what is called for by one shall be as binding as if called for by both.

1.16.2 The Drawings are generally diagrammatic. Lay out work at the site to conform to all applicable Codes and existing conditions; layout work to conform to architectural, structural, mechanical, and electrical conditions; layout work to avoid all obstructions; and to conform to details of manufacturer's installation as requirements. Provide an integrated, satisfactorily operating installation. All necessary offsets in piping, fittings,

etc., required to avoid interferences between piping, equipment, architectural, and structural elements shall be provided by the Contractor. Provide all necessary routing and offsets to avoid conflict.

- 1.16.3 Verify and arrange that sufficient space is provided for the installation of proposed products and that adequate access will exist for service, safe operation, and maintenance of equipment.

1.17 COMPLEMENTARY DOCUMENTS

- a. Contract documents are complementary; requirements are not necessarily repetitively stated at each possible subject; consider that a requirement applies wherever applicable. When either specifications or drawings illustrate work or equipment to be provided, it shall be provided as if illustrated by both with no exceptions. All support systems, ancillary equipment, utilities, and control programming requirements shall be met and provide for a complete operable system.
- b. In the event of conflicting requirements in different parts of the Documents, the more expensive shall be presumed to apply, unless the Engineer clarifies the requirement in a less expensive manner and waives the more expensive requirement in writing.
- c. Since codes and standards are incorporated by reference, a particular conflict may appear in that a reference may use language that implies that a particular requirement in the Contract Documents is waived under the reference. This is not the case, unless specifically so clarified by the Engineer. Generally, the specific Drawings and Specifications take precedence over waivers in multi-purpose reference documents.
- d. Because of licensure and workmanship requirements, persons performing the work are presumed to be familiar with applicable codes, ordinances, laws, regulations and standards. Therefore, details of materials, methods, arrangements and size contained in such publications are not necessarily replicated in the Contract Documents. This in no way deletes the requirement of the Contractor to comply. In the event of an apparent conflict between such publications and the Contract Documents, request clarification from the Engineer prior to construction. Always install work in accordance with applicable codes.

1.18 REGULATORY MATTERS

Comply with laws, rules and regulations, permit requirements, and ordinances. It is intended that the work of the Division be estimated and performed under the supervision of licensed master craftsman who are familiar with these requirements, whether illustrated or specifically detailed in the particular Contract Documents of this project or not. Therefore, regulatory requirements may not be so illustrated or detailed.

1.19 PROTECTION

All work, equipment and materials shall be protected at all times to prevent damage or

breakage either in transit, storage, installation or testing. All openings shall be closed with caps or plugs during installation. All material and equipment shall be covered and protected against dirt, water, chemicals or mechanical injury. Work, equipment, and materials which have not been adequately protected in the opinion of the Engineer shall be provided additional protection, and any damage, debris, and soiling repaired, replaced, or cleaned by the contractor at his cost upon written request by the Engineer.

1.20 CUTTING AND PATCHING

The work shall be carefully laid out in advance and the exact size and locations of openings arranged.

1.21 VIBRATION AND NOISE

Objectionable vibration and/or noise will not be tolerated, provide sound insulation around objectionable area, including lagging and isolation. This applies to both.

1.22 DEMOLITION

Coordinate with owner, contractor and other divisions before commencing work, provide notification and schedule for work.

1.22.1 All openings cut in masonry and plaster walls or concrete floors shall be core drilled or sawed when possible. Contractor shall check building construction before making penetrations to avoid cutting through structural beams and reinforcing. Contractor shall inform the engineer if reinforcing is cut or damaged while making openings. Contractor shall reinforce all openings as required by drawings and specifications. Patch and seal openings with 6000 psi cement grout. Install decorative trim (equipment flanges, framing or escutcheons) around openings in finished areas. Coordinate all cutting and patching with the other trades.

1.22.2 On any work shown on mechanical drawings requiring demolition of existing or new building structures and finishes, it shall be the responsibility of the contractor to complete the necessary demolition. Contractor shall patch and repair all demolition work. Patching shall be completed with the same materials as the surrounding areas, or with Engineer-approved patching materials. Repairs shall be completed according to architectural specifications. All refinishing shall be approved by the architect.

1.22.3 All pipes, ductwork fasteners and equipment removed during demolition shall be disposed of by the contractor unless specifically noted otherwise. Sections and ends of pipes and ducts which remain in the building shall be properly capped and sealed to prevent leakage; ends shall be trimmed back to a wall, ceiling or other structure which is new or existing and refinished to look neat and not detract from the surroundings. Broken areas left by fasteners in exposed walls and ceilings shall be filled and smoothed over with proper patching materials. Fastener and bracket damages in finished areas shall be dealt with in accordance with the note above.

1.23 RECORD DOCUMENTS

1.23.1 Drawings: Prior to final acceptance, request mechanical drawings from the Engineer. Revise the drawings to reflect as-built conditions, including all addenda, change orders, final shop drawing reviews, and field routing. Underground utilities shall be dimensionally located relative to readily accessible and identifiable permanent reference points, with accurate slope and elevation indicated. Submit prints for review. Revise, certify accuracy, and provide two final sets to the Engineer.

1.23.2 Owner's Manual: Prior to final acceptance, provide two bound volumes to the Engineer. Index by subject. Include corrected submittals and shop drawings that reflect final review comments; installation, operation and maintenance instructions, parts lists, wiring diagrams, and piping diagrams; warranties.

1.24 INSPECTION, OBSERVATION, AND TESTING

1.24.1 Cooperate with Engineer's representative and authorities having jurisdiction. Provide complete access to the work at reasonable times.

1.24.2 Cover-up: Prior to covering up work, or conducting observed tests, request observation as appropriate. Provide adequate advance notice. In some cases the Engineer's representative may waive observation; otherwise arrange for observed construction and testing prior to cover-up.

1.24.3 Pre-Testing: Self-inspect, pre-test, and remedy work prior to performing observed tests.

1.24.4 Sectional Work: In circumstances where a requirement for phased construction or other considerations dictate sectional construction and/or testing, notify the Engineer when construction begins on the first section of a system, and when the first section will be ready for observed testing, as well as subsequent sections. Test in the largest practical sections.

1.25 WORK PERFORMED UNDER OTHER DIVISIONS

1.25.1 Refer to Division 33 for piped utilities beyond 5' 0" from the building perimeter.

1.25.2 Refer to Division 26 for power wiring systems external to equipment and control panels; starters in motor control centers; safety switches not integral to equipment or starters.

1.26 REFERENCES TO OTHER DIVISIONS

1.26.1 Refer to Division 26 for additional material requirements of electrical components provided under Division 22, such as loose starters, wiring and devices integral to equipment.

1.26.2 Refer to Division 33 for additional requirements governing excavation and backfill, supplemental to the requirements stated in this Division 22.

1.26.3 Comply with all requirements applicable to work required under this Division.

1.27 TESTING SERVICES

1.27.1 Additional Testing: In addition to any specified testing, the Engineer may cause additional testing to be performed by an independent testing laboratory or any other qualified party. If such testing reveals deficient work by the Contractor, the Contractor shall pay for both the testing and remedial work. If such testing does not reveal deficient work by the Contractor, the Owner shall pay for the testing and the cost of repairing any damage caused by such testing.

1.27.2 Specified Testing Services: If independent testing services are specified regarding work under this Division, cooperate fully with the testing agency. Provide access to the work. Provide test holes and taps necessary. Remove work that is not tested on site, deliver to testing agency, and reinstall if undamaged; replace if damaged. Provide utilities, operational capability, and facilities for on-site testing as necessary.

1.28 WARRANTY

1.28.1 All equipment under Division 22 shall carry a full warranty, including parts and labor, for a period of one year from the date of final construction payment. Submit warranty letters with Operation and Maintenance manuals.

END OF SECTION

DIVISION 22 - PLUMBING

SECTION 22-07-00 - HVAC INSULATION

1.0 GENERAL

1.1 The Conditions of the Contract apply to this Section.

1.2 Section 15000, "Mechanical General Requirements," applies to this section.

1.3 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent applicable.

1.3.1 Federal Specification (Fed. Spec):

HH-B-100B Barrier Material Vapor (For Pipe, Duct and Equipment Thermal, Insulation)

L-P-535E Plastic Sheet (Sheeting); Plastic Strip: Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid

1.3.2 Military Specifications (MIL. Spec):

MIL-A-3316B (7) Adhesives, Fire-Resistant, Thermal Insulation

MIL-C-19565C Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor Barrier

MIL-A-24179A (2) Adhesive, Flexible Unicellular-Plastic Thermal Insulation

1.3.3 American Society for Testing and Materials (ASTM) Publications:

A 167 Stainless and Heat-Resisting Chromium- Nickel Steel Plate, Sheet and Strip

C 177 Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, Test Method

C 195 Mineral Fiber Thermal Insulating Cement

C 533 Calcium Silicate Block and Pipe Thermal Insulation

C 534 Performed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

C 547 Mineral Fiber Performed Pipe Insulation

C 522 Cellular Glass Block and Pipe Thermal Insulation

C 553 Mineral Fiber Blanket and Felt Insulation (Industrial Type)

C 592 Mineral Fiber Blanket Insulation and Blanket Type Pipe Insulation (Metal-Mesh covered) (Industrial Type)

C 612 Mineral Fiber Block and Board Thermal Insulation

- C 916 Adhesives for Duct Thermal Insulation
- C 921 Properties of Jacketing Materials for Thermal Insulation
- E 84 Surface Burning Characteristics of Building Materials
- E 96 Water Vapor Transmission of Materials
- 1.3.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MMS) Publications:
 - SP 58 Pipe Hangers and Supports - Materials, Design, and Manufacture
 - SP 69 Pipe Hangers and Supports - Selection and Application
- 1.3.5 National Fire Protection Association (NFPA) Publication:
 - 255 Surface Burning Characteristics of Building Materials, Method of Test
- 1.3.6 Underwriters Laboratories, Inc. (UL) Publication:
 - 723 Test for Surface Burning Characteristics of Building Materials
- 1.4 REQUIRED STANDARDS
 - a. Laws and Regulations of the State of Texas
 - b. County of Nueces, City of Corpus Christi, Texas, codes and ordinances
- 1.5 SUBMITTALS
- 1.5.1 Manufacturer's Data:
 - a. Insulation materials
 - b. Vapor barrier materials
 - c. Accessory materials
- 1.5.2 Shop Drawings: Insulation system assemblies other than those specified as manufactured assembled systems.
- 1.5.3 Samples:
 - a. Insulation Materials (if other than specified)
 - b. Paint color chips
- 1.6 DEFINITIONS - INSULATION MATERIALS
- 1.6.1 Manufacturer's Stamp or Label: Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to the project site for use must have the manufacturer's stamp or label attached giving name of manufacturer, brand and description of material. Insulation packages and containers shall be marked "asbestos-free."
- 1.6.2 Fire Resistance:

- a. Indoor materials: Insulation, adhesives, vapor-barrier materials and other accessories, except as specified herein, shall be noncombustible. The materials shall have a flame-spread of not more than 25 and a smoke- developed rating of not more than 50. Provide the above ratings in accordance with NFPA 255, ASTM E 84 or UL 723.
- b. Outdoor materials: Flexible unicellular insulation shall have a flame-spread rating of 25 or less but shall be exempt from smoke-developed rating.
- c. Materials tests: Test factory-applied materials as assembled. Field-applied materials may be tested individually. Use no fugitive or corrosive treatments to impart flame resistance. UL label or satisfactory certified test report from an approved testing laboratory will be required to indicate that fire hazard ratings for materials proposed for use do not exceed those specified. Flame-proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.
- d. Nylon anchors and PVC fittings and valve covers shall be exempt from fire-resistant rating.

1.7 GENERAL REQUIREMENTS

Insulate all hot and cold surfaces unless otherwise indicated. Surfaces, such as equipment, that are inadequately insulated shall be insulated. All equipment, including tanks, strainers, pumps, chillers, valves, pressure vessels and heat exchangers shall be insulated.

2.0 PRODUCTS

2.1 INSULATION

2.1.1 Buried Pipe Insulation: All buried chilled water HVAC system piping shall be pre-insulated conduit with an ASTM-A-53 grade A or B electric welded or ASTM-A-120 steel internal pipe and white polyvinyl chloride (PVC) seamless (minimum 0.070 inch wall) external pipe, meeting SCS-430 EE. The annulus shall be filled with a minimum of 1 1/2-inch thick polyurethane foam insulation or polyisocyanurate foam, with a "k" factor of .14 at 75°F. Pipe connections and fittings shall be butt welded or threaded with either wrought steel or malleable iron fittings. Refer to piping systems Section 15250 "HVAC Piping Systems."

2.1.1.1 Buried Pipe Insulation at Fittings: All buried pipe fittings shall be insulated as part of the pre-insulated conduit system with materials, covers and vapor barrier systems provided by or approved by the pre-insulated conduit manufacturer. Fittings shall generally be insulated with pre-molded polyisocyanurate insulation, sealed with mastic, and covered with pre-molded PVC sections. The outside of the PVC covers, at seams, shall be sealed with 6-inch wide strips of Grace Servi-Wrap, 65 mil.

2.1.2 System I: Flexible Unicellular insulation tubing with $k = .27 \text{ BTU-in/hr-ft}^2\text{-}^\circ\text{F}$, applied

with manufacturer's recommended adhesive to pipe surface, joints, and seams. Suitable from -40°F to +220°F. Armstrong Armaflex AP 2000.

- 2.1.3 System II: System I, finished in 2 coats of Armaflex vinyl lacquer in color as selected by Engineer.
- 2.1.4 System III: Flexible unicellular insulation sheet with $k = .28 \text{ BTU-in/hr-ft}^2\text{-}^\circ\text{F}$, applied with manufacturer's recommended adhesive to pipe surface, joints, seams, and between sheets. Not fire rated. Finish in 2 coats of Armaflex vinyl lacquer - flexible waterproof paint in color as selected by Engineer. Armstrong Armaflex II.
- 2.1.5 System IV: Fibrous glass, preformed to match pipe O.D., fibers bonded by phenolic resin. Provide all-service jacket of laminated aluminum foil interior and white kraft paper exterior with fiberglass scrim reinforcing. Self-sealing tape edges may be used if tightly bonded to clean paper. Otherwise, use staples and vapor-proof white tape. Jacket vapor transmission shall be #0.01 perm. Pipe joints, fittings and valves shall be insulated with a similar system, field cut and taped. Rated at 0-450°F continuous duty. Certainteed 500° Snap-on; Manville Micro-Lok; Owens-Corning ASJ.
- 2.1.6 System V: Same as System IV, except that where possible, fittings, joints and valves shall be jacketed with stapled and taped white PVC moldings, 25 mil minimum thickness, and filled with preformed fibrous glass sections. Manville Zeston 2000; Proto LoSmoke.
- 2.1.7 System VI: Foamed cellular glass with compressive strength of 100 psi, or 5 pcf density, $k = 0.35 \text{ BTU-in/hr-ft-}^\circ\text{F}$ at 75°F, impermeable, non-absorptive. Rated for -290°/+120°F. Coat joints and seams with hot asphalt. Finish with white PVC fitting covers and jacketing for indoor use, 25-mil minimum thickness. Pittsburgh Corning Foamglass block; Ceel-co 330-UVR Cealtite jacket; Proto Lo-Smoke.
- 2.1.8 System VII: System VI, except with finish of white PVC fitting covers and jacketing for outdoor use. Ceelco 330-UVR; Proto Lo-Smoke.
- 2.1.9 System VIII: Foamed cellular glass with compressive strength of 100 psi, 8.5 pcf density, $K = .35 \text{ BTU-in/hr-ft-}^\circ\text{F}$ at 75°F, impermeable, non-absorptive. Rated for 0-400°F. Coat joints and seams with gypsum cement. Finish with a corrosion-resistant Tedlar faced glass fabric-Hypalon.
- 2.1.10 System IX: Flexible mineral fiber blanket, 1 ½ – 3 inches thick, 0.75 pcf density, $k = 0.24 \text{ BTU-in/hr-ft-}^\circ\text{F}$ at 75°F, foil facing.
- 2.1.11 System X: Flexible mineral fiber blanket, 1 ½” and 2” inches thick, 0.75 pcf density, $k = 0.24 \text{ BTU-in/hr-ft-}^\circ\text{F}$ at 75°F, foil facing.
- 2.1.12 System XI:
- a. Fibrous glass board; 3 pcf density; $k = 0.22 \text{ BTU-in/hr-ft-}^\circ\text{F}$ at 75°F; 0.002-inch foil scrim facing for air conditioning ducts outside covering. Owens-Corning 703

with FRK-25 jacket.

- b. Secure with waterproof, fire-retardant type, adhesive, and impale anchors (16" O.C.), galvanized steel, 12 gage, self-adhesive pad or welded. Cover with vapor sealing patches. Seal joints with 5-inch wide self-adhesive metal tape.

- 2.1.13 System XII: Fibrous glass board, 3 pcf density, $k=.22$ BTU-in/hr-ft-°F, with aluminum foil reinforced jacket with fiberglass scrim and laminated to craft paper, 0.02 perm transmission. Secure to duct with adhesive and mechanical fasteners, 16 inches on center. Rated 450°F. Owens-Corning 703 with FRK-25 jacket and white 0.015" PVC jacketing material. All seams and joints shall be sealed with 3-inch wide glass fabric and vinyl acrylic. Vinyl acrylic shall be brushed on or hand applied to a smooth finish. Finish color shall be gloss white.
- 2.1.14 System XIII: Semi-rigid fibrous glass blanket, rated for grease duct application UL 1479. Apply first layer in a thickness equalling the depth of external duct reinforcement, mechanically fastened to duct with welded pins and speed clips not more than 16 inches on center. Apply second layer with staggered joints and secure with stainless steel bands. Install per UL Five Stop System No. C-AJ-7032. Certainteed Flame Check Fiberglass Insulation.
- 2.1.15 System XIV: Install a layer of Dow Trymer 2000, rigid polyisocyanurate foam insulation, 2.05 lbs/ft³ density, ASTM D-1622. Material shall have a $k = .14$ BTU-in/hr-ft-°F at 75°F, temperature application limits -297°F to +300°F. Install a single layer of foam. Apply the foam in preformed shapes on piping and fittings. Use sheets and blocks to insulate equipment. Pack voids with loose fiberglass batting. Secure the foam in place with 16 gauge 304 stainless steel wire and seal with Childers CP-10 or CP-11 VI-Gryl vinyl-acrylic mastic. Jacket the insulation with Childers 0.022-inch Aluminum Jacketing of appropriate thickness for the type of space. Secure jacketing with 1/2-inch aluminum bands per manufacturer's recommendation.
- 2.1.16 System XV: Install the same insulation, polyisocyanurate, as in system XIV, but eliminate the metal jacketing. Install Speed Line Mfg. Co. PVC (0.010 inches thick) preformed zip jackets on all pipe and fittings. Secure with aluminum bands, 1-inch vinyl tape and vinyl adhesive per manufacturer's recommendations. Material color shall be as detailed in the identification schedule at the end of this section. PVC jacket shall provide a complete vapor barrier with a minimum rating of 0.03-perm vapor transmission.
- 2.1.17 System XVI: Phenolic foam insulation, preformed pipe, board and curved sections. Insulation shall be equal to Childers Koolphen k, 2.2-lbs/cu ft density. With an average $k = .13$ BTU-in/hr-ft²°F at 75°F. Temperature application limits are -290°F to +250°F. Apply the foam in preformed shapes, pipe, and fittings. Utilize curved sections and board materials to insulate boxes, pumps, casings, vessels, and other equipment. Pack voids and expansion joint gaps with loose fiberglass batting material. Secure the foam in place with glass tape or 1/2-inch wide 304 stainless steel bands (all lines over 12-inch dia.). Seal the joints with Childers CP-76 X CHIL-BYY joint sealant. Use Childers CP-56 CHIL STIX X WB water-based pressure sensitive adhesive to adhere, pieced insulation to piping and equipment. A vapor barrier of 30-50 mils of Childers CHIL-

Perm WB shall be applied with glass mesh reinforcing, Childers' CHIL-Glas #10, as specified by the manufacturer. On Piping provide PVC jackets, white and paint per spec color.

2.1.18A System XVII: Same as System XVI, except install 0.020-inch aluminum jacketing as indicated.

2.1.18B System XVIIIB: Same as System XVII, except install 0.020-inch aluminum jacketing as indicated.

2.1.19 System XVIII: Same as System XVI except wrapped with Grace Servi-Wrap, 65 mil Bituminous rubber vapor barrier material.

2.1.20 System XIX: Calcium silicate with metal jacket. IIG Thermo-12 Gold, high temperature, abuse-resistant pipe and block insulation. Composed of hydrous Calcium Silicate for use on systems operating up to 1200oF (649oC). Thermo-12 Gold shall meet or exceed the physical and thermal property requirements of ASTM C533, Type I. Density – 14.5 pcf, k = 0.60 Btu/hr ft²°F at 600°F.

2.2 INSULATION FINISHES

2.2.1 All Purpose Jacket: All permeable pipe insulation shall be provided with a factory applied all-purpose jacket with integral vapor barrier as required by the service. Provide jackets on insulation in exposed locations with a white surface suitable for painting without sizing. All-purpose jacket shall have a permeability rating of not more than 0.02 in accordance with ASTM D 781; and a tensile strength of not less than 35 lbs/in./width in accordance with ASTM D 828.

2.2.2 Vapor-Barrier: Material shall be resistant to flame and moisture penetration and not support mold growth. Vapor-barrier shall be provided on insulation as required for all cold services, and in crawl spaces, tunnels, outdoor service and trenches.

2.2.3 Metal Jackets: Pipe insulation located outside and passing through sleeves where caulking is required shall be provided with metal jackets. Metal jackets located outside shall have a moisture barrier lining unless the surface of the insulation to which it is applied is provided with a vapor barrier jacket. Do not apply metal jackets to insulated piping that is buried or encased in concrete.

a. Aluminum jackets: ASTM B 209, Temper H14, 0.020-inch thick, smooth.

b. Stainless Steel Jackets: Type 304 316 0.010- 0.016-inch thick, smooth.

2.2.4 Fittings, Flanges, and Valves in Outside Locations: Finish elbows and curved piping with factory-fabricated metal covers. Finish tees, flanges, and valves with metal covers. Covers shall be same thickness and material as jackets on adjacent piping.

2.2.5 Vinyl Lacquer: Unicellular insulation located outside shall be coated with two coats of latex base finish recommended by the insulation manufacturer in color as selected by Engineer.

2.3 FIRESTOPPING

General Electric "Pensil" firestop. Fill voids with "Pensil 500" intumescent putty and seal exposed surfaces with "Pensil 100" sealant. System shall meet UL 278V and carry a UL label. System shall be used at all fire barrier penetrations.

2.4 SLEEVE INSULATION

Foamglas sleeve insulation, ASTM C552 cellular glass, 1-inch thick, with Childers CP11 mastic seal or fibrous glass, ANSI/ASTM C553, Owens-Corning Fiberglass - Series 701, semi-flex, 1-inch thick, $k = 0.24 \text{ BTU-in/hr-ft-}^{\circ}\text{F}$ at 75°F , wrapped into sleeve and sealed with Childers CP-30 V.B. and Childers CP-10 mastic at non-fire rated barriers.

2.5 STAPLES

Stainless steel or monel.

3.0 EXECUTION

3.1 GENERAL

Insulation materials shall not be applied until all systems tests have been satisfactorily completed and surfaces to be insulated have been cleaned and dried. Insulation shall be clean and dry when installed and during the application of any finish. Install materials neatly with smooth and even surfaces with jackets drawn tight and smoothly cemented down on longitudinal and end laps. Scrap pieces shall not be used where a full-length section will fit. Insulation shall be continuous through sleeves, wall and ceiling openings, except at fire walls. Piping shall be individually insulated. A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces for which a vapor seal is specified. Where practical, avoid penetrations of the vapor barrier.

3.2 PIPE INSULATION

- 3.2.1 Pipe Insulation (Except Unicellular and Calcium silicate Insulation): Sections of insulation shall be placed around the pipe and tightly butted into place. The jacket laps shall be drawn tight and smooth and secured with fire resistant adhesive or factory applied self-sealing lap and with non-corrosive outward clinching staples spaced not over 4 inches on centers and 1/2-inch minimum from edge of lap. Circumferential joints shall be covered with butt strips, not less than 3 inches wide, of material identical to the jacket material. Adhesive used to secure the butt strip shall be the same as used to secure the jacket laps. Staples shall be applied to both edges of the butt strips. When a vapor barrier is required, as indicated in the Application Schedule, staples and seams shall be sealed with a brush coat of fire resistant vapor-barrier coating applied at all longitudinal and circumferential laps. Ends of sections of insulation that butt against flanges, unions, valves, and fittings, and joints at intervals of not more than 12-feet on continuous runs

of pipe shall be coated with a vapor barrier coating. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and cementing, stapling and coating as specified for butt strips. The patch shall extend not less than 1-1/2 inches past the break in both directions. At penetrations such as thermometers, the voids in the insulation shall be filled with vapor barrier coating and the penetration sealed with a brush coat of the same coating. Staples shall not be used to secure jacket laps on pipes carrying fluid medium at temperatures below 35°F.

3.2.2 Flexible Unicellular Insulation: Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. After adhesive cures, apply 2-inch wide, pressure sensitive, adhesive, vinyl tape on 9- inch centers. Where pipes penetrate firewalls, provide mineral-fiber insulation inserts and sheet metal sleeves. On cold piping, secure insulation to pipe with adhesive. Vapor-barrier or metal jackets are not required on flexible unicellular insulation. Insulate flanges, unions, valves, and fittings in accordance with manufacturers published instructions.

3.2.3 Calcium Silicate Pipe Insulation: Insulation shall be applied in two layers with the joints tightly butted and staggered a minimum of 3 inches. For high temperature, as recommended by the manufacturer. The inner layer of insulation shall be secured with 14-gauge soft annealed stainless steel wire on 12-inch maximum centers. The outer layer shall be secured with stainless steel metal bands on 12-inch maximum centers. Apply a skim coat of setting cement directly to the insulation. Apply a flooding coat of adhesive over the dry cement, and while still wet, press a layer of glass cloth or tape into adhesive and seal laps and edges with adhesive. Coat cloth with adhesive cut at a ratio of one part water to five parts adhesive in color other than the finish color for the purpose of visual inspection to insure sizing of entire surface. When dry, apply a finish coat of adhesive.

3.3 HANGERS AND ANCHORS

3.3.1 Avoid penetrating pipe insulation with hangers, but when penetrated, pipe insulation shall be continuous through pipe hangers. Where pipe is supported by the insulation, shields or saddles conforming to MSS-SP-69 shall be provided. Insulation inserts shall be provided at points of hangers and supports. Insulation inserts shall be molded glass fiber (minimum 8 pcf) or other approved material of the same thickness as the adjacent insulation. Insulation inserts shall cover the bottom half of the pipe circumference and be not less in length than the protection shield. Vapor-barrier facing of the insert shall be of the same material as the facing on the adjacent insulation. Seal inserts into the insulation with vapor barrier coating. Where protection saddles are used, fill all voids with the same insulation material as used on the adjacent pipe. Where anchors are secured to cold piping to be insulated, insulate anchors same as piping for a distance not less than four times insulation thickness to prevent condensation. Insulation around anchors shall be vapor sealed.

3.3.2 Inserts Required:

<u>Service</u>	<u>System</u>	<u>Insert</u>	<u>Remarks</u>
All	I, II	None	

Hot Water, Steam	IV, V	Wood	(1)
Steam Condensate		Steel	(2)
All	VI, VII, VII	None	
Chilled/Hot Water	XIV (Outdoor)	Cellular Glass	(3)
HVAC (All Commercial Projects)	XV (Indoor)	Cellular Glass	(3)

Remarks

- (1) Below 300°F fluid and 8" pipe
- (2) Above 300°F fluid and 6" pipe
- (3) Eliminate on steel shoes, insulate shoes with System II

3.4 SLEEVES AND WALL CHASES

Where penetrating walls, extend a metal jacket 2 inches out on either side of the wall and secure on each end with a band. Where penetrating floors, extend a metal jacket from a point below the back-up material to a point 10 inches above the floor with one band at the floor and one not more than one inch from end of metal jacket.

3.5 FLANGES, UNIONS, VALVES AND FITTINGS (EXCEPT FLEXIBLE UNICELLULAR)

When segments of insulation are used, provide elbows with not less than three segments. For other fittings and valves, cut segments to required curvature, or use nesting size sectional insulation. Place and join the segments of the insulation with adhesive. After the segments are in place, apply vapor barrier coating as applicable. Where unions, flanges, and valves are to be insulated with removable sections, terminate the covering neatly at the ends with insulation cement trowelled on a bevel. Apply a vapor barrier coating to the beveled ends. Cover unions and flanges and valve bonnets with removable sections of insulation vapor barrier sealed inside and outside with adjacent insulation ends neatly finished and vapor barrier sealed.

3.6 BARRIERS

3.6.1 Vapor Barrier: On cold surfaces, and other surfaces as required, provide a continuous vapor barrier composed of appropriate materials, without gaps or vapor transmission bridges through the material.

3.6.2 Fitting and Valve Insulation Vapor Barrier: Outer surfaces of the insulation shall be vapor sealed as follows: A single layer of open weave glass fabric 20 x 20 mesh shall be embedded into the wet coat. The fabric shall be drawn smooth and tight with a 2-inch overlap at all joints. When the first coat is dry, a final coat of vapor barrier compound thickness shall be applied. For temperatures above 35°F, one piece premolded fitting and valve covers made of polyvinyl chloride (PVC) with precut insulation insert conforming to ASTM C 553, Type I, Class B5, may be used. Covers shall overlap adjoining pipe covering and vapor barrier jackets. The use of PVC fitting covers shall be limited to not less than 35°F medium temperatures and below 150°F ambient temperatures.

- 3.6.3 Weather Barrier: On hot surfaces, indoor or out, provide a water-tight weather barrier (permeable) to prevent impinging water droplets from entering the insulation system from any direction.

3.7 METAL JACKETS

Metal jackets shall have side and end laps at least 2 inches wide with the cut edge of the side lap turned under one inch to provide a smooth edge. Place laps to shed water. Seal laps on chilled and cold piping with weatherproof coating. Secure jackets in place with stainless steel bands on 9-inch centers or aluminum or stainless steel screws on 5-inch centers. Where pipes penetrate exterior walls, continue the increased insulation thickness required for piping exposed to weather and the metal jackets through the sleeve to a point 2 inches beyond the interior surface of the wall. For fittings, flanges, and valves in outside locations, secure metal covers in place with metal bands and seal with a weatherproof coating. Protect fittings, flanges, and valves with a weatherproof coating prior to installation of metal covers.

- 3.8 PAINTING: All steel parts including piping, hangers, duct supports and pipe supports are to be cleaned by SSPC-SP-2-63T hand cleaning or if oil or grease is present, then solvent cleaning SSPC-SP-1-63T will precede the hand cleaning. Prime coat to be 3 Mils minimum Oil Alkyd primer with Zinc Chromate with Alkyd topcoat 3 Mils Grey or other color selected by Engineer. This specification will be used unless other piping painting requirements are shown in Section 9 or on the drawings.

Color Coding: Paint all pipe color codes per the Identification Schedule. Use paint systems compatible with the vapor barrier material, or use color-coded PVC jacket. All pipe indoors shall be coded and labeled. Exterior pipe only shall be labeled unless specifically noted otherwise.

3.9 APPLICATION SCHEDULE

PIPING

<u>Service</u>	<u>Limits</u>	<u>Size</u>	<u>Location</u>	<u>System</u>	<u>Thickness</u>	<u>Remarks</u>
Chilled Water	40°F	All Pipe	Outdoor Indoor Abuse Areas	XVII/XV XVII	2 1/2" 2"	
Hot Water	400°F	All Pipe	Indoor Outdoor Indoor	XVI IV V	2" 2 1/2" 2 1/2"	Provide Aluminum 0.020 Jacket

<u>Service</u>	<u>Limits</u>	<u>Size</u>	<u>Location</u>	<u>System</u>	<u>Thickness</u>	<u>Remarks</u>
Condensate Drain	50°F	1/2-2"	Indoor Outdoor	I II	3/4"	

DUCTWORK

Supply, Return, Outside Air, and Exhaust		≤30" Rect. >30" All round	Conditioned	XI XI	2" 3"	(3) (3)
Supply and Return		All	Outdoor	III	3"	(2) (5)
Supply, Return, Outside Air, and Exhaust		≤30" Rect. >30" All round	Unconditioned Unconditioned	XI XI	2" 2"	(4) (4)
Diffuser Necks and Spin-In Fittings		All		IX	2 1/2"	

EQUIPMENT

Expansion tanks, basket, strainers, exchangers	40°-90°F	As required, up to 72" dia.	Indoor	III	1"	(4)
Tanks, vessels, exchangers	40°-300°F	As required, up to 20' 0" dia x 100' L	Indoor Metal Jacket	XIV	1"	(4)
	40°-300°F	As required, up to 20' 0" dia x 100' L	Outdoor Metal Jacket	XIV	2"	

<u>Service</u>	<u>Limits</u>	<u>Size</u>	<u>Location</u>	<u>System</u>	<u>Thickness</u>	<u>Remarks</u>
Pumps, Mechanical Equipment	40°-180°F	As required	Indoor	III	1"	(4)
	40°-180°F	As required	Outdoor	XIV	2"	

Note:

All fittings, flanges, and valves (except valve stems, hand wheels, and operators) in piping systems requiring insulation, i.e., the entire system, shall be insulated unless otherwise specified. Fitting, flange, and valve insulation shall be premolded, precut, or job-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be cleanable, grease-resistant, non-flaking and non-peeling.

Remarks:

- (1) Do not use in attics.
- (2) Total thickness of two layers. Provide staggered joints.
- (3) Treat return-air plenums similarly.
- (4) Indoor space that is not conditioned and not a return air plenum. Includes ventilated and unventilated attics. Includes partially or spot-conditioned areas including kitchen and laundry.
- (5) Apply with staggered joints and 100% adhesive between layers.
- (6) For return air plenum areas.

3.10 PREPARATION

3.10.1 Install materials after piping and ductwork piping and equipment have been tested and approved.

3.10.2 Clean surfaces for adhesives.

3.11 INSTALLATION

3.11.1 Install materials in accordance with manufacturer's instructions.

3.11.2 Provide installation with vapor barrier when air conveyed may be below ambient temperature.

3.12 INSULATION APPLICATION

3.12.1 Secure insulation and vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

3.12.2 Secure insulation without vapor barrier with staples, tape, or wires.

3.12.3 Install without sag on underside of ductwork, tanks and equipment. Use adhesive or mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive. Stop and point insulation around valve actuators, equipment tags, ASME stamps, inspection ports, rotary connections, flanged vessel heads, instruments, access doors and damper operators to allow operation without disturbing insulation.

3.13 IDENTIFICATION SCHEDULE

3.13.1 Piping and Equipment Systems:

<u>Material/Unit</u>	<u>Color</u>	<u>Label Sized to be Visible</u>	<u>Label Data</u>
Chilled Water Supply	Drk. Blue	Chilled Water Supply	
Chilled Water Return	Lt. Blue	Chilled Water Return	
Hot Water Supply	Orange	Hot Water Supply	Temperature
Hot Water Return	Yellow	Hot Water Return	
Condenser Water Supply	Med. Green	Condenser Water Supply	
Condenser Water Return	Lt. Green	Condenser Water Return	
Compressed Air	Drk. Green	Compressed Air	Pressure
Gas Lines	Drk Yellow	Natural Gas	Pressure
Steam	White	Steam	Pressure
Steam Condensate	White	Steam Condensate	
<u>Material/Unit</u>	<u>Color</u>	<u>Label Sized to be Visible</u>	<u>Label Data</u>
Domestic Water	White	Domestic Water	

Fire Water	Red	Fire Line	
Vacuum	Black	Vacuum	
Pumped Effluent	Brown	(Name of Material)	Hazard
Medical Gas	Per Code	(Name of Material)	Hazard
Roof Drains /A/C Condensate	White		

END OF SECTION

DIVISION 22 - PLUMBING

SECTION 22-07-00 - PLUMBING INSULATION

1.0 GENERAL

1.1 The Conditions of the Contract apply to this Section.

1.2 Section 22-01-00

1.3 REFERENCE PUBLICATIONS

The publications listed below form a part of this specification to the extent applicable.

1.3.1 Federal Specifications (Fed. Spec.):

HH-I-573B Insulation Thermal (Flexible Unicellular)

1.3.2 American Society for Testing and Materials (ASTM) Publications:

A 47 Malleable-Iron Castings

A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless

A 74 Cast-Iron Soil Pipe and Fittings

C 533 Calcium Silicate Block and Pipe Thermal Insulation

C 534 Flexible Unicellular Insulation

C 547 Mineral Fiber Preformed Pipe Insulation

C 553 Mineral Fiber Blanket and Felt Insulation (Industrial) Type

C 591 Rigid Preformed Cellular Urethane Thermal Insulation

D 781 Puncture and Stiffness of Paperboard, Corrugated and Solid Fiberboard

D 828 Tensile Breaking Strength of Paper and Paperboard

E 84 Surface Burning Characteristics of Building Materials

1.3.3 National Fire Protection Association (NFPA) Publications:

54 National Fuel Gas Code

211 Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances

255 Test Methods, Surface Burning Characteristics of Building Materials

1.3.4 International Building Code

1.3.5 National Association of Plumbing-Heating-Cooling Contractors (PHCC) Publications:

National Standard Plumbing Code

1.3.6 Underwriters' Laboratories (UL) Publications:

723 Tests for Surface Burning Characteristics of Building Materials

1.4 REQUIRED STANDARDS

- a. Laws and Regulations of the State of Texas.
- b. County of Nueces, City of Corpus Christi, Texas, codes and ordinances.

1.5 SUBMITTALS

1.5.1 Manufacturer's Data:

- a. Insulation materials
- b. Jackets
- c. Vapor barrier materials
- d. Accessory materials
- e. Pre-insulated conduit

1.5.2 Samples: As required by Engineer.

1.5.3 Shop Drawings: Insulation assemblies

1.6 CERTIFICATION - INSULATION MATERIALS:

1.6.1 Manufacturer's Stamp or Label: Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use must have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material. Insulation packages and containers shall be marked "asbestos-free".

1.6.2 Fire Resistance:

- a. Insulation, adhesives, vapor-barrier materials, and other accessories, except as specified herein, shall be noncombustible. The materials shall have a flame-spread of not more than 25 and a smoke-developed rating of not more than 50. Provide the above ratings in accordance with NFPA 255, ASTM E 84 or UL 723.
- b. Materials tests: Test factory-applied materials as assembled. Field-applied materials may be tested individually. Use no fugitive or corrosive treatments to impart flame resistance. UL label or satisfactory certified test report from an approved testing laboratory will be required to indicate that fire hazard ratings for materials proposed for use do not exceed those specified. Flameproofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.
- c. Exempt materials: Materials noted as "Not Fire-Rated" are not required to meet the fire resistance ratings.

1.7 GENERAL REQUIREMENTS

A complete insulation system protecting all components subject to energy exchange or damage due to high or low temperature is required.

2.0 PRODUCTS

2.1 MISCELLANEOUS PIPING MATERIALS

2.1.1 Pipe Supports (Hangers): Provide Type 40 insulation protection shields for insulated piping.

2.2 PIPE INSULATION

2.2.1 Piping Insulation: Piping systems requiring insulation, types of insulation required and insulation thickness shall be as listed in the Insulation Application Schedule. All fittings, joints, flanges, and valves (except valve stems, hand wheels, and operators) in piping systems requiring insulation shall be insulated unless otherwise specified. Fitting, flange, and valve insulation shall be premolded, precut, or job-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling.

2.2.2 Rigid Foam Insulation: Insulation shall be modified polyisocyanurate cellular plastic rigid foam, Dow Chemical Company, Trymer 2000. Material shall be 2.0 PCF, $k = 0.14$, $R = 5.5$ at 75°F for 1" thickness, water absorption 0.05 PSF. Provide flame-safe jacket. (Use in unoccupied areas only)

2.2.3 Phenolic foam insulation: Pipe insulation shall be closed cell phenolic foam, Childers Koolphen K or equal, preformed to pipe and fitting shapes. The material shall be 97 percent closed cell by ASTM D 2856 and have water absorption of .5 percent by volume per ASTM 209. The material shall be 2.2 lbs/cu ft density with a "k" factor of .13 (BTU in/hr X sq ft x °F) at 75°F mean temperature per ASTM C 518. Pack insulation voids and expansion joints with mineral wool fiber ASTM C 553.

2.2.4 Buried Pipe Insulation: Hot water piping buried outside of buildings shall be factory fabricated, pre-insulated conduit suitable for 150 psig water service. Pipe, insulation, and outer enclosing jacket shall be a manufactured unit. Couplings, anchors, thrust-blocks and other installation details shall be not less than one inch nominal thickness of foamed polyurethane having a "K" factor of not less than 0.14 BTU/HR - sq. ft. - F/in. at 73°F. Outer enclosing jacket shall be continuous. Installation shall be in accordance with manufacturers written instructions. Shop drawings and manufacturers' written installation recommendations shall be submitted for approval prior to installation of system.

2.2.5 Flexible Unicellular Insulation: Flexible unicellular insulation shall conform to Fed. Spec. HH-I-573 and shall not be used in pipe chases and firewalls, nor penetrate

firewalls. Use an adhesive recommended by insulation manufacturer, and apply in accordance with manufacturer's published instructions.

2.2.6 Calcium Silicate Insulation: Insulation shall conform to ASTM C 533, Type II.

2.2.7 Mineral Fiber Insulation: Blanket mineral fiber insulation shall conform to ASTM C 553, Type 1, Class B-3, 3/4 PCF. Rigid mineral fiberboard shall conform to ASTM C 612, Class 2, 3 PCF. Preformed mineral fiber pipe insulation shall conform to ASTM C 547.

2.2.8 Piping Insulation Finishes:

- a. All purpose jacket: All pipe insulation, except that located outside or unicellular insulation, shall be provided with a [factory applied] all-purpose jacket with or without integral vapor barrier as required by the service. Provide jackets on insulation in exposed locations with a white surface suitable for painting without sizing. All-purpose jacket shall have a permeability rating of not more than 0.02 in accordance with ASTM D 781; and a tensile strength of not less than 35 lbs/in./width in accordance with ASTM D 828.
- b. Vapor-barrier material: Material shall be resistant to flame and moisture penetration and not support mold growth. Vapor-barrier material shall be provided on pipe insulation as required in Table II, except that all pipe in crawl spaces, tunnels, and trenches shall have a factory applied vapor barrier jacket for all services. Vapor-barrier shall be provided for all fittings and valves located in systems requiring vapor barrier.
- c. Metal jackets: Pipe insulation located outside and passing through sleeves where caulking is required shall be provided with metal jackets. Metal jackets located outside shall have a moisture barrier lining unless the surface of the insulation to which it is applied is provided with a vapor barrier jacket. Do not apply metal jackets to insulated piping that is buried or encased in concrete.
 1. Aluminum jackets: ASTM B 209, Temper H14, 0.020- inch thick, smooth.
- d. Fittings, Flanges, and Valves in Outside Locations: Finish elbows and curved piping with factory-fabricated metal covers. Finish tees, flanges, and valves with metal covers. Covers shall be same thickness and material as jackets on adjacent piping.
- e. Vinyl Lacquer: Unicellular insulation located outside shall be coated with two coats of latex base finish recommended by the insulation manufacturer in [white] [color as selected by Architect].

3.0 EXECUTION

3.1 PIPING TO RECEIVE INSULATION

All plenum mounted PVC root drains, all hot water lines, and all cold water lines with vapor barrier insulation shall meet IEC requirements.

3.2 INSULATION

Insulation materials shall not be applied until all systems tests have been satisfactorily completed and surfaces to be insulated have been cleaned and dried. Insulation shall be clean and dry when installed and during the application of any finish. Install materials neatly with smooth and even surfaces with jackets drawn tight and smoothly cemented down on longitudinal and end laps. Scrap pieces shall not be used where a full-length section will fit. Insulation shall be continuous through sleeves, wall, and ceiling openings, except at firewalls. Piping shall be individually insulated. A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces for which a vapor seal is specified.

3.2.1 Pipe Insulation:

3.2.1.1 Pipe insulation (except unicellular and calcium silicate insulation): Sections of insulation shall be placed around the pipe and tightly butted into place. The jacket laps shall be drawn tight and smooth and secured with [fire resistant adhesive] [or] [factory applied self-sealing] lap and with non-corrosive outward clinching staples spaced not over 4 inches on centers and 1/2-inch minimum from edge of lap. Circumferential joints shall be covered with butt strips, not less than 3 inches wide, of material identical to the jacket material. Adhesive used to secure the butt strip shall be the same as used to secure the jacket laps. Staples shall be applied to both edges of the butt strips. When a vapor barrier is required, as indicated in Para. 3.3, staples and seams shall be sealed with a brush coat of fire resistant vapor-barrier coating applied at all longitudinal and circumferential laps. Ends of sections of insulation that butt against flanges, unions, valves, and fittings, and joints at intervals of not more than 12-feet on continuous runs of pipe shall be coated with a vapor barrier coating. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and cementing, stapling and coating as specified for butt strips. The patch shall extend not less than 1-1/2 inches past the break in both directions. At penetrations such as thermometers, the voids in the insulation shall be filled with vapor barrier coating and the penetration sealed with a brush coat of the same coating. Staples shall not be used to secure jacket laps on pipes carrying fluid medium at temperatures below 35°F.

3.2.1.2 Flexible unicellular insulation: Bond cut, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. After adhesive cures, apply 2-inch wide pressure sensitive, adhesive vinyl tape on 9-inch centers. Where pipes penetrate firewalls, provide mineral-fiber insulation inserts and sheet metal sleeves. On chilled and cold piping, secure insulation to pipe with adhesive. Separate vapor-barrier or metal jackets are not required on flexible unicellular insulation. Insulate flanges, unions, valves, and fittings in accordance with manufacturers published instructions.

3.2.1.3 Calcium silicate pipe insulation: Insulation shall be secured with stainless steel metal

bands on 12-inch maximum centers. Insulation shall be applied in two layers with the joints tightly butted and staggered a minimum of 3 inches. For high temperature, as recommended by the manufacturer. The inner layer of insulation shall be secured with 14-gauge soft annealed stainless steel wire on 12-inch maximum centers. The outer layer shall be secured with stainless steel metal bands on 12-inch maximum centers. Apply a skim coat of insulating cement directly to the insulation. Apply a flooding coat of adhesive over the dry cement, and while still wet, press a layer of glass cloth or tape into adhesive and seal laps and edges with adhesive. Coat cloth with adhesive cut at a ratio of one part water to five parts adhesive in color other than white for the purpose of visual inspection to insure sizing of entire surface. When dry, apply a finish coat of adhesive.

- 3.2.1.4 Hangers and anchors: Pipe insulation shall be continuous through pipe hangers. Where pipe is supported by the insulation, shields or saddles conforming to MSS-SP-69 shall be provided. Where shields are used on pipe 2 inches and larger, insulation inserts shall be provided at points of hangers and supports. Insulation inserts shall be molded glass fiber (minimum 8 pcf) or other approved material of the same thickness as the adjacent insulation. Insulation inserts shall cover the bottom half of the pipe circumference and be not less in length than the protection shield. Vapor-barrier facing of the insert shall be of the same material as the facing on the adjacent insulation. Seal inserts into the insulation with vapor barrier coating. Where protection saddles are used, fill all voids with the same insulation material as used on the adjacent pipe. Where anchors are secured to piping to be insulated, insulate anchors same as piping for a distance not less than four times insulation thickness to prevent condensation. Insulation around anchors shall be vapor sealed.
- 3.2.1.5 Sleeves and wall chases: Where penetrating interior walls, extend a metal jacket 2 inches out on either side of the wall and secure one each end with a band. Where penetrating floors, extend a metal jacket from a point below the floor to a point 10 inches above the floor with one band at the floor and one not more than one inch from end of metal jacket.
- 3.2.1.6 Flanges, unions, valves and fittings: When segments of insulation are used, provide elbows with not less than three segments. For other fittings and valves, cut segments to required curvature, or use nesting size sectional insulation. Place and join the segments of the insulation with adhesive. After the segments are in place, apply vapor barrier coating as applicable. Where unions, flanges, and valves are to be insulated with removable sections, terminate the covering neatly at the ends with insulation cement trowelled on a bevel. Apply a vapor barrier coating to the beveled ends. Cover unions and flanges and valve bonnets with removable sections of insulation vapor barrier sealed inside and outside with adjacent insulation ends neatly finished and vapor barrier sealed.
- 3.2.1.7 Fitting and valve insulation vapor barrier: Outer surfaces of the insulation shall be vapor sealed as follows: A single layer of open weave glass fabric 20 x 20 mesh shall be embedded into the wet coat. The fabric shall be drawn smooth and tight with a 2-inch overlap at all joints. When the first coat is dry, a final coat of vapor barrier compound thickness shall be applied. For temperatures above 35°F, one piece premolded fitting and valve covers made of Poly-Vinyl Chloride (PVC) with precut insulation insert

conforming to ASTM C 553, Type I, Class B5, may be used. Covers shall overlap adjoining pipe covering and vapor barrier jackets. The use of PVC fitting covers shall be limited to not less than 35°F medium temperatures and below 150°F ambient temperatures, and in non-air plenum areas.

- 3.2.1.8 Metal jackets: Metal jackets shall have side and end laps at least 2 inches wide with the cut edge of the side lap turned under one inch to provide a smooth edge. Place laps to shed water. Seal laps on chilled and cold piping with weatherproof coating. Secure jackets in place with stainless steel bands on 9-inch centers or aluminum or stainless steel screws on 5-inch centers. Where pipes penetrate exterior walls, continue the increased insulation thickness required for piping exposed to weather and the metal jackets through the sleeve to a point 2 inches beyond the interior surface of the wall. For fittings, flanges, and valves in outside locations, secure metal covers in place with metal bands and seal with a weatherproof coating. Protect fittings, flanges, and valves with a weatherproof coating prior to installation of metal covers.

3.3 INSULATION APPLICATION SCHEDULE

<u>Service</u>	<u>Material</u>	<u>Pipe Sizes (Inches)</u>				<u>Vapor Barrier Required</u>	<u>Jacket Required</u>
		<u>1/4 to 1-1/4</u>	<u>1-1/2 to 3</u>	<u>3-1/2 to 5</u>	<u>6 to 10</u>		
Domestic Hot Water & Recirc. Piping #120°F	Flexible Unicellular	1.0	1.0	1.0	N/A	No	No
	Phenolic Foam	2.0	2.0	2.0	2.5	Yes	No
	Mineral Fiber	2.0	2.0	2.5	2.5	Yes	No
Domestic Cold Water Piping	Flexible Unicellular	0.5	0.5	0.5	0.5	No	No
	Rigid Foam	1.0	1.0	1.0	1.0	Yes	No
	Phenolic Foam	1.0	1.0	1.0	1.5	Yes	No
	Mineral Fiber	1.5	1.5	1.5	1.5	Yes	No
A/C Condensate Drain Located inside Building	Flexible Unicellular	3/4	3/8	3/8	NA	No	No
Roof Drains	Mineral Fiber	1.0	1.0	1.5	1.5	Yes	No

NOTE: All exterior insulation shall be 1 inch thicker than shown. All exterior exposed piping shall be with metal jacket.

END OF SECTION

DIVISION 22 - PLUMBING

SECTION 22-10-00 – FACILITY WATER DISTRIBUTION**1.0 GENERAL**

1.1 The Conditions of the Contract apply to this Section.

1.2 REFERENCE PUBLICATIONS

The publications listed below form a part of this specification to the extent applicable.

1.3.1 American National Standards Institute (ANSI) Publications:

A112.18.1M	Finished and Rough Brass Plumbing Fixture Fittings
A112.26.1	Water Hammer Arresters
A112.26.2	Water Pressure Reducing Valves for Domestic Water Supply Systems
A112.36.2	Metallic Cleanouts
B16-1	Cast Iron Pipe Flanges and Flanged Fittings
B16-3	Malleable-Iron Threaded Fittings
B16.12	Cast-Iron Threaded Drainage Fittings
B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
B16.24	Bronze Pipe Flanges and Flanged Fittings
B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
B16.39	Malleable-Iron Threaded Pipe Unions
B40.1	Gauges, Pressure, Indicating Dial Type, Elastic Element

1.3.2 American Society for Testing and Materials (ASTM) Publications:

A 47	Malleable-Iron Castings
A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A 120	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless for Ordinary Uses
A 183	Carbon Steel Track Bolt and Nuts
A 536	Ductile-Iron Castings
B 32	Solder Metal
B 61	Steam or Valve Bronze Castings

B 62	Composition Bronze or Ounce Metal Castings
B 88	Seamless Copper Water Tube
B 306	Copper Drainage Tube (DWV)
D 1785	Poly-Vinyl Chloride (PVC) Plastic Pipe Schedules 40 and 80 and Schedule 40 Fittings
D 2464	Poly-Vinyl Chloride (PVC) Plastic Pipe Schedule 80 Threaded Fittings
D 2467	Poly-Vinyl Chloride (PVC) Plastic Pipe Sch. 80 Socket Type Fittings
D 2564	Solvent Cements for Poly-Vinyl Chloride (PVC) Plastic Pipe and Fittings
D 2846	Chlorinated Poly-Vinyl Chloride (CPVC) Plastic Hot and Cold Water Distribution Systems
D 3309	Polybutylene (PB) Plastic Hot and Cold Water Distribution Systems
F 439	Socket-Type Chlorinated Poly-Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80
F 441	Chlorinated Poly-Vinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80
F 493	Solvent Cements for Chlorinated Poly-Vinyl Chloride (CPVC) Plastic Pipe and Fittings
1.3.3	American Society of Sanitary Engineers (ASSE) Publications:
1010	Water Hammer Arresters
1013	Reduced Pressure Backflow Preventer
1.3.4	American Water Works Association (AWWA) Publications:
C 506	Standard for Backflow Prevention Devices
C 601	Disinfecting Water Mains
C 700	Cold Water Meters, Displacement Type
C 701	Cold Water Meters, Turbine Type for Customer Service
C 702	Cold Water Meters, Compound Type
1.3.5	Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Publications:
SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture
SP-69	Pipe Hangers and Supports - Selection and Application
SP-80	Bronze Gate, Globe, Angle and Check Valves

- 1.3.6 National Fire Protection Association (NFPA) Publications:
 54-80 National Fuel Gas Code
 211-80 Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances
- 1.3.7 Plumbing and Drainage Institute (PDI) Publications:
 WH201-77 Water Hammer Arrestors
- 1.3.8 International Plumbing Code
- 1.4 REQUIRED STANDARDS
- a. Comply with State of Texas Trenching Law and other applicable statutes on plumbing systems.
 - b. Comply with County of Nueces, City of Corpus Christi, Texas, construction codes and ordinances on plumbing systems.
- 1.5 DESCRIPTION OF WORK
- This Section covers work within the building planform and to 5 feet beyond the building, as indicated on the Drawings. [It also covers this work:
- a. Water: Pipe and distribution to fixtures and site buildings
- 1.6 SUBMITTALS
- 1.6.1 Product Data:
- a. Pipe and fittings
 - b. Valves
 - c. Pipe supports
 - d. Gauges and thermometers
 - e. Accessory materials
 - f. Pre-insulated conduit
- 1.6.2 Samples: As requested by the Engineer.
- 1.6.3 Shop Drawings:
- a. Access panels
 - b. Special and shop fabricated assemblies and fittings.
- 1.6.4 Certified Data:
- a. Backflow preventers
- 1.6.5 Operation and Maintenance Manuals:
- a. Pumps

1.6.6 Parts Lists:

a. Pumps

1.7 ELECTRICAL MOTORS, CONTROLLERS, CONTACTORS, AND DISCONNECTS

Furnish motors, controllers, contactors, and disconnects with their respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to and shall have electrical connections provided under Division 26.

1.8 CONNECTIONS TO OTHER WORK

1.8.1 Connect water and hot water to kitchen equipment indicated.

1.8.2 Connect water, hot water, and waste to plumbing fixtures indicated on drawing plumbing fixture schedule.

2.0 PRODUCTS

2.1 POTABLE COLD WATER

2.1.1 Above Slab or Grade - 1/2"-3" Sizes: Type L hard drawn copper tubing with sweat joints and J.W. Harris "Bridget" lead-free solder.

2.1.2 Above Slab or Grade - 4" and Larger: Schedule 40 steel with roll-formed grooved coupling joints, galvanized after forming.

2.1.3 Below Slab or Grade - 1/4"-2" Sizes: Type K soft-temper continuous tubing without joints.

2.1.4 Below Grade - 2 1/2"-3" Sizes: Type K hard drawn copper tubing with sweat joints and J.W. Harris "Bridget" lead-free solder.

2.1.5 Below Grade - 4"-12" Sizes: AWWA C-900 Class 200, DR14 PVC with ring-bell and spigot joints with elastomeric ring gaskets.

2.2 POTABLE HOT WATER

2.2.1 Above Slab or Grade - 1/2"-3" Sizes: Type L hard drawn copper tubing with sweat joints and J.W. Harris "Bridget" lead-free solder.

2.2.2 Above Slab or Grade - 4" and Larger: Schedule 40 steel with roll-formed grooved coupling joints, galvanized after forming.

2.2.3 Below Slab or Grade - 1/4"-2" Sizes: Type K soft-temper continuous tubing without joints.

2.3 FITTINGS

2.3.1 Adapters: Where threaded PVC adapters are necessary, threads shall be molded into Schedule 80 fittings. Brass (chromeplated if exposed) threaded nipples shall be used to connect brass fixture wastes to waste piping. Connect below grade PVC piping to ductile iron piping with flanged adapters.

2.3.2 Couplings:

- a. Provide wrought copper, socket-type solder fitting on all copper lines and socket solvent cement couplings in PVC. Weight shall match pipe.
- b. Provide malleable iron 150 lb. couplings for black steel threaded piping.
- c. Provide flexible gasketed couplings for roll-end steel pipe, with galvanized bolting hardware.
- d. Rubber couplings with ring clamps are not allowed.

2.3.3 Unions and Flanges: Provide unions or flanges at each valve, meter, and equipment connection. Provide dielectric unions or dielectric flange assemblies at hot water heaters and where joining dissimilar metallic piping. ANSI B16.1, Class 125, for use in ferrous piping; ANSI B16.22 or ANSI B16.24 for use in copper tubing; with full face flat type synthetic rubber gaskets.

2.4 VALVES

2.4.1 Water Valves: Provide valves suitable for minimum of 125 psig and minimum of 180°F hot water. Valves shall have [threaded end connections with a union on all but one side of the valve or solder end connections for connections between bronze valves and copper tubing. Copper alloy and bronze valve body shall be ASTM B 61 or ASTM B 62 copper alloy. Ball valves may be provided in lieu of gate valves.

2.4.2 Gate Valves: MSS SP-80 Bronze or Cast-Iron, Bronze Trim, Class 125.

2.4.3 Check Valves: MSS SP-80 Bronze, Cast Iron, or Bronze Trimmed, Class 125, swing check.

2.4.4 Ball Valves: MSS SP-80 Bronze, full port design, copper alloy. Valves shall have insulated lever handles.

2.4.5 Butterfly Valves: Full port design, cast-iron body, copper alloy or stainless steel disc, stainless steel stem, buna seals. Valves shall have multi-position lever handles (min. of 10 position). Valves 8 inches and larger shall have gear drive operator.

2.4.6 Combination Pressure and Temperature Relief Valves: Bronze body and trim valve with test lever.

2.4.7 Pressure Relief Valves: Bronze body, with test lever, and shall be suitable for the intended service.

2.4.8 Water Temperature Mixing Valves: Provide copper alloy body valve of the pressure

equalizing type. Valve shall be of the adjustable thermostatic type and shall mix the hot water and cold water to deliver hot water at set temperature.

2.4.9 Water Pressure Reducing Valves: ANSI A112.26.2

2.4.10 Pressure Reducing Principle Valve: Bypass detector system UL approved.

2.4.11 WATER METERS

NOT USED

2.5 STRAINERS

Class 125, Style Y, with blowoff plug.

2.6 INSTRUMENTS

2.6.1 Gages: ANSI B40.1, single style pressure gage for water with 4.5-inch dial, brass case, bronze tube, gage cock, pressure snubber, and siphon. Provide scale range suitable for the intended service.

2.6.2 Thermometers: Provide bi-metal dial type thermometers with stainless steel case, stem, and fixed thread connection; 5-inch diameter dial with glass face gasketed within the case; accuracy within 1.0 percent of scale range. Provide scale range suitable for the intended service.

2.7 WATER HAMMER ARRESTERS

ANSI A112.26.1, for 100°-300°F.

2.8 VALVE BOXES

For each buried valve, provide cast-iron box of a suitable size. Provide cast-iron cover for the box with WATER cast on the cover.

2.9 BACKFLOW PREVENTERS

AWWA C 506.

2.9.1 Reduced Pressure Principle System: ASSE-1013, bronze body, corrosion resistant internal parts, stainless steel springs, two independent operating check valves, spring and diaphragm operated automatic air vent. Automatic vent shall maintain a minimum 2 psi positive differential pressure. The space between the check valves shall form an air gap on backflow.

2.10 PIPING ACCESSORY MATERIALS

2.10.1 Escutcheon Plates: Provide one-piece or split-hinge type 304 stainless steel plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide chromium-plated or brushed heavy wall stainless steel finish on plates in finished spaces. Provide paint finish on plates in unfinished spaces. Securely anchor plates in

place with set screws.

2.10.2 Pipe Sleeves:

- a. Generally: Provide where piping passes through walls, floors above grade, roofs, and partitions. Secure sleeves in proper position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, roofs and partitions. Provide not less than 0.25-inch space between exterior of piping or pipe insulation and interior of sleeve. [Firmly pack space with insulation and caulk at both ends of the sleeve with plastic waterproof cement that will dry to a firm but pliable mass in visible areas provide a segmented elastomeric seal.
- b. In fire separation assemblies: Pack space with intumescent firestop putty.
- c. Sleeves in masonry and concrete walls, floors, roofs: Provide ASTM A 53 Schedule 40 or Standard Weight, hot-dip galvanized steel pipe sleeves. Extend sleeves in floor slabs 3 inches above the finished floor.
- d. Sleeves in partitions and other than masonry and concrete walls, floors and roofs: Provide hot-dip galvanized 16 gal. steel sheet.
- e. Sleeves for copper pipe: Provide piping isolators between the pipe and the sleeve before packing.

2.10.3 Pipe Supports (Hangers): Provide MSS SP-58 and MSS SP- 69, Type 1 or 6, of the adjustable type, except as indicated or specified herein. Provide Type 40 insulation protection shields for insulated piping. Provide steel support rods. Provide nonmetallic or plastic piping isolators between copper pipe and the hangers. Provide flat wide band hangers for uninsulated plastic piping with a 1/8-inch rubber insert to prevent chaffing of the pipe. All non-plastic elements shall be hot-dip galvanized.

2.10.4 Access Panels: Provide factory prefabricated and primed steel access panels including 16-gage steel frame with a hinged 14-gage steel cover with turn-latch. Provide panel with factory-primed rust-inhibitor paint. Size and furnish panels under this section to provide proper access to concealed valves and control devices.

3.0 EXECUTION

3.1 INSTALLATION

Plastic piping shall not penetrate fire walls.

3.1.1 Threaded Connections: Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape PTFE powder and oil; apply only on male threads.

3.2 PIPE SUPPORTS (HANGERS)

3.2.1 Provide additional supports at the concentrated loads in piping between supports, such

as for in-line water pumps and flanged valves.

3.2.2 Maximum Spacing Between Supports:

- a. Vertical piping: Support metal piping at each floor, but at not more than 10-foot intervals. Support plastic and glass piping at each floor and at midpoint between floors, but at not more than 5-foot intervals. Glass piping shall not contact concrete or other abrasive materials.
- b. Horizontal piping: Support cast-iron piping at 5-foot intervals, except for pipe exceeding 5-foot length, provide supports at intervals equal to the pipe length but not exceeding 10 feet. All other piping to be suspended as per the following table. Support Borosilicate glass the same as cast iron.
- c. Uniformly slope straight piping runs that could contain liquids for positive drainage. Account for sag between supports, but do not allow visible sag.

3.3 PIPE SUPPORT MAXIMUM SPACING (FEET)

<i>Nominal Pipe Size (Inches)</i>	<i>1.0 & Under</i>	<i>1.25</i>	<i>1.5</i>	<i>2.0</i>	<i>2.5</i>	<i>3.0</i>	<i>3.5</i>	<i>4.0</i>	<i>5.0</i>	<i>6.0</i>
Steel Pipe	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	16.0	17.0
Copper Tube	6.0	7.0	8.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
Fiberglass	7.0	7.0	7.7	8.7		9.3		11.2	12.4	
- or as per Manufacturer's Recommendation for 150°F										
PVC Sch 40	4.0	4.0	4.0	4.0		4.0		4.0		4.0

3.4 VALVES

Install isolation valves on all equipment, pumps, meters, etc., which might require service. Install valves with stems upright or horizontal, not inverted. Use gate valves for isolation services unless indicated otherwise. Install globe valves for flow control. Provide high and low point vents and drains for all liquid system (not normally shown on plans). Provide drains at all equipment locations.

3.5 FIELD TESTING

Before final acceptance of the work, test each system as in service to demonstrate compliance with the contract requirements. Perform the tests specified in the IBC International Plumbing Code, except as modified herein. Correct all defects in the work provided by the Contractor, and repeat the tests until the work is in compliance with contract requirements. Furnish water, electricity, instruments, connecting devices and personnel for the tests.

3.5.1 Water Piping: Water piping shall be tested under 125 psi hydrostatic pressure for a period of 24 hours. Any leaks made evident shall be repaired and the test repeated to completion.

3.6 PAINTING

All steel parts including piping, hangers, pipe supports are to be cleaned by SSPC-SP-2-63T hand cleaning or if oil or grease is present, then solvent-cleaning SSPC-SP-1-63T will precede the hand cleaning. Prime coat to be 3 Mils minimum Oil Alkyd primer with Zinc Chromate with Alkyd topcoat 3 Mils. This specification will be used unless other piping painting requirements is shown in Section 9 or on the drawings.

3.7 STERILIZING OF WATER PIPING

After the installation of all water piping is made, it shall be thoroughly sterilized with a water solution containing not less than 50 P.P.M. of available chlorine, in accordance with the regulations of the State Health Department. Sterilizing agent shall be thoroughly mixed with the water; solution shall remain in pipes not less than six hours and the lines shall then be flushed out.

END OF SECTION

DIVISION 23- MECHANICAL

SECTION 23-05-00 – COMMON WORK RESULTS FOR HVAC

1.0 GENERAL

- 1.1 The Conditions of the Contract apply to this Section.
- 1.2 Examine all plans and specifications, visit the site(s) of the proposed project, and become fully informed as to the extent and character of the work required.
- 1.3 REQUIRED STANDARDS
 - a. Laws and Regulations of the State of Texas.
 - b. County of Nueces, City of Corpus Christi, codes and ordinances.
- 1.4 COORDINATION
 - 1.4.1 Coordinate work under this Division to avoid conflicts and to attain satisfactory and complementary systems.
 - 1.4.2 Coordinate work under this Division with work under other Divisions to avoid conflicts and to allow for adequate installation, maintenance, and operating space. Obtain the Engineer's approval for penetrations of other parts of the Work prior to effecting them.
 - 1.4.3 In resolving pipe, duct and conduit coordination, meet all requirements and be guided by these general orders of precedence:
 - a. Accommodate gravity flow lines with required slopes before other lines.
 - b. Accommodate lines with specific slope requirements (i.e., steam and refrigerant gas) before other lines.
 - c. Accommodate work with a required reference elevation before other work.
 - d. Accommodate mains before branches.
 - e. Accommodate pipe and duct before conduit.
 - f. Accommodate large lines before small lines.
 - g. Accommodate pipe before duct.
 - h. Accommodate high-pressure and high-velocity duct before low-pressure and low-velocity duct.
 - i. Accommodate data cable trays equally with ductwork and coordinate each with Division 26.
- 1.5 DEFINITIONS
 - 1.5.1 Specific meanings used in Division 23 (variant forms are inferred):
 - a. Work: This project, or the referenced part.
 - b. Provide:

1. Furnish and install, complete with necessary appurtenances.
 2. "Provide" is implied throughout this Division unless language is specific.
- c. Required: Required by the Contract Documents.
 - d. Necessary: Necessary in order to obtain a finished system in satisfactory operating condition and meeting all requirements.
 - e. Furnish: Procure and deliver, ready for installation, necessary and/or required.
 - f. Install: Receive, place securely, ready for connection to work specified elsewhere, and bring into satisfactory operating condition, as necessary and/or required.
 - g. Connect: Connect properly to mechanical work. This includes non-physical "connections" such as indirect waste drains.

1.6 SCOPE OF WORK

1.6.1 The work under this Division includes providing complete HVAC systems for the project, internal to and within 5' 0" of the building or structure exterior perimeter.

1.6.2 All items of labor, material or equipment not required in detail by the specifications or plans, but incidental to, or necessary for the complete installation and proper operation of all phases of work described herein, or reasonably implied in connection therewith, shall be furnished as if called for in detail by the Contract Documents.

1.7 WORKMANSHIP

All labor shall be performed in a workmanlike manner by mechanics skilled in their particular trades. All installations shall be complete in both effectiveness and appearance whether finally enclosed or left exposed. The Engineer reserves the right to direct the removal or replacement of any item which in his opinion shall not present a reasonable neat or workmanlike appearance, providing that same can be properly installed in an orderly way.

1.8 MANUFACTURER'S INSTRUCTIONS

Obtain written recommendations and installation and start-up instructions from material vendors and comply, unless otherwise required. Bring discrepancies between these instructions and project requirements to the attention of the Engineer, and resolve prior to construction. Provide signed inspection report by manufacturer's representative at system start-up to verify construction and warrantability.

1.9 PERMITS AND FEES

1.9.1 Permits: Obtain special permits necessary for this portion of the Work.

1.9.2 Fees: Pay any fees associated with permits and required inspections.

1.10 LICENSES

- a. Work under this Division shall be performed by organizations and individuals holding a current license to perform such type of work by the authority having jurisdiction. "License" in this sense means any process, regardless of its appellation, which is normally mandated by the authority in order to perform such type of work within its jurisdiction. The stipulation of this paragraph applies even if the work is located physically on property owned or controlled by a higher authority. E.G., to work within the city limits of Corpus Christi, Texas, on a Federal project, State of Texas and City of Corpus Christi licenses which would be mandated to work on a private project shall be required even though the City and State may have no jurisdiction over the higher government.
- b. In the event that the licensed organization loses its license or is unable to obtain one, or the licensed individual performing the work becomes unlicensed or departs the organization, notify Engineer immediately in writing.

1.11 UTILITY COORDINATION – NOT REQUIRED EXCEPT FOR LOCATION

1.12 LISTING AND LABELLING

Materials that require listing shall be listed and labeled for the particular service if a listing is available. Obtain and comply with the terms of listing. Listed materials include:

- a. NSF: Potable water and sanitary waste systems components.
- b. UL: Electrical materials.
- c. AMCA: Air moving devices and related accessory items.
- d. ARI: HVAC equipment.
- e. FM or UL: Hazardous fluid and fire protection system components.
- f. FIA, FM or AGA: Fuel gas system components.

1.13 MATERIALS AND EQUIPMENT

- a. All materials and equipment shall be new. Products shall be currently manufactured.
- b. All materials and equipment shall be clearly marked, stamped or labeled for identification. Do not obscure nameplates.

1.14 SUBMITTALS AND REVIEW

1.14.1 Contractor shall furnish to the Engineer, within a reasonable time after award of contract, and prior to commencing any work, complete brochures in quadruplicate of all materials and equipment that the contractor proposes to furnish on the project. Data shall include descriptive literature, performance data, diagrams, capacity information, etc., to substantiate that proposed equipment will meet all of the requirements of the plans and specifications.

1.14.2 All data must be checked and any required changes noted thereon by the contractor, signed and dated prior to furnishing same to the Engineer for approval. Contractor's attention is directed that it is mandatory that he thoroughly review data prior to

furnishing same to assure that equipment is in accordance with plans and specifications and to assure prompt return of the data.

1.14.3 Deviations: Specifically call to the attention of the Engineer every proposed deviation from the Contract Document requirements. Failure to identify deviations as such constitutes a representation that all requirements are met.

1.14.4 Review of submittals shall not be construed as releasing the Contractor from responsibility, but rather as a means to facilitate coordination of the work and the proper selection and installation of the products. All work shall be subject to final acceptance by the Engineer at the completion of the project.

1.14.5 If above information is not provided complete as specified above and within the allocated time, all equipment shall be furnished exactly as specified without any substitutions.

1.15 SUBSTITUTIONS

1.15.1 Refer to the Conditions of the Contract.

1.15.2 Where one vendor is indicated for a product, it is to establish a level of quality and performance; provide a product equal to that product in all respects from a vendor of equivalent performance.

1.15.3 Where multiple vendors are indicated for a product, any of those vendors meeting the requirements may be submitted.

1.15.4 Some product specifications in this Division are of the Acceptable Manufacturer type. Vendors listed as Acceptable Manufacturers are acceptable as vendors. However, the product submitted is subject to review as being fully equivalent in detail to the basis of design.

1.15.5 Where multiple vendors are listed with product model numbers, each model and vendor is acceptable, provided all requirements are met. Model numbers are indicated to the extent believed necessary to identify a type and are not necessarily complete.

1.16 DRAWINGS AND SPECIFICATIONS

1.16.1 These specifications are accompanied by Drawings. The Drawings and Specifications are complementary each to the other, and what is called for by one shall be as binding as if called for by both.

1.16.2 The Drawings are generally diagrammatic. Lay out work at the site to conform to all applicable Codes and existing conditions; layout work to conform to architectural, structural, mechanical, and electrical conditions; layout work to avoid all obstructions; and to conform to details of manufacturer's installation as requirements. Provide an integrated, satisfactorily operating installation. All necessary offsets in piping, fittings, etc., required to avoid interferences between piping, equipment, architectural, and structural elements shall be provided by the Contractor. Provide all necessary routing and offsets to avoid conflict.

- 1.16.3 Verify and arrange that sufficient space is provided for the installation of proposed products and that adequate access will exist for service, safe operation, and maintenance of equipment.

1.17 COMPLEMENTARY DOCUMENTS

- a. Contract documents are complementary; requirements are not necessarily repetitively stated at each possible subject; consider that a requirement applies wherever applicable. When either specifications or drawings illustrate work or equipment to be provided, it shall be provided as if illustrated by both with no exceptions. All support systems, ancillary equipment, utilities, and control programming requirements shall be met and provide for a complete operable system.
- b. In the event of conflicting requirements in different parts of the Documents, the more expensive shall be presumed to apply, unless the Engineer clarifies the requirement in a less expensive manner and waives the more expensive requirement in writing.
- c. Since codes and standards are incorporated by reference, a particular conflict may appear in that a reference may use language that implies that a particular requirement in the Contract Documents is waived under the reference. This is not the case, unless specifically so clarified by the Engineer. Generally, the specific Drawings and Specifications take precedence over waivers in multi-purpose reference documents.
- d. Because of licensure and workmanship requirements, persons performing the work are presumed to be familiar with applicable codes, ordinances, laws, regulations and standards. Therefore, details of materials, methods, arrangements and size contained in such publications are not necessarily replicated in the Contract Documents. This in no way deletes the requirement of the Contractor to comply. In the event of an apparent conflict between such publications and the Contract Documents, request clarification from the Engineer prior to construction. Always install work in accordance with applicable codes.

1.18 REGULATORY MATTERS

Comply with laws, rules and regulations, permit requirements, and ordinances. It is intended that the work of the Division be estimated and performed under the supervision of licensed master craftsman who are familiar with these requirements, whether illustrated or specifically detailed in the particular Contract Documents of this project or not. Therefore, regulatory requirements may not be so illustrated or detailed.

1.19 PROTECTION

All work, equipment and materials shall be protected at all times to prevent damage or breakage either in transit, storage, installation or testing. All openings shall be closed with caps or plugs during installation. All material and equipment shall be covered

and protected against dirt, water, chemicals or mechanical injury. Work, equipment, and materials which have not been adequately protected in the opinion of the Engineer shall be provided additional protection, and any damage, debris, and soiling repaired, replaced, or cleaned by the contractor at his cost upon written request by the Engineer.

1.20 CUTTING AND PATCHING

The work shall be carefully laid out in advance and the exact size and locations of openings arranged.

1.21 VIBRATION AND NOISE

Objectionable vibration and/or noise will not be tolerated, provide sound insulation around objectionable area, including lagging and isolation. This applies to both.

1.22 DEMOLITION

Coordinate with owner, contractor and other divisions before commencing work, provide notification and schedule for work.

1.22.1 All openings cut in masonry and plaster walls or concrete floors shall be core drilled or sawed when possible. Contractor shall check building construction before making penetrations to avoid cutting through structural beams and reinforcing. Contractor shall inform the engineer if reinforcing is cut or damaged while making openings. Contractor shall reinforce all openings as required by drawings and specifications. Patch and seal openings with 6000 psi cement grout. Install decorative trim (equipment flanges, framing or escutcheons) around openings in finished areas. Coordinate all cutting and patching with the other trades.

1.22.2 On any work shown on mechanical drawings requiring demolition of existing or new building structures and finishes, it shall be the responsibility of the contractor to complete the necessary demolition. Contractor shall patch and repair all demolition work. Patching shall be completed with the same materials as the surrounding areas, or with Engineer-approved patching materials. Repairs shall be completed according to architectural specifications. All refinishing shall be approved by the architect.

1.22.3 All pipes, ductwork fasteners and equipment removed during demolition shall be disposed of by the contractor unless specifically noted otherwise. Sections and ends of pipes and ducts which remain in the building shall be properly capped and sealed to prevent leakage; ends shall be trimmed back to a wall, ceiling or other structure which is new or existing and refinished to look neat and not detract from the surroundings. Broken areas left by fasteners in exposed walls and ceilings shall be filled and smoothed over with proper patching materials. Fastener and bracket damages in finished areas shall be dealt with in accordance with the note above.

1.23 RECORD DOCUMENTS

1.23.1 Drawings: Prior to final acceptance, request mechanical drawings from the Engineer.

Revise the drawings to reflect as-built conditions, including all addenda, change orders, final shop drawing reviews, and field routing. Underground utilities shall be dimensionally located relative to readily accessible and identifiable permanent reference points, with accurate slope and elevation indicated. Submit prints for review. Revise, certify accuracy, and provide two final sets to the Engineer.

- 1.23.2 Owner's Manual: Prior to final acceptance, provide two bound volumes to the Engineer. Index by subject. Include corrected submittals and shop drawings that reflect final review comments; installation, operation and maintenance instructions, parts lists, wiring diagrams, and piping diagrams; warranties.

1.24 INSPECTION, OBSERVATION, AND TESTING

- 1.24.1 Cooperate with Engineer's representative and authorities having jurisdiction. Provide complete access to the work at reasonable times.

- 1.24.2 Cover-up: Prior to covering up work, or conducting observed tests, request observation as appropriate. Provide adequate advance notice. In some cases the Engineer's representative may waive observation; otherwise arrange for observed construction and testing prior to cover-up.

- 1.24.3 Pre-Testing: Self-inspect, pre-test, and remedy work prior to performing observed tests.

- 1.24.4 Sectional Work: In circumstances where a requirement for phased construction or other considerations dictate sectional construction and/or testing, notify the Engineer when construction begins on the first section of a system, and when the first section will be ready for observed testing, as well as subsequent sections. Test in the largest practical sections.

1.25 WORK PERFORMED UNDER OTHER DIVISIONS

- 1.25.1 NOT USED

- 1.25.2 Refer to Division 26 for power wiring systems external to equipment and control panels; starters in motor control centers; safety switches not integral to equipment or starters provided under Division 23.

- 1.25.3 NOT USED

1.26 REFERENCES TO OTHER DIVISIONS

- 1.26.1 Refer to Division 26 for additional material requirements of electrical components provided under Division 23, such as loose starters, wiring and devices integral to equipment.

- 1.26.2 NOT USED

1.26.3 Comply with all requirements applicable to work required under this Division.

1.27 TESTING SERVICES

1.27.1 Additional Testing: In addition to any specified testing, the Engineer may cause additional testing to be performed by an independent testing laboratory or any other qualified party. If such testing reveals deficient work by the Contractor, the Contractor shall pay for both the testing and remedial work. If such testing does not reveal deficient work by the Contractor, the Owner shall pay for the testing and the cost of repairing any damage caused by such testing.

1.27.2 Specified Testing Services: If independent testing services are specified regarding work under this Division, cooperate fully with the testing agency. Provide access to the work. Provide test holes and taps necessary. Remove work that is not tested on site, deliver to testing agency, and reinstall if undamaged; replace if damaged. Provide utilities, operational capability, and facilities for on-site testing as necessary.

1.28 WARRANTY

1.28.1 All equipment under Division 23 shall carry a full warranty, including parts and labor, for a period of one year from the date of final construction payment. Submit warranty letters with Operation and Maintenance manuals.

END OF SECTION

DIVISION 23 - MECHANICAL

SECTION 23-05-23 - HVAC PIPING SYSTEMS

1.0 GENERAL

1.1 The Conditions of the Contract apply to this Section.

1.2 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent applicable.

1.2.1 American National Standards Institute (ANSI) Publications:

- B1.1 Unified Inch Screw Threads (Un and Var Thread Form)
- B2.1 Pipe Threads (Except Dryseal)
- B2.4 Hose Coupling Screw Threads
- B16.1 Cast Iron Pipe Flanges and Flanged Fittings, 225, 125, and 800 lb.
- B16.3 Malleable Iron Screwed Fittings, 150, and 300 lb.
- B16.5 Steel Pipe Flanges, Flanged Valves, and Fittings
- B16.9 Factory Made Wrought Steel Butt Welding Fittings
- B16.10 Face to Face and End to End Dimensions of Ferrous Valves
- B16.11 Forged Steel Fittings, Socket Welding and Threaded
- B16.18 Cast Copper Alloy Solder Joint Pressure Joint Pressure Fittings
- B16.20 Ring Joint Gaskets and Groovers for Steel Pipe Flanges
- B16.21 Nonmetallic Gaskets for Pipe Flanges
- B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- B18.2.1 Square and Hex Bolts and Screws, including Hex Cap Screws and Lag Screws
- B18.2.2 Square and Hex Nuts
- B31.1 Power Piping including B31.1A-80 and B31.1B-80 Addenda
- Z 49.1 Welding and Cutting
- B16.39 Malleable-Iron Threaded Pipe Unions
- B40.1 Gauges, Pressure, Indicating Dial Type, Elastic Element

1.2.2 American Petroleum Institute:

- 5L Line Pipe

1.2.3 American Society for Testing and Materials (ASTM) Publications:

- A 47 Malleable Iron Castings

A 53	Pipe, Steel, Black and Hot-Dipped, Zinc- Coated Welded and Seamless
A 120	Pipe, Steel, Black and Hot Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
A 126	Gray Iron Castings for Valves, Flanges and Pipe (R1979) Fittings
A 183	Carbon Steel Track Bolts and Nuts
A 194	(Rev. B) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
A 234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
A 307	Carbon Steel External and Internally Threaded Standard Fasteners
A 386	Zinc Coating on Assembled Steel Products
A 536	Ductile Iron Castings
B 32	Solder Metal
B 61	Steam or Valve Bronze Castings
B 62	Composition Bronze or Ounce Metal Castings
B 88	Seamless Copper Water Tube
D 1785	Poly-Vinyl Chloride (PVC) Plastic Pipe Sch 40 & 80 and Schedule 40 Fittings
D 2464	Poly-Vinyl Chloride (PVC) Plastic Pipe Sch 80 Threaded Fittings
D 2467	Poly-Vinyl Chloride (PVC) Plastic Pipe Sch. 80 Socket Type Fittings
D 2564	Solvent Cements for Poly-Vinyl Chloride (PVC) Plastic Pipe and Fittings
F 2389-07	Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

1.2.4 American Society of Mechanical Engineers:

ASME Boiler and Pressure Code

Section 8-D- Pressure Vessels, with Addenda

1.2.5 International Conference of Building Official (ICBO) Publication:

International Plumbing Code

1.2.6 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS) Publications:

SP58 Pipe Hangers and Supports - Materials, Design and Manufacture

SP67 Butterfly Valves

SP69 Pipe Hangers and Supports - Selection and Application

SP70	Iron Gates
SP71	Iron Checks
SP80	Bronze Gates, Globes, Checks
SP85	Iron Globes
SP110	Bronze Ball Valves

1.3 REQUIRED STANDARDS

- a. Laws and regulations of the State of Texas.
- b. Comply with County of Nueces, City of Corpus Christi, Texas, construction codes and ordinances on HVAC systems.

1.4 SUBMITTALS

- a. Manufacturer's Literature and Data
 1. Piping and Fittings, Gaskets, Valves and Piping Specialties
 2. Instrumentation, Hangers and Supports
- b. Operation and Maintenance Manuals:
 1. Flow Measuring Equipment
 2. Piping Diagrams
- c. Shop Drawings: Refrigerant Piping Diagrams

2.0 PRODUCTS

2.1 PIPING

- 2.1.1 Steel Piping, Type I: Black, Schedule 40, per ASTM A 53 or A 120, with threaded ends.
- 2.1.2 Steel Piping, Type II: Black, Schedule 40, per ASTM A 53, Grade A or B, electric resistance welded or seamless, with threaded ends.
- 2.1.3 Steel Piping, Type III: Black, Schedule 80, per ASTM A 53, Grade A or B, electric resistance welded or seamless, with threaded ends.
- 2.1.4 Steel Piping, Type IV: Black, Schedule 40, per ASTM A 53 or A 120, electric resistance welded or seamless, with plain ends.
- 2.1.5 Steel Piping, Type V: Black, Schedule 40, per ASTM A 53, electric resistance welded or seamless, with plain ends.
- 2.1.6 Steel Piping, Type VI: Black, Schedule 80, per ASTM A 53, electric resistance welded or seamless, with straight or beveled ends.

- 2.17 PPR Piping, Type VII: Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. Hydronic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

Pipe shall be Aquatherm® Green Pipe® MF® or Blue Pipe® MF®, (**or Equal Approved by Submittal before Bid/Proposal receipt**) available from Aquatherm, NA. Piping specifications and ordering information are available at www.aquatherm.com

- 2.1.8 Copper Tubing: Type L hard drawn with sweat joints and J. W. Harris "Bridget" lead-free solder. Brazing material equal to BCup-5, use procedures per AWS-5.8.

- 2.1.9 Flanged Steel Pipe Connections: Pipe lengths of any size connected to flanges (by welded, threaded, or mechanical joint connections) shall not be continuous furnace butt welded; use seamless or electric resistance welded piping.

2.2 COUPLINGS

- 2.2.1 Type I Steel Pipe: Black, Schedule 40, straight thread mill couplings of steel or wrought iron, or taper thread malleable iron 150 lb. class.

- 2.2.2 Type II for Steel Pipe: Black, Schedule 40, taper thread API Spec. 5L, or malleable iron 150 lb class.

- 2.2.3 Type III for Steel Pipe: Black, Schedule 80, taper thread mill couplings or malleable iron 150 lb class.

- 2.2.4 Dissimilar Metal Connections: Provide insulated union with impervious insulation barrier capable of limiting galvanic current to one percent of the short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600V breakdown test.

2.3 FLANGES

- 2.3.1 Cast Iron Connections: Flanged connections between steel pipe and cast iron equipment shall be flat face flanges. Material shall be steel for welded connections and steel or cast iron for threaded connections, with rating matching the equipment flange.

- 2.3.2 Steel Pipe Flange Type I: Steel, weld neck or slip-on, flat face, 125 lb. rating, with metallic ring gasket.

- 2.3.3 Steel Pipe Flange Type II: Steel, weld neck or slip-on, raised face, 150 lb. rating, with metallic ring gasket.

- 2.3.4 Steel Pipe Flange Type III: Steel, weld neck or slip-on, raised face, 300 lb.. rating, with metallic ring gasket.
- 2.3.5 Dissimilar Metal Connections: Provide dielectric flange kits with suitable temperature rating.
- 2.3.6 Bolting: Material used for bolts and studs shall be stainless steel. Threads shall conform to ANSI B1.1 coarse type with class 2A fit for bolts and studs, and class 2B fit for nuts. Bolts or studs shall extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts shall have American Standard regular square or heavy hexagon heads and shall have American Standard heavy semi-finished hexagonal nuts.
- 2.4 FITTINGS
- Threads shall conform to ANSI B1.1 coarse type with class 2A fit for bolts and studs, and class 2B fit for nuts. Bolts or studs shall extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts shall have American Standard regular square or heavy hexagon heads and shall have American Standard heavy semi-finished hexagonal nuts.
- 2.4.1 Steel Pipe Fittings: Elbows shall be standard or long radius. Where possible, branches shall be made at 45° to the main. Size reductions shall be made with concentric reducers, except that eccentric reducers shall be provided where necessary to maintain liquid drainage or venting slopes.
- 2.4.2 Steel Pipe Fittings, Type I: Reinforced outlet pattern, malleable iron, threaded 150 lb. rating.
- 2.4.3 Steel Pipe Fittings, Type II: Reinforced outlet pattern, malleable iron, threaded 300 lb. rating.
- 2.4.4 Steel Pipe Fittings, Type III: Steel wrought fittings, butt welding ends, standard weight per ASME B 16.9. Fittings shall be smooth one piece fabrications (no miter joints). Laterals to branches more than 1/2 the diameter of the main shall be made with full size tees and reducers.
- 2.4.5 Steel Pipe Fittings, Type IV: Steel wrought fittings, butt welded ends, extra strong weight per ASME B 16.9. Fittings shall be smooth one-piece fabrications (no miter joints). Laterals to branches more than 1/2 the diameter of the main shall be made with full-size tees and reducers.
- 2.4.6 Fittings for Steel General Piping: Fittings sized 2 inches and smaller shall be threaded. Malleable iron conforming to ANSI B16.3, Class 150. Fittings on piping sized larger than 3 inches shall be forged steel butt-welding type. Flanges shall be welding neck or slip on type. All fittings shall be suitable for 150 psi hot and cold service. Fittings for temperatures above 200°F shall be steel.
- 2.4.7 Fittings for Mild Corrosive Exposure General Piping: Galvanized malleable iron conforming to ANSI B16-3, Class 150 for piping sized 4 inches and smaller shall be

threaded. Fittings for piping sized over 4 inches shall be welding type or flanged with welding necks conforming to ANSI B16.9 steel or flanged type conforming to ANSI B16.5. Fittings for temperatures above 200°F shall be galvanized steel.

2.4.8 Fittings for Welded Pipe Piping:

- a. Socket welding fittings in sizes 1/8 to 2 inches conforming to ANSI B16.11.
- b. Butt welding fittings in size 2-1/2 inches and above conforming to ANSI B16.9.

2.4.9 PPR Fittings, Type VII: Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

2.5 THREADED JOINTS

Thread per ASME B1.20.1. Make up with either pipe dope specifically approved for the service, or teflon tape. Tape with DuPont Teflon Brand only, with 50% lap. Do not apply dopes containing teflon.

2.6 REFRIGERANT PIPING SYSTEMS – NOT USED

2.7 PLASTIC PIPING SYSTEM

2.7.1 PVC Pipe Type I: Schedule 80, Type I 1120 Grade 1 with plain ends per ASTM D 1785.

2.7.2 PVC Pipe Type II: Schedule 80, Type I 1120 Grade 1 with plain ends per ASTM D 1785.

2.7.3 PVC Pipe Type III: Schedule 40, Type I 1120 Grade 1 with roll-grooved ends per ASTM D 1785.

2.7.4 PVC Couplings Type I: Socket type with stop ring, Schedule 80, Type II high-impact 2120 Grade 1 per ASTM D 2467.

2.7.5 PVC Couplings Type II: Socket type with stop ring, Schedule 80, Type I, 1120 Grade I per ASTM D 2466.

2.7.6 PVC Couplings Type III: Mechanical joint with flexible gasket for roll-grooved pipe, hot-dip galvanized malleable iron housing, zinc electroplated bolts and nuts, EPDM gasket. Rated at 300 psig at 100°F. Victaulic 775 with Grade E gasket.

2.7.7 PVC Fittings Type I: Molded Schedule 80, Type II high-impact 2120 Grade 1 with socket neck ends, solvent cemented; provide molded thread fittings where necessary.

2.7.8 PVC Fittings Type II: Schedule 80, Type I 1120 Grade 1 with socket neck ends, solvent cemented; provide molded thread ends where necessary.

- 2.7.9 PVC Fittings Type III: Schedule 40 Type I 1120 Grade 1 with socket neck ends, solvent cemented; provide flanges to connect adjoining flanged materials.
- 2.7.10 PVC Fittings Type IV: Schedule 40, Type I 1120 Grade 2 with flanged ends. Provide rolled groove neck at one end where connecting flange to grooved pipe.
- 2.8 VALVES
- 2.8.1 Gate Valve Type I: Bronze body, threaded bonnet, bronze trim with non-rising stem, threaded ends, and malleable iron handwheel rated at 200 psig CWOOG at 100°F. Nibco T-113.-MILWAUKEE- 105
- 2.8.2 Gate Valve Type II: Bronze body, screw-in bonnet, bronze trim with non-rising stem, solid wedge, threaded ends, red bronze lock shield, and hose cap with brass safety chain. NIBCO T-113-HC-L. Provide loose aluminum handwheel, nut and washer. Stem packing shall be non-asbestos fibers. Rated at 125-psig steam at 406°F/200 psig CWOOG at 100°F.
- 2.8.3 Gate Valve Type III: Bronze body, screw-in bonnet, non-rising stem, solid wedge, threaded ends, bronze trim, and aluminum handwheel, rated at 125 psig steam at 406°F/200 psig CWOOG at 100°F. NIBCO T-113. Stem packing shall be non-asbestos fibers.
- 2.8.4 Gate Valve Type IV: Bronze body, block pattern, union bonnet, rising stem, solid wedge, bronze trim, threaded ends, and malleable iron handwheel, rated at 150 psig steam at 406°F/300 psig CWOOG at 100°F. Stem packing shall be non-asbestos fibers. NIBCO T-134.-MILWAUKEE 1151
- 2.8.5 Gate Valve Type V: Bronze body, stainless steel plug disc, block pattern, rising stem, solid wedge, union bonnet, threaded ends, rated at 300 psig steam/600 psig CWOOG at 100°F. Stem packing shall be non-asbestos fibers. NIBCO T-174-SS.-MILWAUKEE 1184
- 2.8.6 Gate Valve Type VI: Iron body, bronze mounted, bolted bonnet, OS&Y, solid wedge, with Class 125 flange ends and malleable iron handwheel. Stem packing shall be non-asbestos fibers. Rated 125 psig steam at 450°F/200 psig CWOOG at 100°F. NIBCO F-617-0.-MILWAUKEE F-2885M
- 2.8.7 Service Considerations:
- a. Valves, 2 1/2 inch and larger, exposed to outside air, shall have galvanized or stainless steel bolting hardware, and drain holes at bottom with bronze or galvanized c.i. threaded plugs.
 - b. Steam and condensate valves feeding mains, multi-tap branches, and shell and tube heat exchangers shall have integral bypass lines with malleable iron handwheel bypass valves.
- 2.8.8 Gate Valve Type VII: Iron body, bronze mounted, bolted bonnet, OS&Y, solid wedge, with Class 250 flanged ends and malleable iron handwheel. Stem packing shall be

- non-asbestos fibers. Rated 250 psig steam at 450°F/500 psig wwp at 100°F. NIBCO F-667-0.-MILWAUKEE F-2894A
- 2.8.9 Globe Valve Type I: Bronze body, bronze trim, TFE seat disc, screw-in bonnet, with aluminum handwheel and threaded ends, rated at 125 psig steam at 406°F/200 psig CWOG at 100°F. Packing shall be non-asbestos fibers. NIBCO T-211-Y.-MILWAUKEE 502
- 2.8.10 Globe Valve Type II: Bronze body, bronze trim, TFE seat disc, union bonnet, with malleable iron handwheel and threaded ends, rated at 150 psig steam at 406°F/300 psig CWOG at 100°F. Packing shall be non-asbestos fibers. NIBCO T-235-Y.-MILWAUKEE 590-T
- 2.8.11 Globe Valve Type III: Bronze body, bronze trim, replaceable stainless steel plug disc and seat ring, union bonnet, with malleable iron handwheel and threaded ends, rated at 300 psig steam at 406°F/600 psig CWOG at 100°F. Packing shall be non-asbestos fibers. NIBCO T-276AP.-MILWAUKEE 593A
- 2.8.12 Globe Valve Type IV: Iron body, bronze mounted, bolted pattern, OS&Y pattern. NIBCO F-768-B.-MILWAUKEE F-2983M
- 2.8.13 Pressure Reducing Station Service: Provide globe valves with integral bypass piping and malleable iron handwheel bypass valves.
- 2.8.14 Check Valve (for pump discharge): 2 1/2-inch and larger wafer-style with stainless steel spring, bronze disc plates, Buna-N seat, cast iron body rated at 200 psig CWOG at 200°F. NIBCO W-920-W.-MILWAUKEE 8800
- 2.8.15 Check Valve Type I: Swing check, bronze body, bronze trim, with Buna-N seat disc and threaded ends, rated at 200 psig CWOG at 100°F. NIBCO KT-403-W.
- 2.8.16 Check Valve Type II: Swing check, bronze body, bronze trim, with TFE seat disc and threaded ends, rated at 125 psig steam at 406°F/200 psig CWOG at 100°F. NIBCO T-413-Y.-MILWAUKEE 509T
- 2.8.17 Check Valve Type III: Swing check, bronze body, bronze trim, with TFE seat disc and threaded ends, rated at 150 psig at 406°F/300 psig CWOG at 100°F. NIBCO T-433-Y.-MILWAUKEE 510T
- 2.8.18 Check Valve Type IV: Swing check, bronze body, bronze trim, with TFE seat disc and threaded ends, rated at 300 psig steam at 421°F/600 psig CWOG at 100°F. NIBCO T-473-Y.-MILWAUKEE 507
- 2.8.19 Check Valve Type V: Silent check, bronze body, ring check poppet pattern, spring actuated, stainless steel trim, with Buna-N disc, TFE seat ring, and threaded ends, rated at 250 psig CWOG at 100°F. NIBCO T-480.-MILWAUKEE 548T
- 2.8.20 Check Valve Type VI: Silent check, bronze body, ring check poppet pattern, spring actuated, stainless steel trim, with TFE disc and seat ring, and threaded ends, rated at 125 psig steam. NIBCO T-480-Y.

- 2.8.21 Check Valve Type VII: Silent check, iron body, twin disk wafer style, aluminum bronze disc, Buna-N seat, 316 SS springs and trim, Class 125, NIBCO W-920-W.-MILWAUKEE 8800
- 2.8.22 Ball Valve (for natural gas service): Two-piece bronze body (no yellow brass) with chrome plated bronze ball and silicon bronze or copper silicon blowout proof stem, TFE seat and seals UL listed (UL 842). Full port, 1/4-inch through 1-inch, NIBCO T-585-70-UL. Standard port, 1/1/4-inch through 3-inch, NIBCO T-580-70-UL.
- 2.8.23 Ball Valve Type I: Two-piece, full port bronze body (no yellow brass), with chrome plated bronze or 316 SS ball, silicon bronze or 316 SS blowout-proof stem, TFE seat rings, non-asbestos packing, and threaded ends. Rated at 150 psig SST/600 psig CWO. NIBCO (SS trim) T-585-70-66, (brass trim) T-585-70. Provide memory stop. MILWAUKEE-BA-100S/400S-(SS Trim) BA-100/400 (Brass Trim)
- 2.8.24 Ball Valve, Type II: Three-piece, full port, with chrome plated bronze or brass ball, silicon bronze blowout-proof stem, TFE slot rings, TFE packing, and threaded ends. Rated at 150 psig SST/600 psig CWO. NIBCO T-595-Y (1/4 to 2 1/2 inch). Bronze trim.-MILWAUKEE BA-300
- 2.8.25 Ball Valve Handles: Provide extended tee handle for valves on insulated lines, and vinyl, insulated lever handle on uninsulated lines. NIBCO NIB-SEAL® handle.-MILWAUKEE-TIH-(Thermal Insulated Handel
- 2.8.26 Ball Valve Type III: One piece,-split body full port, carbon steel body, with stainless steel ball and stem, 300 lb, Class B flanged ends. TFE carbon-filled seats and packing (1/2 to 10 inch), NIBCO F-535-CSF.-MILWAUKEE F201CSN2
- 2.8.27 Ball Valve Type IV: True union body, PVC with EPDM seal, PTFE seats, polypropylene handle, rated at 105 psig at 120°F. NIBCO U-45TB-E
- 2.8.28 Butterfly Valve Type III: Ductile iron body, aluminum bronze disc, 416 stainless steel shaft, bronze bearings; Reinforced Nylon EPDM disc seat and shaft seal; gear operator 8-inches and larger. Rated 200 psig wwp at dead end shutoff without the need for a downstream flange. NIBCO LD-2000.-MILWAUKEE ML233E-LEVER AND ML333E-GEAR
- 2.8.29 Butterfly Valve Type IV: Ductile iron body, aluminum bronze disc, 416 stainless steel shaft, bronze bearings; Reinforced Nylon EPDM disc seat and shaft seal; 10-position lever actuator with **memory stop**. Rated 200-psig wwp at dead end shutoff service without the need for down stream flange. NIBCO LD-2000.MILWAUKEE ML233E-MS-LEVER AND ML333E-MS- GEAR
- 2.8.30 Butterfly Valve Type V: Cast iron body, bronze disc, 416 stainless steel shaft, bronze bearings; resilient terpolymer of ethylene propylene (Nordel) disc seat and shaft seal; weatherproof actuator suitable for buried construction, with square operating nut and stainless steel bolting hardware. Rated 150 psig wwp at dead tight shutoff. DeZurik 632.

- 2.8.31 Butterfly Valve Type VI: Ductile iron lug body, stainless steel ASTM A-743, Grade CF8M disc, stainless steel ASTM A-564, Type 17-4PH stem, 316 SS bushings, fluorocarbon rubber disc seat and shaft seal, 10-position lever actuator with memory stop. Rated 250 psi wwp at dead shut-off service without need for downstream flange. ANSI 150-pound flanges, NIBCO LD 3222.-MILWAUKEE HL234E-LEVER AND HL334E- GEAR

HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. The basis of design is MILWAUKEE VALVE
2. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psig at 100 deg F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, Stainless Steel
 - e. Seat: RPTFE
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: CF8M Stainless steel.
 - h. Service: Bidirectional.

MILWAUKEE – HP1LCS4212- LEVER AND HP1LCS4213-GEAR

- 2.8.32 Special Operators: Where indicated on the Drawings, provide galvanized chain wheel operators and chain with chain guides in lieu of general use operators. Bottom of chain shall be 6 ft. 10 inches AFF.
- 2.8.33 Pressure Relief Valves: Bronze body and trim valve with test lever.
- 2.8.34 Needle Valves:
- 2.8.35 Solenoid Valves: Shall be of the direct acting or pilot operating type for use with service indicated. The valves shall conform to ARI 760, and UL 429, and shall be designed for the pressure drop required. Each valve shall include a coil housing, stem and plunger assembly nonmagnetic to the plug, stainless steel enclosing tube, seat and plunger, and proper inlet and outlet connections for installing into the piping system. Direction of flow shall be indicated on the body. Solenoid valves shall be designed, manufactured and tested specifically for the service in all respects, including material. The coil housing shall be as specified for the NEMA requirement.
- 2.8.36 Pressure Regulating Valves: Valves shall be operated by an electric or pneumatic operator. The regulating valve shall limit the flow to the actual requirements of the system load. Valves shall be sized so that the head loss at maximum flow will not exceed that shown on the drawing. Valves shall be of the globe, straight through, or angle type [as indicated] suitable for a working pressure of not less than 150 psig. The Automatic Regulating Valve shall be three way with the common outlet piped as shown. The common outlet shall have balancing cocks provided in the upstream

pipng for required equal pressure adjustments for three-way systems. Valves shall be of the single seat type with renewable composition discs having V-port skirts, tapered plugs or other means that will give the best control for the service. Valves up to and including 1 inch in size shall be brass or bronze, with threaded end connections. Valves 1-1/4 inches and 1-1/2 inches may be as specified for the smaller sizes or of iron as specified for the larger sizes. Valves 2 inches and larger shall be flanged iron bodies with brass or bronze trim. Materials of valve and operating motor shall be corrosion-resisting material to preclude corrosion of working parts due to leakage of water from stem packing. Valves shall have direction of flow clearly and permanently indicated. Two-position type valves not intended for modulating service shall have quick-opening type plugs.

2.8.37 Stop-Check Valves:

2.9 HYDRONIC SPECIALTIES

2.9.1 Strainers 1/2 to 2 inch: Cast iron body, Y-pattern, threaded ends, with 20-mesh Monel screen. Rated 125 psig SST/200 psig cwp. Crane 988 1/2.

2.9.2 Strainers 2 1/2 to 8 inch: Cast iron body, Y-pattern, flanged ends, with 20-mesh Monel screen. Rated 125-psig sst/200 psig cwp. Crane 989 1/2.

2.9.3 Automatic Air Vents: Cast brass vent valve with 3/4-inch MPT inlet, 1/8-inch IPS safety drain outlet, and built-in check valve. Rated 150 psig at 250°F. Hoffman 78.

2.9.4 Storage Tank Automatic Air Vent: Cast iron body with stainless steel float and trim, 3/4-inch FPT inlet, 1/2-inch FPT safety drain outlet, and 1/2-inch FPT equalizing port. Rated 250 psig @ 300°F. Hoffman 792.

2.10 STEAM SPECIALTIES – NOT USED

2.11 COMPRESSED AIR SPECIALTIES – NOT USED

2.12 COMPRESSION TANKS

2.12.1 Compression Tanks shall be welded steel, and shall be constructed and tested hydrostatically in accordance with Section VIII of the ASME Boiler Pressure Vessel Code. The design working pressure of the tank shall be either the head imposed on it by the system plus 50 psig or 150 psig, whichever is greater. The tank shall be zinc coated inside and out after fabrication by the ASTM A385 hot dip process. Tank shall have drain, fill, sight glass isolation valves and guard, air charging and system connections, automatic makeup, and automatic relief to drain with air gap between relief outlet and drain. Tank shall be pneumatically pressurized during charging of water, so that the system is fully charged with the water and with level in the expansion tank at normal level at normal operating conditions. Open tanks shall have pressure rating to match the system, sight glass and automatic make up system.

2.13 FLOW MEASUREMENT

2.13.1 Flow Meters: Onicon type paddle wheel, magnetic pulse counter. Meter tubes and

orifice plates shall be stainless steel.

2.14 AIR SEPARATOR

- 2.14.1 External Air Separation Tank: Shall be of steel, designed and constructed in accordance with Section 8-D- 1 of the ASME Boiler and Pressure Vessel Code and ASME labeled for 150 psig working pressure and factory tested for 150 psig. The capacity of the separator shall not be less than as indicated. Tank shall have tangential connections, flanged for size 2-1/2 inches and larger and threaded connections for 2 inches and smaller inlets and outlets. Each unit shall have an internal design suitable for creating the required vortex and subsequent air separation, for air release to the system compression tank and shall also have a galvanized steel strainer. A blow down connection shall be provided with a gate valve piped to nearest floor drain.

2.15 INSTRUMENTS

- 2.15.1 Thermometers: Bi-metallic type, 4-inch dial with well to match piping. Scale and temperature ranges shall be suitable for the intended service. Dial type thermometers selected shall be suitable for the intended service.
- 2.15.2 Pressure gauges: Gauge for air, steam, oil and water. The pressure gauge case shall be Metal 304 stainless steel, 4-inch diameter dial. The scale ranges, graduations, figure intervals, size of gauge, and type of mounting shall be selected specifically for the intended service. The gauge shall be of a design that is readable from the floor. Pressure gauges mounted on machinery shall be provided by the machinery manufacturer in conformance with the specifications furnished for the machinery.

2.15.3 Pressure-Temperature Taps – Peats - Plugs

2.16 FLEXIBLE CONNECTORS

- 2.16.1 Flexible Connections: Install flexible pipe connectors or couplings on piping connected to equipment. Flexible section shall consist of rubber, tetrafluoroethylene resin, corrosion-resisting steel, bronze, monel or galvanized steel. The material used and the configuration shall be suitable for pressure, temperature and circulating medium. The flexible section may be reinforced with metal retaining rings, with built-in braided wire reinforcement and restriction bolts, or with wire braid cover suitable for the service intended.

2.17 IDENTIFICATION – See Section 23-05-53

2.18 PIPE SLEEVES

- a. Generally: Provide where piping passes through walls, floors above grade, roofs, and partitions. Secure sleeves in proper position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, roofs and partitions. Provide not less than 0.25-inch space between exterior of piping or pipe insulation and interior of sleeve. Firmly pack space with insulation and caulk at both ends of the sleeve with plastic waterproof

cement which will dry to a firm but pliable mass or provide a segmented elastomeric seal.

- b. In fire separation assemblies: Pack space with intumescent firestop putty.
- c. Sleeves in masonry and concrete walls, floors, roofs: Provide ASTM A 53 Schedule 40 or Standard Weight, hot-dip galvanized steel pipe sleeves. Extend sleeves in floor slabs 3 inches above the finished floor.
- d. Sleeves in partitions and other than masonry and concrete walls, floors and roofs: Provide hot-dip galvanized 16ga steel sheet.
- e. Sleeves for copper pipe: Provide piping isolators between the pipe and the sleeve before packing.

2.19 PIPE SUPPORTS (HANGERS)

Provide MSS SP-58 and MSS SP-69, Type 1 or 6, of the adjustable type, except as indicated or specified herein. Provide Type 40 insulation protection shields for insulated piping. Provide steel support rods. Provide nonmetallic, or plastic piping isolators between copper pipe and the hangers. Provide flat wide band hangers for uninsulated plastic piping with a 1/8-inch rubber insert to prevent chaffing of the pipe. All non-plastic elements shall be hot-dip galvanized.

3.0 EXECUTION

3.1 INSTALLATION

Piping connections to equipment shall be arranged so that removal of equipment or components of equipment including tube withdrawal from heat exchangers, pump casing, shaft seals and similar work can be accomplished with the least amount of disassembly or removal of the piping system. Piping connected to equipment with vibration isolators shall be provided with flexible connections that shall conform to vibration and sound isolation requirements for the system. Electric isolation shall be provided between dissimilar metals to reduce the rate of galvanic corrosion.

3.2 PIPING SYSTEMS

Cut to the measurements established at the site and work into place without springing or forcing. Install piping with line flexibility included to absorb the expansion and contraction due to temperature changes of the piping systems. Piping line flexibility shall be achieved by the use of pipe bends or loops. The piping shall be run concealed in finished spaces except as indicated. Where piping shall pass through the structure of the building the pipe joints shall not be concealed but shall be located where they are accessible for inspection and repair. All lines will be pitched for drainage and shall have high point vents and low point drains.

- 3.2.1 Flanged Joints: Faced true, square, tight and used where necessary for normal maintenance. Mate with valves and the various equipment connections. Gaskets, packing, and thread compounds shall be suitable for the particular fluid with which

they shall be in contact.

- 3.2.2 Reducing Fittings: Shall be used to connect changes of sizes in piping lines. Branch connections shall be made with tees except that factory made forged steel welding branch outlets or nozzles having integral reinforcements and conforming to ANSI B31.1 may be used if the nominal diameter of the piping system branch does not exceed one nominal pipe size less than the nominal size of the piping segment, which contains the fitting.
- 3.2.3 Insulation: Piping insulation shall be as indicated as shown in the INSULATION section with enough clearance allowed between pipes to permit application of the insulation.
- 3.2.4 Valves: Install isolation valves at all equipment pumps, etc., to allow maintenance or isolation, and to establish proper and sequential operation of the complete system. Install block and balance valves with stems horizontal where necessary to avoid trapping of fluid.
- 3.2.5 Dielectric Unions or Flanges: Provide between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections. Flanges and unions shall conform to the requirements of ANSI B16.10 Standard.
- 3.2.6 Pipe Sleeves: Pipes and tubing which penetrate the building structure shall be provided with pipe sleeves. Sleeves shall be securely retained in position and location before and during construction. Space between pipe and sleeves, or between insulation of pipe and sleeves, shall be not less than 1/4-inch between outside of pipe or insulation and inside wall of sleeves. Pack the annular space with hemp or fiber glass, and seal with elastic cement. Sleeves for uninsulated pipes shall have ends flush with finished wall surfaces and pipe or tubing with outside perimeter of pipe caulked to the sleeve. Sleeves for insulated pipes shall extend 1/2-inch from concrete or masonry ceiling or wall faces and outside perimeter of the insulation shall be caulked to the sleeve on both sides of the faces. Terminal ends of pipe insulation shall be sealed with mastic. Sleeves for lines passing through floors shall extend 3 inches above finished floor slab, and shall be caulked to the slab. Pipes passing through exterior walls and roof areas shall be equipped with flashing and counter flashing to form a water-tight roof seal. Uninsulated lines penetrating pitched roofs shall be passed through Pate Pipe Seals for 1/2 to 6-inch OD pipes; passed through Pate Pipe Curbs for 1/2 to 10-inch OD pipes for flat roof penetrations; and the curb may also be used for multiple penetrations on pitched roofs with matching curb pitch. Curb height shall be not less than 12 inches above roof, with raised base and cant strip as necessary, to match roof construction.
- 3.2.7 Welding:
- 3.2.7.1 Welding Procedure Specifications: Before any welding is performed, the Contractor shall submit copies of his welding procedure specification for all metals included in the work together with proof of its qualification as outlined in ANSI B31.1, ANSI Z49A.

- 3.2.7.2 Performance Qualification Record: Before any welder or operator shall perform any welding, the Contractor shall submit one copy of the Welder's Performance Qualification Record in conformance with ANSI B31.1 showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition the Contractor shall also submit each welder's assigned number, letter, or symbol, which shall be used to identify the work of the welder, which shall be affixed immediately upon completion of the weld. Welders making defective welds after passing a qualification test shall be given a re-qualification test and upon failing to pass the test shall not be permitted to work this contract.
- 3.2.7.3 Quality of Welds: The quality of welds shall be in accordance with ANSI B31.1. The surface of the finished welds shall have a bright metallic luster after cleaning, shall be fairly smooth with regular, even ripples, and shall be uniform in contour. Except as necessary to correct defects, the surfaces shall not be dressed, smoothed, or finished for improving their appearance unless required specifically by the project specification. Welds shall be sound throughout and fused thoroughly, and shall be free from gas pockets, oxides, slag inclusions, and surface porosity, except that very small pores or specs of oxides or slag will be allowed if dispersed widely and if not larger or more numerous than those produced in passing qualification tests. Welds shall be free from overlaps, undercuts and excessive convexity. The inside of the pipe shall be free from globules of weld metal which would restrict the pipe area or might become loose. Welds with disputed visual examination may be X-rayed at the Contractor's expense to determine if satisfactory.
- 3.2.7.4 Correction of Defects: Defective or unsound welds shall be corrected by removing and replacing the welds with new welds, or as follows:
- a. Excessive Convexity: Chip or grind weld to required size.
 - b. Undercutting, shrinkage cracks, craters, blowholes, and excessive porosity - chip or grind weld to sound weld and base metal and deposit additional weld metal.
- 3.2.7.5 Undersize and Excessive Concavity: Clean weld and deposit additional weld metal.
- 3.2.7.6 Overlapping and Lack of Fusion: Remove weld by chipping or grinding and reweld.
- 3.2.7.7 Slag Inclusions: Chip or grind weld to remove slag and fill with weld metal.
- 3.2.7.8 Removal of Adjacent Base Metal During Welding: Chip or grind weld to sound base and weld metal and form full size by depositing additional weld metal. Pipe or fittings that cannot be rewelded satisfactorily shall be replaced with new pipe or fittings at the Contractor's expense. Caulking of welds shall not be done. Before adding weld metal or rewelding, the surfaces shall be cleaned thoroughly. The removal of weld metal from a defective weld shall not extend into the base metal beyond the weld penetration. Where incomplete fusion is disclosed by chipping or grinding to correct defects, that part of the weld shall be removed and rewelded. In chipping or grinding welds, the weld or base metal shall not be nicked or undercut.

3.3 CLEANING OF SYSTEMS

When installation of the various components of the piping systems are completed, they

shall be cleaned before final completion. All piping and components shall be cleaned free of scale and thoroughly flushed of all foreign matter. Temporary bypasses shall be provided for all water coils to prevent flushing water from passing through coils. All strainers and valves shall be thoroughly cleaned. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. The Contractor shall maintain the system in this clean condition until final acceptance. Piping and equipment shall be cleaned and painted as per the Mechanical General Requirements and insulation specifications. Contractor shall provide alternate water sources and pumping systems as required to provide a 10 fpm flush velocity. Contractor shall inform the Owner and Engineer 24 hours in advance of starting flushing operations.

3.4 IDENTIFICATION AND FINISHING OF PIPING

Piping shall be identified in accordance with IDENTIFICATION SCHEDULE. Arrange labels to be readily seen, at each change of direction or take-off, and at 50-foot intervals. All central plant and cooling tower pipe shall be color coded by insulation or paint. Provide color code painting of all uninsulated pipes. Paint all pipes.

3.5 PAINTING

All steel parts including piping, hangers, duct supports and pipe supports are to be cleaned by SSPC-SP-2-63T hand cleaning or if oil or grease is present, then solvent cleaning SSPC-SP-1-63T will precede the hand cleaning. Prime coat to be 3 Mils minimum Oil Alkyd primer with Zinc Chromate with Alkyd topcoat 3 Mils color selected by Engineer. This specification will be used unless other piping painting requirements are shown in Section 9 or on the drawings.

Color Coding: Paint all pipe color codes per the Identification Schedule. Use paint systems compatible with the vapor barrier material, or use color-coded PVC jacket. All pipe indoors shall be coded and labeled. Exterior pipe only shall be labeled unless specifically noted otherwise.

3.6 FIELD TESTS

After completion of the piping installation and prior to initial operation, tests shall be conducted on the piping system. Furnish materials, labor and equipment necessary for tests. The Contractor shall correct defects disclosed by the test. Test systems to be insulated or painted prior to insulating or painting.

3.7 STRUCTURAL COORDINATION

Secure specific approval of structural penetrations and attachments prior to construction. Submit shop drawings of each proposed penetration with location, dimensions, and arrangement of penetration. Do not weld to structure, except to attachment clips specifically designed and designated for this purpose.

3.8 PIPING SLOPE

3.8.1 Refrigerant Suction and Hot Gas: Slope horizontal line down in direction of flow a

minimum of 1 inch in 10 feet.

3.8.2 Condensate Drainage: Slope horizontal line in direction of flow a minimum of 1/4 inch/foot.

3.10 CONDENSATE DRAINAGE

Provide trap with minimum of 2-inch water seal near drain pan. Make direction change with threaded crosses. Direct discharge into plumbing drain receptor with required air gap. Pipe size shall be not less than drain pan connection size.

3.11 APPLICATION SCHEDULE - PIPING

<u>System</u>	<u>Pressure</u>	<u>Max Size</u>	<u>Pipe/Type</u>	<u>Ftgs./Type</u>	<u>Joints/Type</u>
Chilled Water PPR VII PERF.		1/2"-2"	Steel I	Steel I	Cplg. I*
		2 1/2"-10"	Steel IV	Steel III	Weld Flng. I*
		1" – 10"	PPR VII	PPR VII	P-Wel
Gravity Condensate Drain		1/2"-2"	PVC II	PVC II	PVC II
Chemical Treatment		1/2"-2"	PVC I	PVC I	PVC I
HOT Water PPR VII PERF.		1/2"-2"	Steel I	Steel I	Cplg. I*
		2 1/2"-10"	Steel IV	Steel III	Weld Flng. I*
		1" – 10"	PPR VII	PPR VII	P-Wel

Provide steel pipe between boilers and buffer tanks, provide Aquatherm PPR VII, in Hydronic Systems and at coils.

*Connectors and Fire Penetrators Only.

3.12 APPLICATION SCHEDULE - VALVES

<u>System</u>	<u>Max. Pressure</u>	<u>Size</u>	<u>Block Valve/Type</u>	<u>Balance Valve/Type</u>	<u>Check Valve/Type</u>	<u>Remarks</u>
Chilled/Hot Water 200 Deg. F Max	100 psig	1/2"-2"	Ball Type II	Ball Type II	Poppet Type V	(1) (4) (5)
	75 psig	2 1/2"-10"	Butterfly III	Butterfly IV	Wafer Type I	
Chemical Treatment		1/2"-2"	Ball IV	Ball IV		

3.13 APPLICATION SCHEDULE - VALVES (Cont'd...)

REMARK NOTES:

- (1) Type II Gates may be used for outdoor or indoor 1/2 to 2-inch drain-down valves to 100 psig, but not blow-downs. Type I Gates shall not be used outdoors on cooling water.
- (2) See Service Considerations paragraph.
- (3) Globe valves shall be provided as bypass control valves on pressure reducing stations.

<u>Pressure</u>	<u>Type</u>	<u>Size</u>
60 psig	I	1/2-2"
75 psig	II	1/2-2"
150 psig	III	1/2-2"
	IV	2" and larger

- (4) In the bypass on three-way valve connections, provide Type I Ball to 200 psig.
- (5) For automatically actuated control valves to 75 psig, provide Butterfly Type V.
- (6) See Drain and Relief paragraph and Remark Note 1 above.

3.14 APPLICATION SCHEDULE - STEAM TRAPS

<u>Service</u>	<u>Type</u>
Indoor Pipe Drips	Thermostatic or F&T
Outdoor Pipe Drips	Thermodisc
Indoor Modulated Equipment	F&T

3.15 EQUIPMENT AND VALVE CONNECTIONS

At each item of equipment, check valve, and control valve, provide block and balance valves. Provide union or flanged joints for service access. Arrange connections so that tubes can readily be cleaned or pulled.

3.16 REFRIGERANT PIPING

The refrigeration unit manufacturer shall certify that the refrigerant piping shop drawings are satisfactory. At startup, a representative of the manufacturer shall inspect the piping and wiring, operate and test the equipment in each mode, and certify that the installation and operation are satisfactory.

3.17 PIPE SUPPORTS (HANGERS)

3.17.1 Provide additional supports at the concentrated loads in piping between supports, such as for in-line water pumps and flanged valves.

3.17.2 Maximum Spacing Between Supports:

- a. Vertical piping: Support metal piping at each floor, but at not more than 10-foot intervals. Support plastic piping at each floor and at midpoint between floors, but at not more than 5-foot intervals.
- b. Horizontal piping: Piping to be suspended as per the following table.
- c. Uniformly slope straight piping runs that could contain liquids for positive drainage. Account for sag between supports, but do not allow visible sag.

3.17.3 PIPE SUPPORT MAXIMUM SPACING (FEET)

<i>Nominal Pipe Size (Inches)</i>	<i>One and Under</i>	<i>1.25</i>	<i>1.5</i>	<i>2.0</i>	<i>2.5</i>	<i>3.0</i>	<i>3.5</i>	<i>4.0</i>	<i>5.0</i>	<i>6.0</i>
Steel Pipe	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	16.0	17.0
Copper Tube	6.0	7.0	8.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
PVC Sch 40	4.0	4.0	4.0	4.0		4.0		4.0		4.0
PVC Sch 80	4.0	4.0	4.0	4.0		4.0		4.0		4.0
PPR-All										

3.18 IDENTIFICATION SCHEDULE – See 23-05-53

3.18.1 Piping and Equipment Systems

<u>Material/Unit</u>	<u>Color</u>	<u>Label Sized to be Visible</u>	<u>Label Data</u>
Chilled Water Supply	Drk. Blue	Chilled Water Supply	
Chilled Water Return	Lt. Blue	Chilled Water Return	
Hot Water Supply	Orange	Hot Water Supply	Temperature
Hot Water Return	Yellow	Hot Water Return	
Condenser Water Supply	Med. Green	Condenser Water Supply	
Condensor Water Return	Lt. Green	Condenser Water Return	
Compressed Air	Drk. Green	Compressed Air	Pressure
Gas Lines	Drk. Yellow	Natural Gas	Pressure
Steam	White	Steam	Pressure
Steam Condensate	White	Steam Condensate	
Domestic Water	White	Domestic Water	
Fire Water	Red	Fire Line	
Vacuum	Black	Vacuum	
Pumped Effluent	Brown	(Name of Material)	Hazard
Medical Gas	Per Code	(Name of Material)	Hazard
Roof Drains/AC/Condensate	White		

END OF SECTION

DIVISION 23 - MECHANICAL

SECTION 23-05-53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

1.0 GENERAL

1.1 SECTION INCLUDES

- A. Equipment labels.
- B. Pipe labels.
- C. Valve tags.
- D. Duct labels.

1.2 REFERENCES

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for HVAC equipment, piping, valve and duct identification.
 - 1. Equipment Label Schedule: Provide a schedule of all equipment to be labeled with the proposed content for each label.
 - 2. Pipe Label Schedule: Provide a schedule of each piping system indicating a proposed nomenclature and location of all pipe markers.
 - 3. Valve Tag Schedule: Provide a proposed valve numbering scheme and schedule for each piping system. Tabulate valve number, piping system, system abbreviation as shown on tag, room or space location of valve, normal-operating position (open, closed, or modulating), and variations for identification. Mark valves intended for emergency shut-off and similar special uses.
 - 4. Duct Label Schedule: Provide a schedule of each duct system indicating a proposed nomenclature and location of all duct markers.
- D. Closeout Submittals: Record actual as built locations of valve tags and update schedules accordingly.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience
- B. Installer Qualifications: Company specializing in performing Work of this section with minimum five years documented experience.
- C. ASME Standards: Comply with ASME A13.1 for color scheme, lettering size, length of color field, and viewing angles of identification devices.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging with labels clearly identifying product name and manufacturer until ready for installation.
- B. Storage: Store materials in clean, dry area indoors until ready for installation.
- C. Handling: Protect materials and finish from damage during handling and installation.
- D. 1.7PRE-INSTALLATION MEETINGS
- E. Convene minimum two weeks prior to commencing Work of this section.
- F. Review installation procedures and coordination required with related Work.
- G. Inspect and make notes of job conditions prior to installation:
 - 1. Record minutes of the conference and provide copies to all parties present.
 - 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 - 3. Installation of identification system shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

1.6 SEQUENCING

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not

install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Marking Services, Inc. , which is located at: 8265 N. Faulkner Rd. P. O. Box 240027; Milwaukee, WI 53224; Toll Free Tel: 800-234-0135; Tel: 414-973-1331; Email: [request info \(sales@markingservices.com\)](mailto:sales@markingservices.com); Web: www.markserv.com
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 MECHANICAL IDENTIFICATION GENERAL

- A. General: Provide manufacturer's standard products of categories and types required for each application specified. For each identification type, provide all products from same manufacturer with same text, style, color, shape, and other identification features.
 - 1. Provide nameplates with the unit number on all mechanical equipment.
 - 2. Provide pipe identification labels including direction-of-flow arrows and with service indicated. All labels shall have background colors matched with specific service designation.
 - 3. Provide valve tag numbers on HVAC piping valves.
 - 4. Provide duct identification labels including direction-of-flow arrows and with service indicated. All labels shall have background colors matched with specific service designation.

2.3 EQUIPMENT LABELS

- A. Plastic Labels for Equipment (Indoor Application):
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick.
 - 2. Letter Color: Black
 - 3. Background Color: White
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 1 by 3 inches.
 - 5. Minimum Letter Size: 1/4 inch.
 - 6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment (Outdoor Application):
 - 1. Material: MS-215 Max-Tek with printed graphics protected by a chemical and UV resistant MS-3000 top laminate.
 - 2. Letter Color: Black

3. Background Color: White
4. Minimum Label Size: Length and width vary for required label content, but not less than 1 by 3 inches.
5. Minimum Letter Size: 1/4 inch.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.4 PIPE LABELS (INDOOR PIPING)

- A. Provide labels for above ground piping located indoors, and not exposed to sunlight or a harsh environment.
- B. Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
- C. Lettering shall be sub-surface printed and protected from direct contact by a layer of plastic. Markers with surface printed lettering will not be accepted.
- D. Pipe Labels for pipe O.D. less than 8 inches: MS-970 Coiled, semi rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive in contact with the pipe surface.
- E. Pipe Labels for pipe O.D. 8 inches and over: MS-970 Strap-on, semi rigid plastic to cover partial circumference of pipe and to attach to pipe with nylon ties

Pipe O.D. (including insulation)	Marker Style	Marker Width	Lettering Height	Marker Type
1/4 inch to 3/8 inch	MS970-TM	3 inches	1/4 inch	Coil-on
1/2 inch to 1 inch	MS970-A	8 inches	1/2 inch	Coil-on
1-1/8 inch to 2-1/4inch	MS970-B	8 inches	3/4 inch	Coil-on
2-3/8 inch to 3-1/4inch	MS970-C	12 inches	1-1/4 inch	Coil-on
3-3/8 inch to 4-1/2inch	MS970-D	12 inches	1-1/4 inch	Coil-on
4-5/8 inch to 5-7/8inch	MS970-E	12 inches	1-1/4 inch	Coil-on
6 inch to 7-7/8 inch	MS970-FC	12 inches	1-1/4 inch	Coil-on
8 inch to 10 inch	MS970-G	24 inches	2-1/2 inch	Strap-on
Over 10 inch	MS970-H	32 inches	3-1/2 inch	Strap-on

G. Pipe Label Color Schedule:		
Service	Lettering Color	Background Color
Chilled Water Piping	White	Green
Condenser Water Piping	White	Green
Heating Water Piping	White	Green

Steam Piping	White	Green
Steam Condensate	White	Green
Refrigerant Piping	Black	Orange

2.5 PIPE LABELS (OUTDOOR PIPING)

- A. Provide labels for above ground piping located outside, and exposed to sunlight or a harsh environment, the following product is specified.
- B. Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
- C. Pipe markers shall be constructed of MS-995 Maxilar material. Pipe markers shall withstand direct contact with all process chemicals, operating temperatures up to 250 degrees F, and prolonged exposure to direct sunlight.
- D. Pipe markers shall be constructed of printed 5 mil (0.005 inch) polyester and top laminated with MS1000 clear ultra violet and chemical resistant plastic film that is engineered to provide maximum durability of the printed legend. Markers shall be pre-coiled to wrap entirely around the circumference of pipe up to 10 inch outside diameter, and self-sealed with a strip of clear ultra violet and chemical resistant plastic film. Coiled markers shall seal to themselves, and not the pipe surface.
- E. Pipe Labels for pipe O.D. up to 10 inches: Shall be labeled with a single piece, pre-printed marker that wraps entirely around the circumference of the pipe, overlaps and seals to itself rather than adhere to the pipe surface.
- F. Pipe Labels for pipe O.D. 10 inches and greater: Shall be constructed of printed 5 mil (0.005 inch) polyester and top laminated with MS1000 clear ultra violet and chemical resistant plastic film that is pre-applied to an acrylic-faced, co-extruded ABS plastic carrier. Carrier shall have pre-formed legs running the entire length of the part to ensure marker remains straight and aligned with pipe. Flow direction shall be identified by application of a separate arrow label of same construction. Carriers shall be affixed to piping by means of two stainless steel straps that wrap entirely around the circumference of the pipe.

G. Pipe Label Schedule:				
Pipe O.D. (including insulation)	Marker Style	Marker Width	Lettering Height	Marker Type
3/4 inch to 1 inch	MS995-A	8 inches	1/2 inch	Wraparound
1-1/8 inch to 2-3/8 inch	MS995-B	8 inches	3/4 inch	Wraparound
2-1/2 inch to 4-3/4 inch	MS995-D	12 inches	1-1/4 inch	Wraparound

5 inch to 7-7/8 inch	MS995-E	12 inches	1-1/4 inch	Wraparound
8 inch to 10 inch	MS995-J	12 inches	1-1/4 inch	Wraparound
Over 10 inch	MS995-MB	32 inches	2-1/2 inch	Carrier

H. Pipe Label Color Schedule:

Service	Lettering Color	Background Color
Chilled Water Piping	White	Green
Condenser Water Piping	White	Green
Heating Water Piping	White	Green
Steam Piping	White	Green
Steam Condensate	White	Green
Refrigerant Piping	Black	Orange

2.6 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping abbreviation and 1/2 inch numbers.
 1. Tag Material: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Background Color: Natural brass.
 3. Letter Color: Black.
 4. Tag Size: 1-1/2 inches, round.
 5. Fasteners: Brass S-Hooks and Jack Chain.
- B. Valve Tags: For outdoor labeling of process valves.
 1. Material: MS-215 Max-Tek with printed graphics protected by a chemical and UV resistant MS-3000 top laminate, and having stainless steel grommet protected predrilled holes with for attachment hardware.
 2. Background Color: To match pipe label color by system.
 3. Letter Color: Either white or black for best contrast to background color.
 4. Tag Size: Minimum 1-1/2 inches.
 5. Fasteners: Stainless steel S-Hooks and stainless steel Jack Chain.

2.7 DUCT LABELS (non-plenum space)

- A. Pre-printed, color-coded, with lettering indicating associated equipment, service, and showing flow direction.
 1. Contents: Include identification of duct service using same system designation as used on Drawings and an arrow indicating flow direction. On each label, prefix the system designation with the associated equipment number (example: AHU-1 SUPPLY AIR).
 2. Material: MS900 vinyl with pressure sensitive acrylic adhesive backing.
 3. Marker Size: 2-1/4 inch high, with length to suit required label content.

4. Lettering Size: Minimum 1-1/2 inches high
5. Direction-of-Flow Arrows: Separate unit for each duct label to indicate flow direction.
6. Arrow Marker Size: 2-1/4 inch by 6-1/2 inches.

B. Duct Label Color Schedule:

Service	Lettering Color	Background Color
Supply Air	White	Green
Exhaust Air	Black	Yellow
Return Air	White	Blue
Relief Air	White	Blue
Outside Air	White	Blue

2.8 DUCT LABELS (plenum space)

A. Pre-printed, color-coded, with lettering indicating associated equipment, service, and showing flow direction.

1. Contents: Include identification of duct service using same system designation as used on Drawings and an arrow indicating flow direction. On each label, prefix the system designation with the associated equipment number (example: AHU-1 SUPPLY AIR).
2. Material: MS-4000 1.6 mil aluminum with pressure sensitive adhesive backing. Meets NFPA 101 Life Safety Code for class A materials.
3. Marker Size: 2-1/4 inch high, with length to suit required label content.
4. Lettering Size: Minimum 1-1/2 inches high
5. Direction-of-Flow Arrows: Separate unit for each duct label to indicate flow direction.
6. Arrow Marker Size: 2-1/4 inch by 6-1/2 inches.

B. Duct Label Color Schedule:

Service	Lettering Color	Background Color
Supply Air	White	Green
Exhaust Air	Black	Yellow
Return Air	White	Blue
Relief Air	White	Blue
Outside Air	White	Blue

2.9 CEILING TACKS

A. Provide steel ceiling tacks with a color-coded head 3/4 inch diameter and a 1.5 inch serrated shank.

1. Provide ceiling tacks in acoustical tile ceilings to locate equipment, valves or dampers that require regular maintenance or are part of a Life Safety System.
2. Tacks shall be color coded as follows (coordinate with Owner):
 - a. Yellow - HVAC equipment

- b. Red - Life Safety (fire dampers, sprinkler valves, etc.)
- c. Green - Plumbing Valves
- d. Blue - Heating/Cooling Valves

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Install identifying devices after completion of coverings and painting.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. For labels that are installed using pressure-sensitive adhesives, clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
- C. For pipe markers that are pre-coiled or strap-on type and do not adhere directly to the piping, no surface preparation is necessary.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Equipment Labels:
 - 1. Install or permanently fasten labels on each major item of mechanical equipment.
 - 2. Locate equipment labels where accessible and visible.
- C. Pipe Labels: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
- D. Valve Tags: Install tags on all shut-off valves and control devices in piping systems, except valves within factory-fabricated equipment units.
- E. Duct Labels: Locate labels where ducts enter into and exits from concealed spaces or is concealed by removable ceiling system as follows:
 1. Near penetrations and on both sides of walls, floors, ceilings, and inaccessible enclosures.
 2. At access doors, manholes, and similar access points that permit view of concealed duct.
 3. Near major equipment items and other points of origination and termination.
 4. Spaced at maximum intervals of 50 feet along each run.
- F. Mark location of equipment or valves located above ceilings with identifying ceiling tacks to help in identification for maintenance.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

3.18.1 Piping and Equipment Systems

<u>Material/Unit</u>	<u>Color Jacket</u>	<u>Label Sized to be Visible</u>
Chilled Water Supply	Drk. Blue	Chilled Water Supply
Chilled Water Return	Lt. Blue	Chilled Water Return
Hot Water Supply	Orange	Hot Water Supply
	Temperature	
Hot Water Return	Yellow	Hot Water Return
Condenser Water Supply	Med. Green	Condenser Water Supply
Condensor Water Return	Lt. Green	Condenser Water Return
Compressed Air	Drk. Green	Compressed Air
	Pressure	
Gas Lines	Drk. Yellow	Natural Gas

	Pressure	
Steam	White Pressure	Steam
Steam Condensate	White	Steam Condensate
Domestic Water	White	Domestic Water
Fire Water	Red	Fire Line
Vacuum	Black	Vacuum
Pumped Effluent	Brown Hazard	(Name of Material)
Medical Gas	Per Code Hazard	(Name of Material)
Roof Drains/AC/Condensate	White	

END OF SECTION

DIVISION 23 - MECHANICAL

SECTION 23-30-00 - AIR DISTRIBUTION

1.0 GENERAL

1.1 The Conditions of the Contract apply to this Section.

1.2 Section 23-05-00 apply to this Section.

1.3 REFERENCE PUBLICATIONS

The publications listed below form a part of this Specification to the extent applicable.

ADC 1062	Certification, Rating and Test Manual
AMCA 500	Test Method for Louvers, Dampers and Shutters
ANSI/ASTM C553	Mineral Fiber Blanket Felt Insulation
ARI 650	Air Outlets and Inlets
ASHRAE 70	Method of Testing for Rating the Air Flow Performance of Outlets and Inlets
ASTM A 90	Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
ASTM A 167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
ASTM A 527	Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate.
NFPA 90A	Installation of Air Conditioning and Ventilating Systems.
NFPA 90B	Installation of Warm Air Heating and Air Conditioning Systems.
NFPA 96	Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.
NFPA 255	Surface Burning Characteristics of Building Materials
SMACNA	Duct Construction Standards.
SMACNA	Fibrous Glass Duct Construction.
SMACNA	Balancing and Adjustment of Air Distribution Systems.
UL 181	Factory-Made Air Ducts and Connectors.
UL 33	Heat Responsive Links for Fire Protection Service
UL 555	Fire Dampers and Ceiling Dampers

1.4 REQUIRED STANDARDS

- a. Laws and Regulations of the State of Texas.
- b. County of Nueces, City of Corpus Christi, Texas, codes and ordinances.

1.5 WORK INCLUDED

- a. Ductwork and accessories.
- b. Air distribution devices.
- c. Duct lining.
- d. Duct cleaning.

1.6 SUBMITTALS

1.6.1 Product Data:

- a. For ductwork accessories, duct liner materials, and air distribution devices. Include construction and performance (including acoustic) data.
- b. Review requirements of outlets and inlets as to size, finish and type of mounting prior to submitting product data and schedules of outlets and inlets.
- c. Submit manufacturer's installation instructions for duct liner.
- d. Submit manufacturer's data for duct sealant.

1.6.2 Shop Drawings: Submit ductwork shop drawings only for those assemblies indicated below in this paragraph; and for any proposed substitutions in duct size or arrangement. Do not submit shop drawings otherwise. For proposed substitutions, illustrate only the items necessary to convey the difference; do not submit unchanged information such as diffuser CFM.

- a. Construction details and methods selected by the Contractor as being acceptable options rather than unique requirements. Marked-up SMACNA tables and plates may be acceptable if clear.

1.6.3 Samples: As indicated in this paragraph, and as requested by the Engineer.

- a. Duct sealant.
- b. Flexible duct.

1.7 DEFINITIONS

1.7.1 Duct Sizes: Inside air flow dimensions.

1.7.2 Low Pressure: Station to 1" WG position pressure. Medium pressure station to 5" WG position pressure

- a. Three pressure classifications: 1/2 inch WG positive or negative static pressure

1.8 QUALITY ASSURANCE

1.8.1 Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

1.8.2 Test and rate performance of louvers in accordance with AMCA 500.

2.0 PRODUCTS

2.1 MATERIALS

2.1.1 General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.

2.1.2 Steel Ducts:

- a. Rectangular duct: ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per square foot for each side in conformance with ASTM A90. Minimum metal gauge shall be 24-gauge below 30-inch width, 22 gauge, 30- to 48-inch width, and 20 gauge, above 48-inch width.
- b. Round duct: ASTM A527 galvanized steel, double walled, insulated between walls, spiral wrap lock seam construction with standard slip joints, having a zinc coating of 1.25 oz per square foot of surface area per ASTM A90. Minimum gauge shall be 20-gauge below 15-inch duct radius, 18-gauge for 15- to 24-inch duct radius, and 16 gauge for above 24-inch duct radius. Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. All fittings shall be long radius type.
- c. Fasteners: Rivets, bolts, or sheet metal screws.
- d. Round takeoffs from rectangular duct: For other than diffuser taps provide bell-mouth fitting.
- e. Round takeoffs from round duct: Tee or wye fitting. At size changes, provide full size fitting and reducer or bell-mouth fitting.
- f. Sealant: Rector Seal "Airlock," water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape on all transverse and longitudinal joints.
- g. Hanger rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded. A galvanized strip, 1 inch x 1/16 inch, may be used in wooden structures. Metal non-galvanized brackets to be painted.

2.1.3 Round Flexible Ducts:

- a. Medium pressure, insulated (to VAV boxes) 3 inch to 16 inch: Provide laminated skin of aluminum foil and aluminized polyester with fiberglass mesh reinforcement, locked around a galvanized wire helix, spiral wrapped. Rated +12 inch/-5 inch w.g., 5500 fpm, -20°/+250°F. Flexmaster Type 3.
- b. Low Pressure, insulated 3 inch to 16 inch (to diffuser and devices): Provide laminated skin of aluminum foil and aluminized polyester with fiberglass mesh reinforcement, locked around a galvanized wire helix. Rated +6 inch/-4 inch w.g., 4000 fpm, -20°/+250°F. Flexmaster Type 5.
- c. Acoustical, insulated 3 inch to 16 inch (used in band hall practice hall): Provide laminated skin of aluminum foil and aluminized polyester with fiberglass mesh

reinforcement, locked around a galvanized wire helix. Rated +6 inch/-4 inch w.g., 4000 fpm, -20°/+250°F. Flexmaster Type 6M.

- d. Support: Support to obtain a maximum bending radius of 1.5 X centerline diameter. Avoid sags. Relatively straight duct may be supported by 1-inch wide galvanized straps, or 1-inch galvanized bands with galvanized wire attachments. Support vertical plane elbows of 45° or more with 3-inch wide galvanized sleeves attached to wire hangers, at the apex of the elbow, angled to obtain the radius.
- e. Standards: UL 181, Class 1 connector. Flame spread <25, smoke developed <50. Water vapor transmission ≤0.02 perm, tested per ASTM E96, procedure A.
- f. Connections: Connect duct with stainless steel alligator clamps on medium pressure and reusable knotted nylon lock ties on low pressure. **Seal vapor barrier to adjacent vapor barriers**, or to smooth metal surface if adjacent to uninsulated sections.
- g. Insulation jackets: Factory wrapped fibrous glass, 1 inch thick, .23 with 3-mil polyethylene jacket having vapor transmission ≤0.1 grains/s.f./3-hr, tested per ASTM E96, procedure A. Flame spread <25, smoke developed <50.

2.1.4 Fibrous Glass Duct to 24-inch Size: Not Used

2.2 FITTINGS

- a. Rectangular elbows: Unless otherwise indicated, 90° ells shall be rectangular, with turning vanes. Turning vanes shall have straight leading and trailing edge sections tangent to the curved section and parallel to duct walls.
- b. Radius elbows: Unless otherwise indicated, elbows other than 90° shall be radiused at 1.5 x elbow width centerline dimension, 1.0 x inside, 2.0 x outside, without turning vanes.
- c. Rectangular takeoffs: Provide 45° inside throats generally. Where indicated in Drawings, provide fully closing extractors with pushrods on supply ducts.
- d. Round takeoffs from rectangular duct: For other than diffuser taps provide bell-mouth fitting.
- e. Round takeoffs from round duct: Tee or wye fitting. At size changes, provide full size fitting and reducer or bell-mouth fitting.
- f. Round diffuser taps: Spin-in bell-mouth tap with butterfly damper and locking quadrant. On insulated systems, extend damper rod through insulation for external handle mounting.
- g. Reducers: Maximum 45° included angle.
- h. Increases: 15° included angle where possible; maximum 30°.
- i. Offsets: Provide ogive where standard fittings cannot fit.
- j. Duct penetrations: Provide airfoil easement and enlarge outside duct to maintain flow area of the section.
- k. Use double nuts and lock washers on threaded rod supports, where duct section

weight exceeds 50 pounds.

- l. Insulation pins: As necessary.

2.3 DUCT ACCESSORIES

2.3.1 Volume Control Dampers:

- a. In round duct: Butterfly-type with locking quadrant.
- b. In rectangular duct: Single blade up to 8 inches wide. Opposed blade pattern for multi-blade dampers in duct larger than 8 inches.
- c. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.3.2 Backdraft Dampers: (Supply fire dampers similar with actuator.)

- a. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16 gauge galvanized steel or extruded aluminum with center pivoted blades of maximum 6-inch width, with flexible vinyl sealed edges, linked together in a rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.
- b. Acceptable manufacturers: Ruskin, Air Balance.

2.3.3 Flexible Duct Connectors: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 36 oz per sq yd, approximately 3 inches wide, crimped into metal edging strip.

2.3.4 Duct Access Doors:

- a. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking handle devices. For insulated ductwork, install minimum 2-inch thick insulation with sheet metal cover.
- b. Access doors smaller than 12 inches square may be secured with sash locks.
- c. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- d. Access doors with sheet metal screw fasteners are not acceptable.
- e. Acceptable manufacturers: Ventlok or equal

2.3.5 Duct Test Holes:

- a. Cut or drill temporary test hole in ducts as required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- b. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.3.6 Combination Fire Smoke Dampers (Model FSD36)

- 2.3.6.1 Section Includes: Class II combination fire smoke dampers suitable for application in HVAC systems with velocities to 2,000 feet per minute (610 m/min) and conforms to:
- a. AMCA 500: Test Methods for Louvers, Dampers and Shutters.
 - b. AMCA 511: Certified Ratings Program for Air Control Devices.
 - c. BSA: City of New York, Department of Buildings, Board of Standards and Appeals.
 - d. CSFM: California State Fire Marshall Listing for Fire Damper and Smoke Damper.
 - e. NFPA 90A: Installation of Air Conditioning and Ventilating Systems.
 - f. NFPA 92A: Smoke-Control Systems.
 - g. UL 555: Standard for Safety; Fire Dampers.
 - h. UL 555S: Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems.
- 2.3.6.2 Manufacturer: Ruskin Manufacturing, 3900 Dr. Greaves Road, Kansas City, Missouri 64030. Phone (816) 761-7476. Fax (816) 765-8955.
- 2.3.6.3 Fabrication:
- a. Model: FSD36.
 - b. Fire Rating: UL 555 classified and labeled as a 1-1/2 hour fire damper.
 - c. Smoke Rating: UL 555S classified and labeled as a Leakage Class II Damper for use in smoke control systems.
 1. Leakage Class II: 10 cubic feet per minute per square foot ($3 \text{ m}^3/\text{min}/\text{m}^2$) at 1 inch w.g. (0.25 kPa).
 - d. Air Flow Rating: UL approved for dual directional air flow.
 - e. Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel.
 - f. Blades:
 1. Style: Single skin with 3 longitudinal grooves.
 2. Action: Opposed
 3. Orientation: Horizontal.
 4. Material: Minimum 16 gage (1.6 mm) equivalent thickness galvanized steel.
 5. Width: Maximum 6 inches (152 mm).
 - g. Bearings: Self-lubricating stainless steel sleeve, turning in extruded hole in frame.
 - h. Seals:
 1. Blade: Inflatable silicone coated fiberglass material for smoke seal to 450°F (232°C) and galvanized steel for flame seal to 1900°F (1038°C). Mechanically attached to blade edge.

- 2. Jamb: Stainless steel, flexible metal compression type.
- i. Linkage: Concealed in frame.
- j. Axles: Minimum 1/2-inch (13 mm) diameter plated steel, hex-shaped, mechanically attached to blade.
- k. Mounting: Vertical
- l. Heat-Actuated Temperature Release Device:
 - 1. Control close and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades.
 - 2. Allow damper to be automatically and remotely resettable after test, smoke detection, or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.
 - 3. Controlled closure and locking of damper to occur in 3 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
 - 4. Electric EFL with electric actuators.
 - 5. Release Temperatures: 165°F (74°C).
- m. Actuator:
 - 1. Electric 24 V, 60 Hz, two-position.
 - 2. Pneumatic: 20 to 30 psi (138 to 207 kPa) supply air pressure, [two-position] [modulating].
 - 3. Fifteen Second Criteria: Meet UBC 15 second operation requirement.
- n. Duct Transition Connection: Rectangular.
- o. Finish: Mill galvanized.
- p. Assembly: Factory assemble damper, actuator, and accessories and furnish as a single unit conforming to UL 555 and UL 555S.

2.3.6.4. Performance Data:

- a. Elevated Temperature Qualified: Damper and actuator assembly qualified in accordance with UL 555S to elevated temperature of 450°F (232°C).
- b. Capacity: Demonstrate capacity of damper and actuator assembly to operate, by opening and closing, in HVAC system operating conditions.
 - 1. Closed Position: Maximum pressure of 4 inches w.g. (1 kPa).
 - 2. Open Position: Maximum air velocity of 2,000 feet per minute (610 m/min).
- c. Leakage Class: Leakage Class II, when applied in systems with maximum pressure of 4 inches w.g. (1 kPa).

2.3.6.5 Accessories:

- a. TS 150EZ FireStat:

1. UL classified.
 2. Electrically and mechanically lock damper in closed position when duct temperatures exceed 165°F (74°C) and still allow appropriate authority to override FireStat and operate damper as may be required for smoke management functions.
 3. Allow damper to remain operable while temperature is below 450°F (232°C).
 4. Interface electrically with [smoke detectors] [building fire alarm systems] [remote indicating and control stations].
 5. High Limit Temperature Sensor:
 - a) Returns damper to fire protection mode when temperatures reach operational limit of damper and actuator assembly of 450°F (232°C).
 - b) Conform to NFPA 92A.
 - c) Replaces EFL or PFL *Ruskin® Controlled Closure* devices on standard dampers.
 6. Blade Position Indicator Switches: Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.
- b. SP 100 Switch Package: Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.
- c. Picture Frame Mounting Angles:
1. One-piece, roll formed retaining angles 1-1/2 x 1-1/2 inches .
 2. Factory matched and shipped on individual damper.
 3. Factory pre-punched screw holes.
 4. Requires factory sleeve.
- d. Factory Sleeve:
1. Minimum 20-gage (1.0-mm) thickness, minimum 17 inches (432 mm) length.
 2. Silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

2.4 AIR DISTRIBUTION DEVICES

2.4.1 Provide mounting frame styles matching the mounting surface.

2.4.2 Provide duct throats matching the connection style.

2.4.3 At diffusers mounted in fire rated assemblies, provide insulation and radiation and/or fire dampers as necessary.

2.5 DUCT LINER

- 2.5.1 Certainteed Tough Gard Duct Liner, Type 300: Flexible glass fiber; ANSI/ASTM C553; k = 0.24 BTU-in/hr-ft²-°F at 75°F; 3 lb/cu ft minimum density; coated air side for maximum 2,500 ft/min. duct liner, meets NFPA 90 and 255 requirements, 1" thickness minimum.
- 2.5.2 Adhesives: Waterproof fire-retardant type, [spot coated] [full area coated]. Seal all edges.
- 2.5.3 Impale Anchors: Galvanized steel, 12 gauge, and self-adhesive pad.
- 2.5.4 Thresholds on High Velocity Duct: Sheet metal nose protected.
- 2.5.5 Acceptable Manufacturers:
- 2.6 SHEET METAL CURBS

Galvanized steel, minimum 16 gauge, with mitered corners and continuously welded seams. Insulation shall be 1 1/2-inch thick rigid fibrous glass on all metal surfaces exposed to the interior. Nailer strip shall be pressure-treated wood. Provide rise from roof below 45° cant as necessary to match roof construction. Minimum height above curb = 12 inches. [Provide sheet metal cap flashed over curb and secured with galvanized screws to nailer side 16 inches O.C. where indicated. Refer to Architectural. Architect's spec shall supersede this section.

3.0 EXECUTION

3.1 INSTALLATION

- 3.1.1 Provide openings in ductwork where required to accommodate thermometers and sensors. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- 3.1.2 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- 3.1.3 Flexible duct connections to diffuser or troffer boots from low-pressure ducts shall not exceed 8 feet in length.
- 3.1.4 During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 DUCTWORK APPLICATION SCHEDULE

<u>Air System</u>	<u>Material</u>	<u>Acoustical Liner</u>
Main Plenums unit	Galvanized Steel	Required an 8ft fan

Supply and Return Ducts Generally	Galvanized Steel	As noted
Ducts Downstream from Terminals	Galvanized Steel	As noted
Relief Ducts Generally	Galvanized Steel	None
Exhaust Ducts Generally	Galvanized Steel	None

3.3 DUCT CLEANING

3.3.1 Remove all debris and dirt from ducts and wipe clean. Before installing air outlets, force air through entire system at maximum attainable velocity to remove accumulated dust. Provide temporary air filters to protect ductwork that may be harmed by excessive dirt. For large systems, clean duct with high power vacuum machines.

3.3.2 Clean surfaces prior to adhesive and sealant applications.

3.3.3 Field Painted Duct and Air Distribution Devices: Remove markings, grime, dirt and other foreign material prior to painting.

3.4 ACCESSORIES

Install accessories in accordance with manufacturer's instructions.

3.4.1 Provide balancing dampers at points on low-pressure supply, return, and exhaust systems where branches are taken from larger ducts as necessary for air balancing.

3.4.2 Provide fire dampers at locations indicated, [and where ducts and outlets pass through fire rated components], and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges. Install access doors where necessary to reset damper.

Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

3.4.3 Provide flexible connectors, immediately adjacent to equipment, in ducts associated with equipment on vibration isolators or suspension rods.

3.4.4 Provide duct access doors for inspection and cleaning before and after filters, coils, fans, dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8-inch size for hand access, 18 x 18-inch size for shoulder access, and as indicated.

3.4.5 Provide duct test holes where indicated and/or necessary for testing and balancing purposes.

3.5 DUCT LINER

3.5.1 Liner Application: Adhere insulation with adhesive for 100-percent coverage. Secure insulation with mechanical fasteners on 15-inch centers maximum on top and side of ductwork with dimension exceeding 20 inches. Seal and smooth joints. Do not use nail-type fasteners. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

3.5.2 Liner Application Schedule:

<u>Ductwork</u>	<u>Liner Type</u>	<u>Thickness</u>	<u>Finish</u>
-----------------	-------------------	------------------	---------------

3.6 SEALANT

3.6.1 Seal all transverse and longitudinal joints and connections with sealant.

3.7 PAINTING

3.7.1 Paint ductwork visible behind air outlets and inlets matte black.

3.8 AIR DISTRIBUTION DEVICES

3.8.1 Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.8.2 Install devices to ductwork with airtight connection.

3.8.3 Provide balancing dampers in duct take-off to diffusers, grilles and registers, regardless of whether dampers are specified as part of the device assembly.

3.9 FIRE/SMOKE DAMPERS

3.9.1 Inspect areas to receive dampers. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

3.9.2 Installation:

- a. Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.
- b. Install dampers square and free from racking with blades running horizontally.
- c. Do not compress or stretch damper frame into duct or opening.
- d. Handle damper using sleeve or frame. Do not lift damper using blades or accessories.
- e. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.10 TESTING

Test main and branch ductwork after sealing and prior to connection of flexible ductwork and/or air distribution devices. Test shall be performed by blocking off all taps and openings and applying a pressure of 1-inch w.g. Pressure shall be monitored using a manometer and shall be held for 30 minutes at no loss in pressure before acceptance. Submit test data signed by Mechanical Contractor Superintendent.

END OF SECTION

DIVISION 23 - MECHANICAL

SECTION 23-70-00 - HVAC EQUIPMENT**1.0 GENERAL**
-----**1.1 CONTRACT CONDITIONS**

The Conditions of the Contract apply to this section.

1.2 Section 15000, "Mechanical General Requirements," applies to this section.

1.3 REFERENCE PUBLICATIONS

The publications listed below form a part of this specification to the extent applicable.

1.3.1 Air Condition and Refrigeration Institute (ARI) Standards:

410	Forced Circulation, Air-Cooling and Air-Heating Coils
430	Central-Station Air-Handling Units

1.3.2 Air Moving and Conditioning Association (AMCA) Standards:

210	Laboratory Method of Testing Fans for Rating
300	Test Code for Sound Ratings for Air Moving Devices

1.3.3 American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standards: 52

1.3.4 Southern Building Code Congress International (SBCC) Publication:

Standard Mechanical Code

1.4 REQUIRED STANDARDS

- a. Laws and Regulations of the State of Texas
- b. County of Nueces, City of Corpus Christi, Texas, codes and ordinances.

1.5 SUBMITTALS**1.5.1 Manufacturer's Data:**

- a. General: Provide performance, construction details, weight distribution and dimensional data, including necessary clearances and sound power data by octave band.
- b. Pumps with pump curves
- c. Boiler systems

1.5.2 Samples: As requested by the Engineer.

1.5.3 Installation, Operation and Maintenance Instructions:

- a. Installation instructions
- b. Operation and maintenance instructions

1.5.4 Parts Lists: For each item subject to disassembly.

1.5.5 Test Reports: On equipment and systems.

1.6 LABELING

Equipment subject to listing and labeling under the reference standards shall be listed and labeled.

1.7 REFER

Refer to Division 26 for material specification requirements for electrical devices, including starters.

1.8 WORK PERFORMED UNDER OTHER DIVISIONS

Coordinate with Division 26, which will provide power conduit, wiring, starters, and disconnects not specified in this Section. Coordinate size, type, accessories, and location.

2.0 PRODUCTS

2.1 MOTORS

Motors: NEMA standard T-frame "high-efficiency" open-drip proof type. Motors in air stream or exposed to weather shall be TEFC or TENV. Provide not less than 1.15 service factor. Select motor horsepower to avoid overload. Provide adjustable motor slide rail.

2.9.1.3 Compressor:

- a. Reciprocating compressor shall withstand high compressor ratios. Equipped with crankcase heater and dual discharge muffler.
- b. Scroll compressor shall provide high efficiency, quiet operation and improved reliability for longer life.

2.9.1.4 Galvanized 20 Gauge Zinc coated Steel Cabinet: Cleaned, rinsed, sealed and dried before the polyurethane primer is applied. Finished with baked-on, beige textured enamel that allows it to withstand 1000 hours of salt spray exposure.

2.9.1.5 Electrical Components: Accessible for routine inspection and maintenance through service panel opening. Lockable hinged, access cover to the circuit breaker or pull disconnect switch.

- 2.9.1.6 Electric Heat Strips: Automatic limit and thermal cut-off safety control.
- 2.9.1.7 Disposable Air Filters: 2-inch pleated filter.
- 2.9.1.8 Condenser Fan and Motor Shroud Assembly: Slide out for easy access.
- 2.9.1.9 Built-in Circuit Breakers on single and three-phase (230/208 volt) equipment. Pull disconnects on all kW versions of three-phase (460 volt) equipment.
- 2.9.1.10 Rain Hood/Sloped Top for drainage.
- 2.9.1.11 Full Length Mounting Brackets: Built into cabinet for easy installation.
 - a. Ventilation package mounted within the unit eliminating the need for an exterior mounted hood or damper assembly on the unit.
 - 1. Barometric Fresh Air Damper: Provides up to 25 percent fresh air to be mixed with conditioned air. Damper opens during blower operation and closes when blower is off. Adjustable stops to limit amount of outside air or to be locked shut.
 - 2. Motorized Fresh Air Damper: Provides up to 25 percent fresh air to be mixed with conditioned air. Two-position damper can be fully open or closed. Damper can be controlled by blower circuit or can be field connected to be controlled based on building occupancy. Powered-open spring- return on power loss.
 - 3. Classroom Ventilator (CRV): Provide fresh air intake and exhaust capability through the CRV. Provides up to 75 percent outside air and exhaust capability. Amount of fresh air supply and exhaust adjustable to meet specific applications. Spring return on loss of power. Complies with ASHRAE Standard 62-89 "Ventilation for acceptable indoor air quality".
 - 4. Control of CRV can be accomplished with indoor blower operation or field control based on room occupancy. Unit can also be managed by the Bard CS2000 that features total system control including CRV operation based on occupancy. Automatic setback/set-up features based on occupancy. Sell programming and requires no user input.
 - 5. Economizer: Fully modulating economizer with enthalpy control, minimum position potentiometer and mixed air sensor. Includes moisture eliminator and prefilter with easy access for cleaning.
- 2.9.1.12 Acceptable Manufactures: Bard or equal.
- 2.10 ELECTRIC DUCT HEATER
 - 2.10.1 Duct Heater: Shall be Red-I, Inc., or equal Model R open-coil design. Heater shall be slip-in design, shall be UL listed for zero clearance and shall meet requirements of the latest edition of the National Electric Code.
 - 2.10.2 Safeties: Heater shall be furnished with two over-temperature safety devices

serviceable and replaceable in the terminal box without removing the heater from the duct. The primary safety device shall be a disc type automatic reset that will cut the heater off when over-temperature and automatically bring the heater back on when the surrounding temperature has cooled. The second safety device shall be heat limiters in the power lines that will open the circuit and de-energize the elements if the primary safety device should fail.

- 2.10.3 Terminal box and frame shall be of heavy gauge (minimum 20 gauge) aluminized steel sufficiently formed and braced to assure structural rigidity of the entire heater assembly. Terminal box and lid must be totally enclosed and free from any perforations or louvers. Terminal box shall have sub panel design for greater cooling effect and rigidity.
- 2.10.4 Elements shall be of high-grade nickel. Elements shall be held in place with floating steatite ceramic bushings, held in place by minimum 20 gauge brackets. Brackets must be replaceable in the field and of sufficient strength so the element wire, when in place, cannot cause brackets to bend.
- 2.10.5 Heater shall be furnished with the following:
- a. Built-in air pressure switch.
 - b. Magnetic contactors.
 - c. Overcurrent protection as required by NEC and U.L.
 - d. Vapor barrier insulation on terminal box.
 - e. Transformer, Class II or if not Class II must be with fused primary.
 - f. Pilot lights showing heater is on.
 - g. Toggle switch to shut-off control circuit.
 - h. Door interlock fused disconnect switch.
- 2.10.6 Heater shall be provided with a control panel as manufactured by the heater manufacturer. All controls, except the over-temperature safety devices and the airflow switch, shall be mounted in the panel. Wiring diagrams on the panel and the heater shall clearly indicate each connection on the power and control terminals for the heater and the panel. Typical wiring diagrams will not be acceptable.
- 2.11 ROOF TOP AIR CONDITIONING UNITS
- 2.11.1 Roof Top Air Conditioning Units (RTAC):
- 2.11.1.1 Shall be self-contained units with a gas furnace, refrigerant compressor, refrigerant expansion coils, refrigerant condenser coils, condenser fans, and evaporator fans. Units shall be minimum 9.0 SEER. Rating shall be in accordance with ARI 210/240 and 270.
- 2.11.1.2 Units shall be complete with all internal power wiring, solid state electronic controls, electronic spark ignition pilot, and shall conform to ASHRAE-15.
- 2.11.1.3 Ductwork connections shall be side-by-side, return and supply air.

- a. Furnace section: Shall be a four-pass, 20-gauge, aluminized steel heat exchanger with 1000 BTU/ft³ gas fired burners.
- b. Compressors: Shall be hermetically sealed, vibration isolated unit with over current and high head pressure protection. Refrigerant shall be R-22.
- c. Cabinets: Shall be zinc-coated steel with factory applied paint finish. Cold compartments within the cabinet shall be insulated with 2-inch flexible fiberglass minimum. The heater section shall be insulated with aluminum foil faced fiberglass. The cabinet shall not sweat under any operational circumstances in 95°F DB/80°F FWB ambient conditions.
- d. Fans: Shall be forward curved belt driven on the indoor blower (except units under 5 tons may be direct driven). Condenser fans shall be propeller type.
- e. Roof Curbs: For RTAC units shall be provided by the manufacturer, fabricated of minimum 16-gauge, galvanized steel. Curb shall meet the requirements of NRCA.
- f. Controls: Provide magnetic starter with ambient compensated overload relays, on-off-auto switch, 120V transformer, safety disconnecting device, and auxiliary contacts as necessary to accomplish the Control Sequence. Enclosure shall be NEMA 3R. All control wiring shall be complete and internal to the RTAC unit. Provide anti-cycle delay compressor control and heat cycle fan delay. Power wiring shall be to a single point connection.
- g. Refrigerant coils: Galvanized steel casing with copper tubes mechanically expanded into aluminum fins. Provide fin spacing of 10 FPI or less. Headers and distributor tubes shall be copper. Working pressure 300 PSIG at 220°F. Factory proof test at 1.5 x working pressure. Leak test with air under water at 1.0 x w.p. Provide 10 percent additional fin surface than the ARI rating requires.
- h. Coil coating: Shall be required on all refrigerant condenser and evaporator coils. Coating shall be per paragraph 3.2, "Corrosion Protection".
- i. Provide coil guards.

2.12 VAV BOXES

Unit type series - constant fan, casing, (22-gauge) .85-mm galvanized steel. Filter provided on plenum inlet.

2.12.1 Insulation System:

2.12.2.3 Double Wall, (.5" or 1") 12.7 mm or 25.4 mm matt insulation: Interior liner is made of (22 gauge) .85 mm steel. All cut edges of insulation are covered by metal flange. All wire penetrations covered by grommet. Available with (1/2") 12.7 mm insulation or (1") 25.4 mm insulation.

2.12.2.4 Access Panel: Entire bottom panel is removable to provide access to fan motor.

2.12.2.5 Agency Listing: Listed and labeled by UL as Fan Coil Unit. Control No. 95X0. Canadian UL agency also available.

- 2.12.2 Primary Air Valve: Cylindrical flow control device with an integral pneumatic or electric actuator. Valve inlet is die cast aluminum and tapered to fit standard round flexible ductwork. Maximum leak rate is 1 percent at (4 inches) 996 kPa wg inlet static pressure. Integral multiple point, averaging flow sensing ring to provide primary airflow measurement within !5 percent of unit rated airflow with 1 1/2 diameters of straight duct upstream of unit. Integral flow taps and calibration chart provided on each unit.
- 2.12.3 Fan: FC style fan wheel.
- 2.12.4 Motor: Permanently lubricated, three-speed (size 30 two-speed) direct drive, permanent split capacitor type. Thermal overload protection provided. Maximum motor temperature rise on all speeds of 55°C. Fan motors available as 115 or 277 volt. Motor and fan assembly is isolated from terminal casing using either torsion flex mounting legs or rubber isolators.
- 2.12.5 Fan Speed Switch: Factory-mounted three-speed or variable speed (SCR) control to change fan motor speed. Variable speed control has minimum stop to vaoid overheating the motor. Adjustment knob located external to control panel. Fan disconnect switch provided as standard with all unit types except those with electric heat and pneumatic controls.
- 2.12.6 Heating System: (As scheduled HW or Electric)
- 2.12.6.1 Hot Water Coil: Factory mounted on plenum inlet of parallel units, discharge outlet of series units. One or two row with (192 aluminum fins per foot) 630 aluminum fins per meter. Full fin collars provided for accurate fin spacing and maximum fin-tube contact. (3/8-inch) 9.5 mm seamless copper types mechanically expanded into the fin collars. Coils are leak tested at (450-psig) 3102 kPa air pressure under water. Sweat-type water connections provided. Available with same-side right hand connections.
- 2.12.6.2 Electric Coil: Factory provided and mounted, UL recognized, resistance open-type heater with a disc-type automatic thermal primary safety device and manual reset thermal secondary cutout when necessary. Heater element material is nickel-chromium. Terminal connections are plated steel with ceramic or phenolic insulators.
- 2.12.7 Outlet Connection: Sheet metal connection at unit discharge to facilitate ductwork installation on series hot water and parallel/series electric heat units only. Parallel units with hot water heat and series/parallel with no unit-mounted heat require duct with 90° outward flange for connection to terminal discharge.
- 2.13 DEHUMIDIFIERS
- 2.13.1 Furnish and install dehumidifier where shown on the plans. Dehumidifier shall be Munters Model M-85-L desiccant non-cycling, absorption type. Dehumidifier shall be complete with reactuation heater, filter, motor, fan desiccant-impregnated honeycomb wheel, access panel, electric controls, and air-cooled condenser. Dehumidification shall be furnished with brackets for wall mounting.

2.14 GAS-FIRED UNIT HEATERS

2.14.1 Gas-fired unit heaters shall consist of heat exchanger burners and controls. Unit heater burner orifices shall be sized for natural gas.

2.14.2 Discharge of unit shall be provided with four-way directional air control louvers; heat exchanger, burner and gas controls shall be enclosed in a heavy gauge bonderized steel finished in durable smooth baked enamel finished cabinet designed for suspension installation.

- a. Gas controls: Each unit shall be complete with 100 percent cut-off gas valve limit and proof of air flow controls, control transformer, and solid state electronic ignition. Burners shall be designed to provide 80 percent AGA rating.
- b. Fans: Each unit shall be provided with a large dynamically balanced, quiet low-speed, guarded, propeller fan, direct driven by a totally enclosed inherently protected, resiliently mounted motor.
- c. Temperature control: Each unit shall be provided with a unit mounted single step low voltage thermostat to provide burner and fan cycling control.
- d. Disconnect switch
- e. Approved Manufacturers:
 - 1. Hastings
 - 2. Reznor

2.15 INFRARED UNIT HEATERS - GAS FIRED

Infrared Unit Heaters Shall Feature the Following Components:

2.15.1 Capacity: Gas fired infrared heaters are to be 60,000 BTU with construction consisting of two or more burners. Combustion surface to be made of a perforated ceramic refractory capable of operating with a temperature no lower than 1550° and no higher than 1810°F. Heaters shall have a secondary radiant surface (rods or screens) 1/4 inch to 1 1/8 inch from the ceramic elements. Radiant surface area is to be a minimum of 152 square inches for the 60,000 Btu units. The surface area is to be calculated by multiplying the length and the width of the horizontal projection of the exposed ceramic-emitting surface.

2.15.2 Pilot: Heaters are to operate on natural gas with a spark pilot ignition, cycle pilot, and automatic re-ignition of the pilot and 100 percent safety shut-off with power off (25 volt only). Disconnect switch.

2.15.3 Clearances: Above heaters to combustibles are to be rated not to exceed 40 inch. This clearance does not allow for shields above heaters.

2.15.4 Certification: Heaters must be design certified by the American Gas Association (AGA) and listed in the A.G.A. directory.

2.15.5 Manufacturer's Warranty: Shall be for ten (10) years for the complete burner assembly and secondary radiant surface (rods or screens) and one year for the entire heater unit and controls.

2.15.6 Approved Manufacturers: Infrared heaters shall meet or exceed this specification. Heaters supplied shall be the below listed or approved equal (approval must be given by the Owner, the Architect, and the Engineer):

- a. Re-Verber-Ray DR60 NSPI-8 (25v)
- b. American Infra-Red 60HBS5-4IN (25v)
- c. Lambert L60-NESD
- d. Ray-Tec RT60 NSPH (25 volt only)

2.16 DIRECT GAS FIRED MAKE-UP AIR UNIT

Furnish and install the following Hastings or equal direct gas-fired make-up air system.

2.16.1 Blower Section:

- a. Blower wheels shall be statically and dynamically balanced forwardly curved, double width, double inlet, Class 1.
- b. Blower wheels shall be mounted on solid turned ground shaft with keyway for driven shaft.
- c. Bearings shall be ball bearing, self-aligning, permanently lubricated, pillow block or flange mounted.
- d. Blower housings, bearings and adjustable motor base shall be mounted on a reinforced frame to insure rigidity and quiet operation.
- e. The driver and driven sheaves shall be of the keyed hub type. The driven sheave shall be of a fixed pitch diameter and the driver sheave shall be of variable pitch diameter through 10 HP and fixed pitch above 10 HP. V-belt drives shall be sized for 135 percent of motor horsepower.
- f. Cabinet shall be constructed of high quality (16) (14) gauge aluminized steel to insure long rust-free life.
- g. Access panels shall be provided to allow easy access to motors and filters (if ordered).
- h. Outside surface of cabinet shall be primed and finished with a coat of enamel.

2.16.2 Burner Section:

- a. The burner shall be a direct gas-fired line burner suitable for complete combustion of propane or propane-air mixture, and having a turndown ratio of 30:1.
- b. Burner combustion must be clean and odorless. Combustion efficiency must limit the products of combustion to a maximum of 5-ppm carbon monoxide and a

- maximum of 0.5-ppm nitrogen dioxide.
 - c. To eliminate the possibility of the build-up of contaminants, recirculated air is not permitted back through the line burner.
 - d. The burner shall have stainless steel combustion baffles, non-clogging gas ports, and spark-ignited, intermittent pilot and flame safeguard system.
 - e. Observation port shall be provided in burner cabinet.
 - f. Profile plates to control proper air velocity across the burner shall be factory-installed, adjusted during an actual firing test and locked in place before shipment.
- 2.16.3 Motor: A T-frame, ODP, 1800 RPM prelubricated ball bearing type motor shall be furnished for voltage as scheduled.
- 2.16.4 Gas and Electric Controls:
- 2.16.4.1 The following controls shall be furnished with the direct gas-fired make-up air system:
- a. Main gas hand shut-off valve.
 - b. Main and pilot gas pressure regulators.
 - c. Pilot controls.
 - d. Electric safety shut-off valve
 - e. Self-contained gas modulating valve for units with burner capacity of 500 MBH or less.
 - f. Electronic flame safeguard system
 - g. High temperature limit switch
 - h. Airflow switch
 - i. Ignition transformer
 - j. Automatic mild weather burner lockout
 - k. Motor starter
 - l. NEMA 1 control box
 - m. Remote control station with system switches and indicating lights
 - n. Disconnect switch
- 2.16.4.2 The system shall be factory assembled and wired with the exception of controls that are remote to the unit.
- 2.16.5 Components:
- 2.16.5.1 Weatherproof Unit: For outdoor installations including hinged and latched weatherproof control enclosure.
- 2.16.5.2 Insulated Blower Section: 1-inch, 2-pound density, mat face fiberglass insulation.
- 2.16.5.3 Storm-Proof Weather Hood: With rainshield and birdscreen. Installed on air intake of horizontal, HR-1 and HR-2, weatherproof units. Not available with optional vertical blower arrangements.

- 2.16.5.4 Birdscreen: For installation on the air intake of units with optional blower arrangements.
- 2.16.5.5 Filter Section: With "V" or "Z" frames for mounting 2-inch throwaway, cleanable or extended surface filters. A clogged filter switch with indicating light is included with this option.
- 2.16.5.6 Extended Grease Lines: For remote greasing of fan bearings from the control side of unit. Not available with SBD-112 or SBD-115 models.
- 2.16.6 Filters:
- 2.15.6.1 Filters shall be American Filter Renu-Filter, Part No. 59-52506, sized as required, holding frame for replaceable media, constructed of 18 gauge galvanized steel, with 11 gauge galvanized wire media support grids, standard 2-inch depth.
- 2.16.6.2 Filter media for filter frames shall be ASHRAE industrial grade with 81 percent arrestance with dust holding capacity of 240 grams per sq. ft., 0.10-inch w.g. clean resistance at 450 FPM.
- 2.16.6.3 Filters shall be installed prior to operation of any fan. Install new media in all units at job completion; deliver to Owner sufficient media of suitable sizes to provide for one complete media change.
- 2.17 FLUES
- Each unit heater shall be provided with approved DuraVent or Williams or equal double wall flue through the roof. Provide base flashing ceiling and roof thimbles, counter flash, extend flues 24 inch above roof and provide Briedert type "L" back draft flue cap. Flash flues through roof as detailed on Plans.
- 2.18 ELECTRIC UNIT HEATERS
- 2.18.1 AEUH/EUH-Electric Propeller Fan Unit Heaters: Provide electric propeller fan unit heaters as manufactured by Reznor. The units shall be completely packaged and arranged for ceiling suspension, with threaded suspension mounting sockets, (ceiling mounting brackets), horizontal louvers.
- 2.18.1.1 The electric heating elements are to be low temperature, enclosed-style made of steel and monel with the spiral fin copper-brazed to the element.
- 2.18.1.2 Sizes 3.0 kW through 12.0 kW utilize a line voltage control circuit and include an automatic high limit. Sizes 15.0 kW through 60.0 kW utilize a 24-volt control circuit, fan time delay control, and an automatic high limit. Motor contactors are to be provided on all three-phase units and all units larger than 5.0 kW. The units are to be provided with propeller fan(s) and permanently lubricated fan motor(s) with internal overloads.
- 2.18.1.3 Each unit is to be design-certified by Underwriters Laboratories and be UL listed. The manufacturer of this equipment must have a minimum of eight years' operating

experience.

2.18.1.4 See drawings for quantities, sizes, and capacities.

2.19 ELECTRIC INFRARED HEATERS

2.19.1 Electric infrared heaters shall be ceiling mounted reflector-type units with ventilated reflector, power connection box, element guards, and radiant heat elements.

2.19.1.1 Reflector: Extruded polished aluminum, ventilated with anodized aluminum exterior housing.

2.19.1.2 Radiant heat elements: U-shaped, .430-inch inconel sheath envelope over nickel chrome alloy coiled element imbedded in magnesium-oxide insulating powder. Operating temperature, "color," 1600°F dull red, radiant efficiency 50 percent, 5,000-hour life.

2.19.1.3 Approved manufacturers: Infrared heaters shall meet or exceed this specification. Heaters supplied shall be as listed below or engineer-, owner-, architect-approved equal.

a. Fosturia Industries, Inc.

2.20 CENTRIFUGAL ROOF VENTILATORS

2.20.1 Construction: Fan shall be of bolted and welded construction. Provide stainless steel hardware/fasteners. Housing shall be of spun aluminum (16-gauge minimum). Provide aluminum base with continuously welded curb cap. Provide integral conduit chase through curb cap to facilitate wiring. Wheel shall be centrifugal backward inclined, made of aluminum with a cast aluminum hub. Motor, bearings, and drives shall be mounted on a minimum 14-gauge steel power assembly, isolated from the unit structure with rubber isolators. Provide engraved aluminum nameplate on fan.

2.20.2 Factory Roof Curb: Provide 14-inch high 16 gallon galvanized steel pine curb with aluminum flashing, with built-up cant strip and one-inch (25 mm) insulation. Aluminum seams shall be continuously welded.

2.20.3 Optional Curb: Provide 8-inch high treated yellow pine curb continuously covered with aluminum flashing, with built-up cant strip and one inch (25mm) insulation. Aluminum seams shall be continuously welded. Curb shall be designed and sized to accept the weight of its associated fan.

2.20.4 Disconnect Switch: Factory wired, non-fusible, on housing with thermal overload protected motor. Motor shall be ODP, voltage as shown on drawings.

2.20.5 Bearings: Provide regreasable ball type in cast iron housing, with a minimum life of L50-200,000 hours at maximum cataloged operating speeds.

2.20.6 Belts and Drives: Provide oil and heat resistant non-static type belts. Drives shall be cast iron or steel, dynamically balanced and keyed. Variable pitch drive shall be factory set to specified RPM.

- 2.20.7 Fan shall be rated by AMCA for both performance and sound, and bear the AMCA certified ratings seal.
- 2.20.8 Accessories:
- a. Ruskin S3G, backdraft damper with mechanically locked blade seals
 - b. Birdscreen - stainless steel
 - c. Motorized damper as scheduled.
- 2.21 CENTRIFUGAL INLINE FAN
- 2.21.1 Construction: Fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18-gauge steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Wheel shall be centrifugal backward inclined, made of aluminum with a cast aluminum hub. Housing shall have an electrostatically applied, baked polyester power coating (exceeds 1000-hour salt spray test under ASTM B117 method). Motor shall be mounted on pivoting base plate with threaded L-bolts for belt tensioning. Provide engraved aluminum nameplate on fan housing.
- 2.21.2 Disconnect Switch: Factory wired, non-fusible, on housing with thermal overload protected motor. Motor shall be ODP, voltage as shown on drawings.
- 2.21.3 Bearings: Provide regreasable ball type in cast iron housing, with a minimum life of L50-200,000 hours at maximum cataloged operating speeds.
- 2.21.4 Belts and Drives: Provide oil and heat resistant non-static type belts. Drives shall be cast iron or steel, dynamically balanced and keyed. Variable pitch drive shall be factory set to specified RPM.
- 2.21.5 Fan shall be rated by AMCA for both performance and sound, and bear the AMCA certified ratings seal.
- 2.21.6 Accessories:
- a. Vibration isolators; spring
 - b. Insulated housing
 - c. Backdraft damper]
 - d. Inlet screen/outlet screen for non-ducted applications
 - e. OSHA belt guard with motor cover
- 2.22 WALL MOUNTED PROPELLER EXHAUSTER
- 2.22.1 Fan shall be a wall mounted, belt driven steel propeller exhaust fan with integral housing, shutter and inlet guard.
- 2.22.2 Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705).
- 2.22.3 Construction: The fan shall be of bolted and welded construction utilizing corrosion

resistant fasteners. The motor, bearings, and drives shall be mounted on a minimum 14-gauge steel power assembly. The power assembly shall be bolted to a minimum 14-gauge wall panel with continuously welded corners and an integral venturi. Fan shall be enclosed in minimum 18 gauge galvanized steel wall housing with factory installed shutter and inlet guard. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit-tested packaging.

- 2.22.4 Coating: All steel fan components shall be Lorenized® with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000-hour salt spray under ASTM B117 test method.
- 2.22.5 Propeller: Propeller shall be a high-efficiency fabricated steel design with blades securely fastened to a minimum 7-gauge hub. The hub shall be keyed and locked to the fan shaft utilizing two setscrews. Propeller shall be balanced in accordance with AMCA Standard 204-96, *Balance Quality and Vibration Levels for Fans*.
- 2.22.6 Motor: Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
- 2.22.7 Bearings: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- 2.22.8 Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined, cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
- 2.22.9 Product: Fan shall be the XLP as manufactured by Loren Cook Company of Springfield, Missouri.
- 2.23 CABINET FAN
- 2.23.1 Construction: Cook Model Gemini GC-200 Series: Fan housing shall be minimum 20-gauge galvanized steel and acoustically insulated. Outlet duct shall include an aluminum backdraft damper. Provide adjustable pre-punched mounted bracket to accommodate various ceiling thickness. Wheel shall be centrifugal forward curved. Grille shall be powder painted white steel.
- 2.23.2 Disconnect Switch: Factory wired, non-fusible, on housing with thermal overload protected motor. Motor shall be ODP, direct drive, with voltage as shown on drawings.
- 2.23.4 Fan shall be rated by AMCA for both performance and sound, and bear the AMCA certified ratings seal.
- 2.23.5 Accessories:

- a. Vibration isolation kit
- b. Ceiling radiation damper
- c. Aluminum Grille
- d. Fan speed controller; unit mounted

2.25 PUMPS

2.25.1 **In-line Circulator Pumps:** (Boiler closed loop to buffer tank)

2.25.1.1 Pump: Bronze body with brass impeller, steel shaft, oil lubricated sleeve bearings, and watertight carbon on ceramic mechanical shaft seal (carbon seal face rotating against ceramic seat). Maximum working pressure 125 PSIG. Flange mounted.

2.25.1.2 Motor: Open drip proof, with oil lubricated sleeve bearings. Motor shall be non-overloading at any point of pump operation, and have integral thermal overload protection.

2.25.1.3 Coupling: Flexible for close-coupled mounting with integral coupling guard.

2.25.2 **Provide End Suction Bronze Trimmed Iron Body Pumps** (Base Mounted) on all Main Hot Water and Chilled Water Pumps: Pump shall be end suction, vertically split case centrifugal type capable of delivering the scheduled capacities and heads (refer to drawings). Pumped liquid will be water at a temperature of 40-180°F with a specific gravity of 1.0.

2.25.2.1 Pump casing shall be cast iron with smooth water passages and fitted with a bronze replaceable wearing ring. Maximum casing working pressure shall be 150 PSIG.

2.25.2.2 The impeller supplied for the specified conditions shall be one piece bronze casting of a diameter not greater than 90 percent of the casing cutwater diameter.

2.25.2.3 Pump shaft shall be stainless steel 304 or 320 of a size and design to limit shaft deflection at the stuffing box to no more than .002 inches.

2.25.2.4 Sealing of the pump liquid cavity shall be accomplished with: (Select as required, use mechanical seals normally.)

- a. Packed pumps, bronze fitted: A minimum of five rows of braided, graphited packing and bronze shaft sleeve.
- b. Packed pumps, all iron: A minimum of five rows of braided, graphited packing and 416 stainless steel shaft sleeve.
- c. Mechanical seal pumps, bronze fitted: A face type mechanical seal with Ni-Resist stationary seat, carbon washer, ethylene propylene flexible members, brass metal parts, and 18-8 stainless steel spring. Seal shall be mounted over a bronze shaft sleeve. The seal shall be capable of operating at 0°F to 250°F.
- d. Mechanical seal pumps, all iron: A face type mechanical seal with Ni-Resist stationary seat, carbon washer, Buna flexible members, and 18-8 stainless steel spring and metal parts. Seal shall be mounted over a 416 stainless steel shaft

sleeve. The seal shall be capable of operating at 0°F to 200°F.

- 2.25.2.5 Pump shall be flexibly coupled to a NEMA frame TEFC electric motor rated as scheduled. Motor and pump bearings shall be regreaseable and sized for a minimum of 20,000 hours B-10 life that is equivalent to 100,000 hours average bearing life. Motor and pump shall be aligned and mounted on a steel base with drip pan. A coupling guard shall be provided.

2.26 BOILERS

2.26.1 Atmospheric Gas Fired, Water Tube Boilers (Hot Water):

- 2.26.1.1 The hot water boiler shall be water-tube with capacities as scheduled.

- 2.26.1.2 The boiler shall be rated in Btu/hour based on being fired with natural gas containing 1,000 Btu/cu. ft.

- 2.26.1.3 The boiler shall be manufactured in accordance with the A.S.M.E. Section IV Heating Boiler Code. Boiler shall be copper fin tube type with a minimum of 1/2-inch diameter tubes.

- 2.26.1.4 The boiler drums shall be furnished with an adequate number of tappings and inspection openings to facilitate boiler inspection and cleaning. The entire tube area is easily accessible for cleaning through removable panel sections. Access openings arranged for visual access to combustion chamber.

- 2.26.1.5 The boiler is complete with an insulated metal jacket, consisting of fiberglass insulation and a rust resistant alloy steel casing painted with a heat resisting primer and lacquer. Jacket and insulation readily removable by section or panel and reinstalled if necessary. The draft hood shall be built into the boiler to minimize headroom requirements and shall not be a separate device on top of the unit.

a. Boiler trim:

1. Operating limit temperature control.
2. Hi-low fire control 500,000-6,000,000 Btu units.
3. Low water cutoff.
4. Low water cutoff drain valve.
5. Combination thermometer and altitude gauge.
6. 100 percent pilot shutoff w/electronic units.
7. Built-in dip tube.
8. A.S.M.E. rated safety relief valve(s).
9. Electronic flame safeguard control.
10. Tankless heater coil (optional, for all or part of boiler output).

- b. Gas burner: Gas burner unit shall be an integral part of the boiler, but so designed that by disconnecting two union fittings the burner may be removed for servicing and cleaning. The gas burner unit and boiler must be tested at the factory prior to shipment. Burner shall be the non-premix jet type for operation with natural gas. Gas burner to be equipped with an automatic electrically operated gas valve, gas pressure regulator, and manual shutoff valve. Burner system shall include a F.I.A. gas train.

- c. Heat exchanger: Provide internal heat exchanger for hot water for domestic or heating hot water, as indicated on plans.

2.29 STARTERS

Provide starters for all equipment provided under Division 23. Refer to control requirement in this Division, and material requirements in Division 26.

2.31 FIRE PROTECTION SEALANT

- 2.31.1 All pipe and duct penetrations through walls, floors, partitions, etc., shall be sealed with General Electric or equal fire stop system. Fire stop sealant and putty shall be U.L. classified 278V for the application and shall have intumescent characteristics. Refer to Section 15450. Use "Pensil 500" intumescent putty and "Pensil 100" sealer.

2.32 WARRANTY - EXTENDED

Provided four (4) year extended parts and labor warranty for all compressorized equipment. Total warranty period shall be five (5) years, including one (1) year base warranty.

3.0 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install air distribution equipment as indicated and in accordance with the manufacturer's instructions. Provide clearance for inspection, repair, replacement, and service. Electrical work shall conform with NFPA 80 and Division 16, "Electrical." Provide overload protection in the operating disconnect switches and magnetic starters. Locate air intake of air handling equipment at a minimum of 10 feet from bathroom vents and sanitary risers. Prevailing wind direction shall not be used as justification for placing air intake closer than 10 feet of exhaust stacks.

- 3.1.2 **Size, Space and "Fit" Requirements:** This project will require very strict sizing and dimensional requirements, which shall be adhered to at all times. This will be particularly critical with respect to the air-handling units, reheat coil units and preheat coil units. The size and allowable space illustrated on the drawings shall be field verified and the equipment provided shall "fit" in the space allotted and available. "Fit" shall be construed to include physical space for maintenance access, 3 ft minimum clearance for electrical equipment, duct access for systems illustrated and piping clearance for normally manufactured and specified fittings. There will be no exceptions for the forced "fit" of any equipment. Contractor shall be responsible for verification of the "fit" and installation of all equipment. Contractor shall obtain equipment that can be disassembled as required for transportation into the allocated space through the openings noted and provided. All disassembly, site erection, rebalancing, and manufacturer's recertification of any equipment on this project required during the installation process shall be completed by the contractor.

- 3.1.3 No other access routes, space, or building openings, other than those shown and noted

on the drawings, shall be provided to or created by the contractor without the express written consent of the Engineer.

3.1.4 Air Handling Units: Install assembled units on vibration isolators and isolate fan section with flexible duct connections. Bolt sections together in high-pressure units. Pipe drain pan to the nearest drain or as shown.

3.1.5 Reheat and Preheat Coil Units: Install assembled units directly into the ductwork or wall mounted louvers where shown. Bolt units between ductwork flanges, and seal with neoprene gaskets.

3.2 CORROSION PROTECTION

3.2.1 Corrosion Protection: Provide a special finish on the equipment where indicated. Apply coating at the premises of a company specializing in such work.

3.2.1.1 Nonferrous Surfaces: Shall be degreased and prepared for coating in accordance with coating applicator's standard procedures for the type metals involved. Coating material shall be resin base thermosetting type phenolic. Phenolic coating shall be applied by immersion dipping of the entire surface. Minimum of two coats shall be applied by immersion dipping. Surface shall be baked or heat dried following each immersion. After final immersion and prior to final baking, entire surface shall be given a spray coating of phenolic with particular emphasis given to building up coating on sheared edges. Completed coating emphasis given to building up coating on sheared edges. Completed coating shall show no evidence of softening, blistering, cracking, crazing, flaking, or loss of adhesion. There shall be no evidence of phenolic "bridging". Minimum dry film thickness of coating shall be 1.5 mils.

3.2.1.2 Galvanized Surfaces (Inside and Outside of the Equipment:

- a. Polyamide epoxy primer: 48 percent, plus or minus 2 percent, solids content by volume; 1 coat, 3 mils minimum dry film thickness.
- b. Vinyl copolymer: 23 percent, plus or minus 4 percent, solids content by volume; 2 coats, 1.5 mils minimum dry film thickness per coat.

3.3 LABELING

Identify each item of equipment with a bakelite nameplate secured with 316 SS screws. Letters 1/4 inch high, black engraved on white background.

3.4 FILTRATION

Do not operate equipment designed for filters without filtration; disposable 2-inch fibrous glass filters may be used during construction. Do not allow pressure drop to exceed recommended levels during construction. Prior to testing, exchange construction filters for specified filters. Vacuum clean the ducts and wash the coils before testing and balancing. Clean the exhaust fans.

3.5 PENETRATIONS

Roof openings shall be no larger than that necessary to accommodate the ducts and/or

pipes penetrating the level. Coordinate size and location of openings to avoid having the entire underside of equipment open to the space below when this is not necessary.

3.6 TESTING AND BALANCING

3.6.1 Startup: Test each control device for satisfactory operation.

3.6.2 Test Reports: Measure operating parameters and record data, in sufficient detail to verify that equipment meets requirements. If desired, the Architect will review proposed record forms prior to testing to assist the Contractor in obtaining adequate data without retesting.

END OF SECTION

DIVISION 23 - MECHANICAL

SECTION 23-90-00 – BUILDING AUTOMATION & CONTROL SYSTEM (BACS)1.0 GENERAL

1.1 OVERVIEW

This document contains the specification for the Building Automation & Control System (BACS). The system architecture shall utilize existing intelligent distributed control modules, located at the School site, which communicate over the controller network. The system shall be an extension of the existing networked control system and shall communicate to the remote existing central site. The system provides the Direct Digital Control (DDC), Scheduling, Energy Management, and Building Automation for the air conditioning, heating and ventilating systems and shall interface with other microprocessor-based systems as shown on the drawings and as specified. The software shall be native BACnet. The system shall be upgraded with full color interactive floor plan and system graphics for the operation of each school campus.

1.2 INSTRUCTIONS TO BIDDERS

The systems specified in this document shall be manufactured by:

- a. Johnson Controls, Trane or Snyder and match their prospective campuses.

1.3 SCOPE OF WORK

1.3.1 Contractor's Responsibilities: The Contractor shall furnish and install all necessary hardware, wiring, computing equipment and software as defined in this specification.

1.3.2 System Requirements

- a. All material and equipment used shall be standard components, regularly manufactured and available, and not custom designed especially for this project. All systems and components, except site-specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.
- b. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.
- c. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

1.3.3 Equipment

1.3.3.1 System Hardware: The Contractor shall provide the following:

- a. Control Modules
- b. All sensing devices and necessary transducers to perform the functions listed in

I/O Summary Tables

- c. All relays, switches, indicating devices, and transducers required to perform the functions listed in I/O Summary Tables
- d. All monitoring and control wiring.
- e. All modems and accessories

1.3.3.2 System Software: The Contractor shall provide all software needed to complete the functions required of this specification and of the systems being installed. The database required for implementation of these specifications shall be provided by the Contractor, including: point descriptor, alarm limits, calibration variables, graphics, reports and point summaries.

1.3.4 Input/Output Summary : The system as specified shall monitor, control, and calculate all of the points and perform all the function as listed in the associated system drawings.

1.4 GENERAL CONDITIONS

1.4.1 Correction of Work

- a. The Contractor shall promptly correct all work defective or failing to conform to the Contract Documents. The Contractor shall bear all cost of correcting such work.
- b. If, within the warranty period required by the Contract Documents, any of the work is found to be defective or not in accordance with the contract documents, the Contractor shall correct it promptly after receipt of a written notice.

1.4.2 Coordination During Construction:

- a. The Contractor shall coordinate any necessary changes in work scheduling to minimize the disruption.
- b. The Contractor shall protect the installed works by other trades.
- c. The Contractor shall coordinate with other trades.

1.4.3 Warranty: The Contractor shall warrant that all systems, subsystems, component parts, and software are fully free from defective design, materials, and workmanship for a period of one year from the date of final acceptance.

1.5 SUBMITTALS, DOCUMENTATION AND ACCEPTANCE

1.5.1 Submittals:

1.5.1.1 Shop Drawings. Electronic shop drawings shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Shop drawings shall also contain complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, and any other details required to demonstrate that the system will function properly. Drawings shall show proposed layout and installation of all

equipment and the relationship to other parts of the work.

- 1.5.1.2 Shop drawings shall be approved before any equipment is installed. Therefore, shop drawings must be submitted in time for review so that all installations can be completed per the project's completion schedule. Ten working days shall be allowed for review submittals.
- 1.5.1.3 All drawings shall be reviewed after the final system checkout and updated or corrected to provide 'record' drawings to show exact installation. All shop drawings will be acknowledged in writing before installation is started and again after the final checkout of the system
- 1.5.1.4 The Contractor shall provide an accurate graphic flow diagram for each software program proposed to be used on the project as part of the submittal process. Revisions made as a result of the submittal process, during the installation, start-up or acceptance portion of the project, shall be accurately reflected in the "as-built" graphic software flow diagrams herein required by this specification.
- 1.5.2 Project Specific Manuals: Reference manuals for the system shall include the following categories: Users Manual, Engineering Handbook, and software documentation. Project specific manuals shall include detailed information describing the specific installation.
 - 1.5.2.1 Users Manual: assumed existing
 - 1.5.2.2 Engineering Manual:
 - a. It shall include detailed information on:
 1. Hardware--cutsheets and product descriptions
 2. Engineering--design requirements for initial installations and/or additions to existing systems
 3. Installation--mounting and connection details for field hardware, accessories and operator workstation equipment
 4. Field hardware set-up, checkout and tuning techniques
 5. Operator Workstation set-up, software loading and checkout techniques
 6. A listing of basic terminology, standard alarms and messages, error messages and frequently used commands
 - 1.5.2.3 Software Documentation:
 - a. Shall contain as minimum descriptions of the control software programs used in the system. Descriptions shall include:
 1. Diagrams and listings showing maximum input/output point configurations for controlled equipment
 2. A description of the control elements and sequences available for the equipment
 3. A listing of the information, which is displayed to the operator for each piece of, controlled equipment
 4. A listing of the alarm and message conditions which may be detected for

each piece of controlled equipment and the standard alarm and message texts which can be displayed when those conditions exist

5. A graphic flow diagram for each software application program provided as part of this project.

- 1.5.3 Owner's Instructions: The Contractor shall provide full instructions to designated personnel in the operation, maintenance, and programming of the system. The training shall be specifically oriented to the system and interfacing equipment installed.

2.0 PRODUCTS

2.1 CENTRAL HARDWARE

Existing central site Operator Workstation (CCISD Facilities Office on Agnes St. , Corpus Christi, TX) will be upgraded with the new software as required for this project. Complete interactive color floorplan graphics and all system equipment graphics shall be added to the operator workstation.

2.2 FIELD HARDWARE

Field hardware must be of a modular design to ensure reliability and system performance.

2.2.1 General Purpose/Multiple Application Controllers (M modules)

- a. The General Purpose/Multiple Application Controllers must, as a minimum support the following Objects:

Binary Input
Binary Output
Binary Value
Analog Input
Analog Output
Analog Value
Calendar
Schedules

- b. Each General Purpose/Multiple Application Controller must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile flash memory, input/output, clock/calendar and voltage transient and lightning protection devices. All non-volatile flash memory shall have a battery backup of at least five years. Firmware revisions to the module should be able to be made from the local workstation, portable operator terminals or from remote locations over modems or LAN's.
- c. The General Purpose/Multiple Application Controllers shall consist of several modules, which provide different I/O point combinations. Additionally each controller shall be able to connect through its expansion bus to up to five I/O Expander Modules.
- d. All point data, algorithms, and application software within a controller shall be

custom programmable from the Operator Workstation.

- e. Each General Purpose/Multiple Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writable non-volatile flash memory within the controller and will be able to upload/download to/from the Operator Workstation.
- f. Each General Purpose/Multiple Application Controller shall be connected to a BACnet Controller Network communicating to/from other controllers and gateway. Each controller shall include self-test diagnostics, which allow the controller to automatically relay to the network controller any malfunctions or alarm conditions that exceed desired parameters as determined by programming input.
- g. Each General Purpose/Multiple Application Controller shall contain both software and hardware to perform full DDC/PID control loops.

2.2.2 Instrumentation and Control:

a. Input Devices:

- 1. Temperature Sensors: Sensors shall be of the type and have accuracy ratings as indicated and/or required for the application and shall permit accuracy rating of within 1% of the temperature range of their intended use.
 - a) Sensors used for mixed air application shall be the averaging type and have an accuracy of $\pm 1^{\circ}\text{F}$.
 - b) OA temperature sensors shall have a minimum range of -52°F to 152°F and an accuracy of within $\pm 1^{\circ}\text{F}$ in this temperature range.
 - c) Room temperature sensors shall have an accuracy, of $\pm 0.36^{\circ}\text{F}$ in the range of 32°F to 96°F .
 - d) Chilled water and condenser water sensors shall have an accuracy of $\pm 0.25^{\circ}\text{F}$ in their range of application.
 - e) Hot water temperature sensors shall have an accuracy of $\pm 0.75^{\circ}\text{F}$ over the range of their application.
- 2. Pressure Instruments
 - a) Differential Pressure and Pressure Sensors.
 - b) Pressure Switches.
- 3. Flow Switches.
- 4. Watt-hour Transducers.
- 5. Voltage-to-Digital Alarm Relays.
- 6. Humidity Sensors.
- 7. Current Sensing Relays.

- b. Output Devices
 - 1. Control Relays
 - 2. Solid State Relays (SSR)
 - 3. Electric Solenoid Operated Pneumatic (EP) Valves
 - 4. Electric to Pneumatic (EP) Transducers.
- c. Valve and Damper Actuators
 - 1. Electronic direct-coupled actuation shall be provided.
 - 2. The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable.
 - 3. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
 - 4. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing.
 - 5. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
 - 6. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal.
 - 7. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC shall not require more than 11 VA.
 - 8. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.
 - 9. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
 - 10. Actuators shall be provided with a conduit fitting and a minimum three-foot

electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

11. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
12. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.

2.3 INTERLOCKING AND CONTROL WIRING

2.3.1 The controls installer will provide the control wiring on this project following the guideline below.

2.3.1.1 Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 26 and all national, state and local electrical codes.

2.3.1.2 Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions.

2.3.1.3 Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required.

2.3.1.4 Provide auxiliary pilot duty relays on motor starters as required for control function.

2.3.1.5 When power wiring is not provided by division 26 to the control panels, Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.

2.3.1.6 All control wiring in the mechanical, electrical, and boiler rooms to be installed in raceways. All other wiring shall be plenum rated cable to be installed neatly and inconspicuously per local code requirements.

3.0 PRODUCTS - SOFTWARE

3.1 GENERAL

3.1.1 The Contractor shall upgrade the existing Supervision software as required for efficient operation of all the functions required by this specification.

3.1.2 The system shall be Graphically Programmed as an extension of the existing system.

3.2 DIRECT DIGITAL CONTROL SOFTWARE

- 3.2.1 The system shall continuously perform DDC functions at the local control module in a stand-alone mode. The operator shall be able to design and modify the control loops to meet the requirements of the system being operated. The operators shall use system provided displays for tuning of PID loops. These displays shall include the past three input variable values, the setpoint for the loop as well as the sample interval and the results of the proportional, integral and derivative effects on the final output.
- 3.2.2 Each control module shall perform the following functions:
- a. Identify and report alarm conditions
 - b. Execute DDC algorithms
 - c. Execute all application programs indicated on the I/O Summary Table
 - d. Trend and store data
- 3.2.3 In the event of a control module failure, all points under its control shall be commanded to the failure mode as indicated on the I/O Summary Table.
- 3.2.4 All DDC software shall reside in the respective control module.
- 3.2.5 Power Failure/Automatic Restart at the control module:
- a. Power failures shall cause the control module to go into an orderly shutdown with no loss of program memory.
 - b. Upon resumption of power, the Control module shall automatically restart and printout the time and date of the power failure and restoration at the respective Workstation system.
 - c. The restart program shall automatically restart affected field equipment. The operator shall be able to define an automatic power up time delay for each piece of equipment under control.
- 3.3 SEQUENCE OF CONTROL
- Refer to drawings.

END OF SECTION

DIVISION 26 - ELECTRICAL

SECTION 26-00-00 - ELECTRICAL GENERAL REQUIREMENTS

Note: This specification requires specific cost based items. Refer to Paragraph 1.27, *Required Allowances and Provisions*.

1.0 GENERAL

- 1.1 The Conditions of the Contract apply to this Section.
- 1.2 Examine all plans and specifications, visit the site(s) of the proposed project, and become fully informed as to the extent and character of the work required.
- 1.3 REQUIRED STANDARDS
 - a. Laws and Regulations of the State of Texas.
 - b. Codes and ordinances of project's County and City location in Texas.
- 1.4 COORDINATION
 - 1.4.1 Coordinate work under this Division to avoid conflicts and to attain satisfactory and complementary systems.
 - 1.4.2 Coordinate work under this Division with work under other Divisions to avoid conflicts and to allow for adequate installation, maintenance, and operating space. Obtain the Engineer's approval for penetrations of other parts of the Work prior to effecting them.
 - 1.4.3 In resolving pipe, duct, and conduit coordination with other divisions, meet all requirements and be guided by these general orders of precedence:
 - a. Accommodate gravity flow lines with required slopes before conduit.
 - b. Accommodate lines with specific slope requirements (i.e., steam and refrigerant gas) before conduit.
 - c. Accommodate pipe and duct before conduit.
 - d. Accommodate work with a required reference elevation before other work.
- 1.5 DEFINITIONS
 - 1.5.1 Specific meanings used in Division 26 (variant forms are inferred):
 - a. Work: This project, or the part of it being referred to.
 - b. Provide:
 - 1. Furnish and install, complete with necessary appurtenances.
 - 2. "Provide" is implied throughout this Division unless language is specific.
 - c. Required: Required by the Contract Documents.
 - d. Necessary: Necessary in order to obtain a finished system in satisfactory operating condition, and meeting all requirements.
 - e. Furnish: Procure and deliver, ready for installation, necessary and/or required.

- f. Install: Receive, place securely, ready for connection to work specified elsewhere, and bring into satisfactory operating condition, as necessary and/or required.
- g. Connect: Connect properly to electrical equipment.

1.6 SCOPE OF WORK

1.6.1 The work under this Division includes providing complete electrical systems for the project.

1.6.2 All items of labor, material or equipment not required in detail by the specifications or plans, but incidental to, or necessary for the complete installation and proper operation of all phases of work described herein, or reasonably implied in connection therewith, shall be furnished as if called for in detail by the Contract Documents.

1.7 WORKMANSHIP

All labor shall be performed in a workmanlike manner by mechanics skilled in their particular trades. All installations shall be complete in both effectiveness and appearance whether finally enclosed or left exposed. The Engineer reserves the right to direct the removal or replacement of any item which in his opinion shall not present a reasonable neat or workmanlike appearance, providing that same can be properly installed in an orderly way.

1.8 MANUFACTURER'S INSTRUCTIONS

Obtain written recommendations and installation and startup instructions from material vendors and comply, unless otherwise required. Bring discrepancies between these instructions and project requirements to the attention of the Engineer, and resolve prior to construction. Provide inspection by manufacturer's representative at system startup to verify construction and warrantability.

1.9 PERMITS, FEES - UTILITY TRANSFORMERS/CONNECTIONS:

1.9.1 Permits: Obtain special permits necessary for this portion of the Work.

1.9.2 Fees: Pay any fees associated with permits, required inspections, and permanent utility connections to this part of the work.

1.9.3 Contractor shall provide either directly or through the local utility company all required utility transformers, primary feed systems, and secondary feed systems. All power entrance work, including equipment, conduit, conductor, main disconnect, trenching, transformer pads, and high voltage transformers shall be provided herein at the contractor's cost.

1.10 LICENSES

- a. Work under this Division shall be performed by organizations and individuals holding a current license to perform such type of work by the authority having jurisdiction. "License" in this sense means any process, regardless of its appellation, which is normally mandated by the authority in order to perform such

type of work within its jurisdiction. The stipulation of this paragraph applies even if the work is located physically on property owned or controlled by a higher authority; e.g., to work within the city limits of a Texas municipality, on a Federal project, the State of Texas and City municipal licenses which would be mandated to work on a private project shall be required even though the City and State may have no jurisdiction over the higher government.

- b. In the event that the licensed organization loses its license or is unable to obtain one, or the licensed individual performing the work becomes unlicensed or departs the organization, notify Engineer immediately in writing.

1.11 UTILITY COORDINATION

- a. Permanent: In general, provide all ancillary work necessary to obtain utility connections. Pay connection fees. Arrange for connection in a timely manner. Coordinate time and arrangement of other work with the serving utility, and comply with utility standards.
- b. Temporary: Refer to Division 1. Provide required equipment in accordance with NEC-latest edition.
- c. Contractor shall provide either directly or through the local utility company all required utility transformers, primary feed systems, and secondary feed systems. All power entrance work, including equipment, conduit, conductor, main disconnect, trenching, transformer pads, and high voltage transformers shall be provided herein at the contractor's cost.

1.12 LISTING AND LABELLING

Materials that require listing shall be listed and labeled for the particular service if a listing is available. Obtain and comply with the terms of listing. Provide black laminate, white letter labels on all panels, starters, disconnects, MSB breakers, MCC modules, VFDs, and contactor switches.

1.13 MATERIALS AND EQUIPMENT

- 1.13.1 All materials and equipment shall be new. Products shall be currently manufactured.
- 1.13.2 All materials and equipment shall be clearly marked, stamped or labeled for identification. Do not obscure nameplates.

1.14 SUBMITTALS AND REVIEW

- 1.14.1 Contractor shall furnish to the Engineer, within a reasonable time after award of contract, and prior to commencing any work, complete brochures in quadruplicate of all materials and equipment that the contractor proposes to furnish on the project. Data shall include descriptive literature, performance data, diagrams, capacity information, etc., to substantiate that proposed equipment would meet all of the requirements of the plans and specifications.
- 1.14.2 All data must be checked and any required changes noted thereon by the contractor,

signed and dated prior to furnishing it to the Engineer for approval. Contractor's attention is directed that it is mandatory that he thoroughly review data prior to furnishing same to assure that equipment is in accordance with plans and specifications and to assure prompt return of the data.

1.14.3 If above information is not provided complete as specified above and within the allocated time, all equipment shall be furnished exactly as specified without any substitutions or deviations.

1.14.4 Deviations: Specifically call to the attention of the Engineer every proposed deviation from the Contract Document requirements. Failure to identify deviations as such constitutes a representation that all requirements are met.

1.14.5 Review: Review of submittals shall not be construed as releasing the Contractor from responsibility, but rather as a means to facilitate coordination of the work and the proper selection and installation of the products. All work shall be subject to final acceptance by the Engineer at the completion of the project.

1.15 SUBSTITUTIONS

1.15.1 Refer to the Conditions of the Contract.

1.15.2 Where one vendor is indicated for a product, provide that product. Alternate products may be submitted only after prior approval to do so is obtained from Engineer in writing. Exceptions to features and performance must be documented with two weeks advance notice of the deadline to order specified products.

1.15.3 Where multiple vendors are indicated for a product, any of those vendors meeting the requirements may be submitted.

1.15.4 Some product specifications in this Division are of the Acceptable Manufacturer type. Vendors listed as Acceptable Manufacturers are acceptable as vendors. However, the product submitted is subject to review as being fully equivalent in detail to the basis of design.

1.15.5 Where multiple vendors are listed with product model numbers, each model and vendor is acceptable, provided all requirements are met. Model numbers are indicated to the extent believed necessary to identify a type and are not necessarily complete.

1.16 DRAWINGS AND SPECIFICATIONS

1.16.1 These specifications are accompanied by Drawings. The Drawings and Specifications are complementary each to the other, and what is called for by one shall be as binding as if called for by both.

1.16.2 The Drawings are generally diagrammatic. Lay out work at the site to conform to existing conditions; architectural, structural, mechanical, and electrical conditions; to avoid all obstructions; and to conform to details of installation as required. Provide an integrated, satisfactorily operating installation. All necessary offsets in conduits

required to avoid interferences between piping, equipment, architectural, and structural elements shall be provided by the Contractor.

- 1.16.3 Verify and provide sufficient space for the installation of proposed products and that adequate access will exist for service and maintenance of equipment.

1.17 COMPLEMENTARY DOCUMENTS

- a. Contract Documents are complementary; requirements are not necessarily repetitively stated at each possible subject; consider that a requirement applies wherever applicable.
- b. In the event of conflicting requirements in different parts of the Documents, the more expensive shall be presumed to apply, unless the Engineer clarifies the requirement in a less expensive manner and waives the more expensive requirement in writing.
- c. Since codes and standards are incorporated by reference, a particular conflict may appear in that a reference may use language that implies that a particular requirement in the Contract Documents is waived under the reference. This is not the case, unless specifically so clarified by the Engineer. Generally, the specific Drawings and Specifications take precedence over waivers in multi-purpose reference documents.
- d. Because of licensure and workmanship requirements, persons performing the work are presumed to be familiar with applicable codes, ordinances, laws, regulations, and standards. Therefore, details of materials, methods, arrangements and size contained in such publications are not necessarily replicated in the Contract Documents. This in no way deletes the requirement of the Contractor to comply. In the event of an apparent conflict between such publications and the Contract Documents, request clarification from the Engineer prior to construction.

1.18 REGULATORY MATTERS

Comply with laws, rules and regulations, permit requirements, and ordinances. It is intended that the work of the Division be estimated and performed under the supervision of licensed master craftsmen who are familiar with these requirements, whether illustrated or specifically detailed in the particular Contract Documents of this project or not. Therefore, regulatory requirements may not be so illustrated or detailed.

1.19 PROTECTION

All work, equipment and materials shall be protected at all times to prevent damage or breakage either in transit, storage, installation or testing. All openings shall be closed with caps or plugs during installation. All material and equipment shall be covered and protected against dirt, water, chemicals or mechanical injury.

1.20 CUTTING AND PATCHING

The work shall be carefully laid out in advance and the exact size and locations of openings arranged.

1.21 VIBRATION AND NOISE

Objectionable vibration and/or noise will not be tolerated.

1.22 DEMOLITION

Coordinate with other Divisions before commencing work.

1.23 RECORD DOCUMENTS

1.23.1 Drawings: Prior to final acceptance, obtain bid set electrical drawings from the Engineer. Revise the drawings to reflect as-built conditions, including all addenda, change orders, final shop drawing reviews, and field routing. Underground utilities shall be dimensionally located relative to readily accessible and identifiable permanent reference points, with accurate slope and elevation indicated. Submit prints for review. Revise, certify accuracy, and provide two final sets to the Engineer.

1.23.2 Owner's Manual: Prior to final acceptance, provide bound volumes to the Engineer in accordance with Division 1. Index by subject. Include corrected submittals and shop drawings that reflect final review comments; installation, operation and maintenance instructions, parts lists, wiring diagrams, and piping diagrams; warranties.

1.24 INSPECTION, OBSERVATION AND TESTING

1.24.1 Cooperate with Engineer's representative and authorities having jurisdiction. Provide complete access to the work at reasonable times.

1.24.2 Coverup: Prior to covering up work, or conducting observed tests, request observation as appropriate. Provide adequate advance notice, minimum one (1) week. In some cases the Engineer's representative may waive observation; otherwise arrange for observed construction and testing prior to cover-up, particularly installation of walls and ceilings.

1.24.3 Pre-Testing: Self-inspect, pre-test, and remedy work prior to performing observed tests.

1.24.4 Sectional Work: In circumstances where a requirement for phased construction or other considerations dictate sectional construction and/or testing, notify the Engineer when construction begins on the first section of a system, and when the first section will be ready for observed testing, as well as subsequent sections. Test in the largest practical sections.

1.25 WORK PERFORMED UNDER OTHER DIVISIONS

1.25.1 Refer to Mechanical for mechanical systems, control panels, starters and safety switches integral to equipment provided under Mechanical.

1.26 REFERENCES TO OTHER DIVISIONS

1.26.1 Refer to Mechanical for additional mechanical system requirements. Provide power to all mechanical schedule equipment and field-verify voltage/phase.

1.26.2 Additional requirements governing excavation and backfill, supplemental to the

requirements stated in this Division 26. When Division 2 is not included, provide 36-inch deep trenches to virgin soil, backfill in 6-inch lifts, and patch and repair. Compact to 95 percent proctor. Paving and landscape to match existing.

1.27 REQUIRED ALLOWANCES AND PROVISIONS (Important)

1.27.1 Comply with all requirements applicable under this Division to work required under other Divisions. Provide weatherproof, GFI 120V/20 amp outlet at each roof-mounted cooling/AC unit. Provide one outlet minimum on all buildings.

1.27.2 DDC Controls: Provide a minimum of two 120V circuits, #12 conductor, 100 ft run, six 2" x 4" boxes, six duplex outlets, each on all projects for DDC power configurations.

1.27.3 Contractor shall provide either directly or through the local utility company all required utility transformers, primary feed systems, and secondary feed systems. All power entrance work, including equipment, conduit, conductor, main disconnect, trenching, transformer pads, and high voltage transformers shall be provided herein at contractor's cost.

1.28 TESTING SERVICES

1.28.1 Additional Testing: In addition to any specified testing, the Engineer may cause additional testing to be performed by an independent testing laboratory or any other qualified party. If such testing reveals deficient work by the Contractor, the Contractor shall pay for both the testing and remedial work. If such testing does not reveal deficient work by the Contractor, the Owner shall pay for the testing and the cost of repairing any damage caused by such testing.

1.28.2 Specified Testing Services: If independent testing services are specified regarding work under this Division, cooperate fully with the testing agency. Provide access to the work. Remove work that is not tested on site, deliver to testing agency, and reinstall if undamaged; replace if damaged. Provide utilities, operational capability, and facilities for on-site testing as necessary.

END OF SECTION

DIVISION 26 - ELECTRICAL

SECTION 26-05-00 - ELECTRICAL DISTRIBUTION SYSTEM

1.0 GENERAL

1.1 The Conditions of the Contract apply to this Section.

1.2 Section 16000, "Electrical General Requirements", applies to this Section.

1.3 REFERENCE PUBLICATIONS

1.3.1 National Fire Protection Association (NFPA) Publications:
Latest Edition of National Electrical Code

1.4 REQUIRED STANDARDS

- a. Laws and regulations of the State of Texas.
- b. County of Nueces, City of Corpus Christi, Texas, codes and ordinances.

1.5 WORK INCLUDED

1.5.1 The work to be accomplished under these specifications includes the furnishing of all labor, materials and equipment required for the complete installation as described herein and as indicated on the electrical drawings.

1.5.2 Work is to be completed from point of service to each outlet shown on plans and/or specified herein with all accessory construction as may be required to make the installation of each piece of equipment complete and ready for normal service.

1.5.3 The installation of this work, including all materials and labor, shall be first class in every respect and in exact accordance with these specifications and accompanying plans. It is intended that these specifications and accompanying plans shall include everything requisite and necessary for proper installation of electrical equipment, even though every item may not be particularly mentioned in detail.

1.6 ELECTRICAL SERVICE

1.6.1 The contractor is responsible for coordinating with the utility company and paying all costs involved and meeting all requirements of the utility company, whether shown or not.

1.6.2 Contractor shall provide either directly or through the local utility company all required utility transformers, primary feed systems, and secondary feed systems. All power entrance work, including equipment, conduit, conductor, main disconnect, trenching, transformer pads, and high voltage transformers shall be provided herein at the contractor's cost.

1.7 TEMPORARY POWER AND LIGHT

- 1.7.1 In accordance with Division 1 and the latest edition of NEC, the Contractor shall provide the necessary wiring, service switches, poles, ground fault equipment, etc., required for temporary power and light during construction.

2.0 MATERIALS

2.1 GROUNDING

- 2.1.1 The entire electrical system shall be grounded in accordance with the National Electrical Code, and as hereinafter specified.
- 2.1.2 Grounding conductors with a green colored insulated jacket or bare conductor shall be provided in all EMT raceways and all raceways containing a section of non-metallic conduit and which are not provided with a raceway ground at the first distribution point beyond the non-metallic raceway.
- 2.1.3 Flexible conduit sections shall be provided with a bonding jumper.

2.2 CONDUIT AND TUBING

- 2.2.1 Conduit is sized for THWN/THHN conductors. Contractor shall adjust size per NEC for provided conductors.
- 2.2.2 All interior wiring shall be run in steel conduit, concealed in finished areas, unless noted. All interior conduit 2 inches and smaller and not run in concrete shall be E.M.T., with compression fittings only, unless noted.
- 2.2.3 Conduit 2 inches in size and larger or conduit installed on exterior, under buildings, in wet locations, or on roofs shall be rigid hot-dip galvanized steel (RGS) conduit, as manufactured by Republic, Allied, Triangle, or an approved equal, with screwed couplings and fittings, unless noted otherwise on plans. All fittings shall be hot-dip galvanized. Rigid polyvinyl chloride, (EPC-40 DB), conduit shall be used underground, in concrete slabs, and in concrete and masonry walls in accordance with National Electrical Code, and as shown on plans.
- 2.2.4 All conduit in furred ceiling spaces, interior masonry or stud partitions, and dry locations shall be galvanized thinwall (EMT) with watertight, gland ring type connectors. Indentor type or set screw type connectors will not be accepted. Couplings shall be Appleton 95T series or equal. Connectors shall be two-piece type with insulated throat, Appleton 86T series or equal.
- 2.2.4.1 Acceptable Manufacturers:
- a. T & B Electric Inc.
 - b. TOMIC.
- 2.2.5 Fittings and connections involving dissimilar metals shall not be allowed in damp or wet locations.
- 2.2.6 An equipment-grounding conductor shall be provided in all nonmetallic conduit

raceways.

- 2.2.7 Flexible conduit may be used where absolutely necessary, and shall be installed in accordance with Article 350 of the N.E.C. In damp locations and motor connections, liquidtight flexible metal conduit and approved fittings shall be used, and shall be installed in accordance with Article 351 of the N.E.C.
- 2.2.8 Installation and Routing of Conduits:
- 2.2.8.1 Main feeders between distribution points shall be run the straightest possible route.
- 2.2.8.2 Not more than 360 degrees of bends will be permitted in any one conduit run, and no run shall be longer than allowed by the National Electrical Code without the installation of pull boxes. Pull boxes or junction boxes shall not be installed in inaccessible space.
- 2.2.8.3 Exposed conduit shall be run in straight lines, at right angles to, or parallel with walls, beams, or columns and shall be supported at maximum of 6 ft 0 inch by malleable conduit straps or suitable clamps on hangers to provide a rigid installation.
- 2.2.8.4 In no case shall conduit be fastened to other conduit, pipe or equipment or so installed as to prevent the ready removal of other conduit, pipes or equipment for repairs. Conduit shall be spaced from hot water and copper pipes three inches.
- 2.2.8.5 All rigid conduit ends are to have a minimum of five full threads. No running threads are to be used. All conduits shall be reamed after cutting and threading and before installation; runs shall be straight and true; elbows, offsets, and bends shall be uniform and symmetrical. All conduits after installation and prior to completion of project shall be capped to prevent entrance of moisture and foreign objects. Conduit shall be swabbed and bushed before installation of wire. PVC conduit joints shall be made in accordance with manufacturer's recommendations.
- 2.2.8.6 All conduits terminating in metal enclosures shall have double locknuts and insulated bushings, except where otherwise noted, in which case the conduit shall be provided with a grounding clamp.
- 2.2.8.7 Underground PVC plastic conduit may be extended above grade at panels, junction boxes, etc. However, plastic conduit subject to physical damage, such as risers at outside service switches, shall have a formed concrete protective guard extending 12 inches below and 12 inches above finished grade with PVC sleeve between the concrete encasement and the plastic conduit.
- 2.2.8.8 Underground conduits shall be installed in accordance with details on the plans, and as hereinafter specified. All underground conduits shall have a minimum cover from top of conduit to finished grade of at least 24 inches. Marker tape shall be placed in trench 12 inches below grade.
- 2.2.8.9 Underground conduit encased in concrete shall have a minimum thickness at any point of 3 inches between the conduit and the earth. The concrete envelope shall be formed and shall extend at least 12 inches above the finished grade where the conduit rises above grade.

- 2.2.8.10 PVC plastic underground feeder conduits outside of the lines of the building shall have a 4-inch thick concrete cap over the top of the conduit to protect the conduit from damage due to excavation.
- 2.2.9 Expansion Joints:
- 2.2.9.1 Expansion joints in metal and PVC plastic conduits shall be provided where conduit rises from underground or crosses an exterior building expansion joint. Metal expansion joints shall be OZ Gedney, Type EX or AX, with bonding jumpers.
- 2.2.9.2 Conduits which are freely suspended in space and crossing an interior building expansion joint shall be considered as having sufficient freedom for any expansion or movement.
- 2.2.9.3 Underground PVC plastic conduit terminating in panelboard, cabinet, switch, or other fixed device shall have an approved PVC expansion joint fitting between the ground or floor slab and the device.
- 2.2.9.4 Underground PVC plastic conduit shall pass through a PVC sleeve in the floor to allow movement between the underground conduit and structural members of the building.
- 2.2.10 Concrete: All concrete encasements shall be readymix concrete and shall be continuously agitated until poured. Concrete shall be 2,500-psi strength, colored red.
- 2.2.11 Pull Wire: Provide pull wire in empty conduit in which wire is to be installed by others. Pull wire shall be plastic having minimum 200-pound tensile strength. Leave minimum of 12 inches of slack at each end of pull wire.
- 2.3 HANGERS AND SUPPORTS
- 2.3.1 Provide hangers and supports for conduit, gutters, cabinets, and equipment of all types. Hangers and supports shall be secure and of a type appropriate in design, application, and dimensions for the particular application. Supports for conduits shall be in accordance with N.E.C.
- 2.3.2 Concrete inserts shall be malleable iron, concrete inserts. Selection of inserts shall be made with a minimum safety factor of 100 percent over published load ratings.
- 2.3.3 Perforated hanger strap and wire shall not be acceptable for any purpose.
- 2.3.4 Supports for conduit on roof, or any horizontal slab or surface, shall be manufactured by Miro Industries or equal.
- 2.4 CONDUCTORS
- 2.4.1 All wiring and cables shall be insulated soft-drawn annealed, 98 percent conductivity copper and shall be new. Voltage rating of wire and cable operating on voltages in excess of 50 volts shall be 600-volts A.C. For circuits operating on voltage less than 50 volts, the voltage rating shall not be less than 300-volts A.C. All wire No. 8 AWG and

larger shall be stranded, and wire of smaller size shall be solid.

- 2.4.2 Power feeder and branch circuit wire and cables shall be Type THW or THWN/THHN unless noted otherwise on plans. Wires shall not be smaller than No. 12 AWG copper and this size shall be used except where larger sizes are shown on the drawings or required by the Code. On any 20 Amp run 100 feet in length or longer, No. 10 AWG (minimum) copper shall be used. Suitable tags shall identify feeder cables where they pass through pull boxes. Conductors as manufactured by Cablec, Cyprus-Rome, Houston Wire and Cable, and Triangle will be acceptable.
- 2.4.3 Conductors for special systems and conditions shall be as hereinafter specified or as noted on the plans.
- 2.4.4 Wire Pulling Lubricants:
 - 2.4.4.1 Contractor shall use "Y-er-EAS" or approved wire-pulling lubricants for all wire installation. Soaps or other substitute material having electrical conduction properties are not acceptable.
- 2.4.5 Color-Coding and Tagging:
 - 2.4.5.1 Any wiring which is furnished which is not color-coded for ready circuit identification shall be identified or shall be removed and reinstalled as directed. Where two or more wires of the same color are used for different circuits in the same conduit, these wires shall be identified.
 - 2.4.5.2 All control wiring shall be color-coded, and the same color shall be used for the same circuit throughout the system, and a different color shall be used for each separate control function.
 - 2.4.5.3 Identification shall be accomplished by means of Brady "Quick-Labels" or approved equal attached permanently to all wire requiring identification in addition to the color-coding. This shall include "Quick-Labels" on all coded wiring installed between the cabinet, or devices to readily identify the circuit at each cabinet or device in which it appears. Acceptable manufacturers: Thomas and Betts, Ideal.
 - 2.4.5.4 All junction boxes shall be labeled with ink marker indicating the circuits enclosed.
- 2.4.6 Insulation of Splices and Cable Terminations:
 - 2.4.6.1 All connections must be made by means of a compression type connector specifically approved for the purpose to which it is used, except that wire #8 and smaller may be soldered in lieu of compression connections, if desired by contractor.
 - 2.4.6.2 All wire shall be insulated at splices and connections with Scotch #33 electrical tape. Any wiring subject to abrasion shall be protected with Okonite "Manson" friction tape over the Scotch plastic type. Wirenuts or similar patented insulation connectors meeting NEC requirements may be used in lieu of tape, if contractor so desires.

- 2.5 OUTLET, SWITCH AND JUNCTION BOXES
- 2.5.1 All boxes shall be galvanized metal and shall be set with covers flush and square with the finished surface.
- 2.5.2 Boxes set in plaster finished walls or concrete shall be 4 inches square boxes, 1 1/2 inches deep or deeper, with 1/2-inch or 3/4-inch raised plaster rings as required by device.
- 2.5.3 Boxes set in concrete block, structural tile, brick, plywood, Formica, or other field installed surfaces shall be square cut masonry boxes, or shall have standard square type corners.
- 2.5.4 All boxes shall be securely attached to the structural members by suitable metal hangers. All ceiling outlet boxes shall be equipped with 3/8-inch no-bolt fixture studs.
- 2.5.5 Junction boxes and pull boxes shall be furnished where shown on the plans, or as required by the N.E.C. Boxes shall be of code gauge galvanized steel or PVC to match conduit system, and shall have removable screw cover. Surface mounted or exposed boxes in finished areas shall have a prime coat of paint before installation, and finish coat after installation to match room finish. Flush boxes shall be used on all walls and ceilings where conduits are concealed. Where conduits are exposed, surface type boxes shall be used.
- 2.5.6 The contractor shall remove any boxes not installed in a workmanlike manner, repair wall and reset box.
- 2.5.7 Boxes and conduit fittings for outdoor work shall be cast metal type and have gasketed coverplates.
- 2.5.8 Location of Boxes:
- 2.5.8.1 Contractor shall determine from the electrical plans, the electrical details and plans, and from other subcontractors, the locations of all pieces of equipment prior to locating any outlet boxes or devices.
- 2.5.8.2 All outlet boxes, devices, etc., shall be located so as to be clear of equipment, permanent fixtures, building trim, etc. If the exact location of any equipment is not clearly defined, the contractor shall request direction from the Engineer prior to locating the facilities for the equipment.
- 2.5.8.3 Locations of services for equipment connections shall be determined accurately from certified shop drawings on equipment to be served, or from actual measurements of the equipment itself.
- 2.5.8.4 All wall outlets for equipment on panel walls shall be located symmetrically with the pattern established by the panels. Determine exact location for all boxes from the Engineer before installation.

- 2.5.8.5 All ceiling outlets shall be located in close cooperation with the air conditioning system and the ceiling finishes, so that outlets will be symmetrical with ceiling pattern established by the air conditioning diffusers and by the acoustical ceiling tile. Final lighting fixture locations shall be as approved by the Engineer. All corridor fixtures shall be mounted in a straight line.
- 2.5.8.6 Switches shall be located 48-inch centers above floor (or nearest coursing), except in areas that have a view window, a wainscot or splash that would interfere with the switchplate. In these areas, locate switches as directed by Engineer. Switches shall be mounted on strike side of doors.
- 2.5.8.7 The height of the various outlets above the floor elevation shall be in accordance with the Americans with Disabilities Act (ADA) and the following table of outlet heights, except as indicated otherwise on the drawings. All heights and locations shall be verified with Engineer before installation.

<u>Outlet</u>	<u>Location</u>	<u>Inches Above Floor</u>
Receptacles	Walls in general	18 inches
Receptacles	Walls at work counters	44 inches
Telephone	Walls in general	18 inches
	Wall or pay phone	42 inches
Thermostats	Walls	48 inches
Switches	Walls	48 inches
Clock Outlets	Walls	6 inches below ceiling

The exact location of outlets shall be as approved by the Engineer who reserves the right to change the position of any outlet from the position shown on the drawings before work is roughed-in, without cost to the owner.

- 2.5.8.8 Outlet boxes for special and/or recessed equipment shall be obtained from the contractor supplying the equipment.
- 2.5.9 Floor Boxes:
- 2.5.9.1 Power floor boxes shall be equal to Steel City Catalog No. 68-D/P-60-DR/P-60-CP. Telephone floor boxes shall be equal to Steel City Catalog No. 68-D/P-60-1/2-2/P-60-CP. Provide carpet flanges as required by architectural finishes.
- 2.6 WIRING DEVICES
- 2.6.1 Wiring devices, or approved equal, as scheduled and/or noted on the plans shall be provided. All receptacles shall be grounding type, and shall be polarized in accordance with the latest standards of the National Electrical Code.
- 2.7 COVERPLATES
- 2.7.1 All coverplates for switches, receptacles and devices, and any other systems, except as hereinafter specified, shall be satin finish stainless steel similar and equal in all respects to those manufactured by P.&S.

- 2.7.2 All coverplates shall have matching screws.
- 2.8 DISCONNECT SWITCHES
- 2.8.1 All disconnect switches shall be Square D Type GD (240V) or Type HD (600V), or approved equal, quick-make quick-break type safety switches with cover interlocked door.
- 2.8.2 All switches on exterior of building and/or exposed to the weather shall be in NEMA 4X enclosures. NEMA 3R enclosures shall be finished with baked enamel over clean phosphatized surface.
- 2.8.3 All motors and fixed equipment connections shall have disconnects as required by the National Electrical Code.
- 2.8.4 All disconnect switches shall have the load served by the switch identified on the outside cover of the switch by means of phenolic or metal labels.
- 2.8.5 Acceptable Manufacturers:
- a. Square D
 - b. Cutler Hammer
 - c. General Electric
- 2.9 FUSES:
- 2.9.1 Fuses shall be provided in each device requiring same. Fuses shall be dual element RK-5 Fuses as manufactured by Bussmann of the size required by the plans or load served.
- 2.10 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS:
- 2.10.1 The Owner or other contractors will furnish certain equipment that will require electrical services and connections by this contractor. Contractor shall rough in and make final connections to all equipment. Rough-in and final connections shall be based upon a certified layout, or actual measurements of existing equipment.
- 2.10.2 Mechanical will furnish and install all motors and control devices as shown on the mechanical plans and specifications.
- 2.10.3 Contractor shall provide all disconnects and motor starters (except those specifically noted as furnished by other Divisions), power connections to all equipment furnished by others and any control devices specifically included in the plans or specifications to be provided by this contractor.
- 2.11 LIGHT FIXTURES
- 2.11.1 Light fixtures as specified and shown on the plans shall be provided. The construction and installation details shown on the plans are a part of each fixture type and shall apply where applicable.
- 2.11.2 Recessed fixtures shall be installed in complete compliance with all codes and with these specifications. Outlet boxes shall have bar hangers.

- 2.11.3 Supports of adequate capacity and rigidity shall be provided for all fixtures. All fixture outlet boxes shall have 3/8-inch no-bolt fixture studs. Refer to "Hanger and Supports" section of these specifications.
- 2.11.4 All fixtures in suspended acoustical tile ceilings shall be supported to the structural system independent of, or with additional supports provided for, the acoustical tile suspension system. All fixtures in other type ceilings shall have additional supports provided where required by weight or size of the fixtures.
- 2.11.5 Alignment of light fixtures and ceiling diffusers shall be carefully coordinated on the job.
- 2.11.6 Continuous row mounting shall be provided as indicated on the plans, with the necessary connectors, joining strips, and hardware, to form a neat compact joint and to maintain a straight line of fixtures.
- 2.11.7 Lamps shall be provided for all fixtures. LED lamps shall be 120/277 volt inside unless otherwise noted. Lamp sizes indicated are the maximum sizes to be provided. In some cases, lower wattage lamps may be required, and if so, shall be provided as directed. Fluorescent lamps shall be energy saving, lite white color.
- 2.11.8 Sockets for all fixtures shall be heavy-duty type made of high density material with all current carrying parts made of heavy copper. All sockets shall be white in color on all exposed lamp fixtures, unless noted.
- 2.11.9 Ballasts for fluorescent and LED fixtures shall be rated for use on 120 volt or 277 volt circuits unless otherwise noted, and shall have CBM, ETL and UL Class P approval. Tandem fixtures shall utilize 2-lamp ballasts. All ballasts shall be electronic, high power factor, and thermally protected, and shall be Universal SLH or approved equal. Two-lamp 40-watt rapid start fluorescent lamp ballasts shall have an "A" sound rating.
- 2.11.10 Ballasts shall be of such design that they shall not permit the temperature of the fixture or any part thereof to exceed 90°C under any condition of operation including end of ballast life. Fixture manufacturer shall certify upon request that (1) they have facilities for making these tests in accordance with U/L requirements, and (2) that their fixtures and ballasts meet these requirements.
- 2.11.11 The data furnished on light fixtures shall indicate by manufacturer the compliance with the above special requirements where applicable. If this information is not provided, the data shall not be accepted.
- 2.12 HVAC CONTROL WIRING
- 2.12.1 Division 23 shall provide all conduit, wire, thermostats, sensors, control connections, and any and all other control work in connection with the installation of the air conditioning automatic temperature control systems, unless shown on the electrical plans.
- 2.12.2 Smoke Detectors: Provide smoke detector to be mounted by Division 23, including

sampling tube. Electrical shall provide power circuit, relays, remote test switch and indicator light, conduit, wire, and connections to air handler motor starter to shut air handler down. Smoke detectors and controls shall be installed per the SBCC and NFPA 82.

- a. Air handlers less than 2,000 CFM serving egress corridors and air handlers, 2,000-15,000 CFM: Provide duct detectors in the return air ducts.
- b. Air handlers greater than 15,000 CFM: Provide duct detectors in the supply and return air ducts.

2.13 WIRING OF MOTORS AND CONTROL EQUIPMENT

2.13.1 Motors provided under other Divisions will be set by the respective contractor. This contractor shall provide power and interlock equipment and wiring, unless noted on Division 16 drawings.

2.13.2 Contractor shall be responsible for checking all overload releases and holding coils in starters, interlocks, and control equipment and shall notify the contractor furnishing these items concerning any changes that are found necessary for safe and satisfactory operation and electrical maintenance of these items.

2.13.3 Contractor shall handle, set, adjust, mount motor base, and pulleys of motors furnished but not installed under other Divisions.

2.14 LIGHTING PANELBOARDS

2.14.1 Contractor shall provide all panelboards as shown on the plans and riser diagrams. Panelboards shall be of dead-front type and shall be complete with door (with lock) and trim. Cabinets shall be code gauge steel, and boxes shall be galvanized and painted. Panel shall have main lugs and/or main breakers as specified. Branch circuits shall be equipped with plug-in type automatic circuit breakers for each circuit. Panel shall bear the Underwriter's Laboratories, Inc., seal of approval. Panel shall have silver plated connections and copper bussing throughout. Bus capacity shall be as noted. Panel shall be provided with ground bar and separate solid neutral bar and, where shown, isolated ground bar.

2.14.2 Branch circuits as shown on the plans shall be connected to the indicated breaker of the panels insofar as possible. Each circuit shall be identified on a typewritten directory card inside the door of each panel. If applicable, existing panels shall have new directories provided.

2.14.3 Two spare 1-inch conduits (capped) shall be provided from panels to an accessible location above the ceiling.

2.14.4 Interior panels shall be NEMA 1, surface or flush mounted as shown. Exterior panels shall be with fully gasketed door, NEMA 3R unless noted 4X. Panels shall be finished with baked enamel electrodeposited over a clean phosphatized surface.

2.14.5 Panels shall be Square D Type NQOD with QO circuit breakers for 240 volt use and Square D Type NEHB (indoors), NF (outdoor) with EH/EDB breakers for 480 volt use.

Multi-pole breakers shall be one handle common trip.

2.14.6 Acceptable Manufacturers:

- a. Square D
- b. Cutler Hammer
- c. General Electric

2.15 DISTRIBUTION PANELS

2.15.1 Provide distribution panelboards as indicated on riser diagram and where shown on the plans. Panelboard shall be dead front safety type equipped with thermal magnetic, molded case circuit breakers of frame and trip ratings as shown on the schedule. Bus shall be silver plated copper.

2.15.2 Panelboard bus structure and main lugs or main breaker shall have current ratings as shown. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C rise above ambient. Heat rise tests shall be conducted in accordance with Underwriter's Laboratories Standard UL67. The use of conductor dimensions will not be accepted in lieu of actual heat tests.

2.15.3 Circuit breakers shall be equipped with individually insulated, braced, and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Provide each breaker with a circuit cardholder and typewritten card identifying the circuit and trip setting. Tripped indication shall be clearly shown by the breaker handle taking a position between ON and OFF. Provisions for additional breakers shall be such that no additional connectors will be required to add breakers.

2.15.4 Each panelboard, as a complete unit, shall have a rating equal to or greater than the integrated equipment rating shown on the panelboard schedule on the plans. Such rating shall be established by test with the circuit breakers mounted on the panelboard. The short-circuit tests on the circuit breaker and on the panelboard structure shall be made simultaneously by connecting the fault to each panelboard breaker with the panelboard connected to its rated voltage source. Method of testing shall be per UL standards pertaining to listing of molded case circuit breakers for high-interrupting capacity ratings. The source shall be capable of supplying the specified panelboard short-circuit current or greater. Test data showing the completion of such test upon the entire range of distribution and power panelboards to be furnished shall be submitted to the Engineer, if requested by him, with or before the submittal of approval drawings. Testing of panelboard circuit breakers for short-circuit rating only with the breaker individually mounted is not acceptable. Testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable.

2.15.5 Cabinet shall be surface mounted, NEMA 1 (or 3R if exterior), and shall be equipped with spring latch and tumbler-lock on door of trim. Doors over 48 inches long shall be equipped with three-point latch and vault-lock. All locks shall be keyed alike. Endwalls shall be removable. Fronts shall be of code gauge full-finished steel with rust-inhibiting primer and baked enamel finish.

- 2.15.6 The panelboard interior assembly shall be dead front, with panelboard front removed. Main lugs or main breaker shall be barriered on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall be barriered.
- 2.15.7 Panelboard shall be listed by Underwriter's Laboratories and shall bear the UL label. Panelboard shall be suitable for use as service equipment. Panelboard shall be Square D I-LINE panelboard, or approved equal.
- 2.15.8 Acceptable Manufacturers:
- a. Square D
 - b. Cutler Hammer
 - c. General Electric
- 2.16 MAIN SWITCHBOARD
- 2.16.1 Provide the switchboard panel as herein specified and shown on the electrical drawings. The switchboard panel shall meet Underwriters' Laboratories requirements and be furnished with an Underwriters' Laboratories label. Switchboard shall be Square D QED-2 or approved equal.
- 2.16.2 The switchboard shall be totally enclosed, dead front, free standing, front and rear aligned with front accessibility. The framework shall be of UL gauge steel and secured together to support all coverplates, bussing and component devices during shipment and installation. Formed removable closure plates shall be used on the front, and sides. All closure plates are to be single tool, screw removable. Ventilation shall be provided when required. Each section shall include a single-piece, removable top plate.
- 2.16.3 All painted parts shall be pre-treated and provided with a corrosion-resistant, UL listed acrylic baked paint finish. The paint color shall be #49 medium light gray per ANSI Standard Z55.1-1967. Type 3R enclosures shall be treated with the same process except that all exterior parts shall be of galvanized steel. All exterior hardware on Type 3R enclosures shall be zinc-plated steel.
- 2.16.4 The entire switchboard shall be suitable for operation at the specified available fault current. The switchboard shall be labeled to indicate the maximum available fault current rating, taking into account the structure, bussing, and switchboard branch circuit devices. The short circuit current rating of the switchboard shall not be less than 100,000 RMS symmetrical amperes. The switchboard branch circuit devices short circuit current rating shall be fully rated or determined by UL labeled series connected ratings.
- 2.16.5 The switchboard through-bus shall be tin-plated copper. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 for temperature rise. The through bus shall have a maximum ampacity of 1200 amperes and extend the full length of the switchboard. The through-bus shall be 100 percent rated. Provisions shall be provided for future splicing of additional sections from either end. The neutral bus shall be 100 percent rated.
- 2.16.6 Utility Metering Compartments: The switchboard utility metering compartment shall

be located in the service entrance section of the switchboard and connected for hot sequence metering. The utility metering compartment shall be [barriered] [unbarriered] and covered with a single hinged door with sealing provisions. A voltmeter and ammeter shall be mounted in the door and supplied with the appropriate transformer[s] and selector switch[es] as required.

- 2.16.7 Main Disconnect Device: The main disconnect device shall be a molded case circuit breaker. In conjunction with the main device, ground-fault protection undervoltage trip phase failure protection capacitor trip alarm switch long time, short time long time, short time, instantaneous shall be provided. Fuses for the bolted pressure switch are to be supplied by the manufacturer user.

Switch shall have switchblades that are visible in the OFF position when the door is open. Bolted pressure contacts shall be made by firmly bolting the switchblades to the stationary contact terminals and to the hinge terminals. Switches having butt-type contacts will not be accepted. Lugs shall be suitable for copper cables and front removable. All current-carrying parts shall be silver-plated. Front-operated, electric trip, fusible switches rated 4,000 amperes or less shall have a manual close-manual/electric trip open, quick-make, quick-break operating mechanism. Switch handle shall have provisions for locking the OPEN position only, with at least three padlocks. A mechanical interlock shall be provided to prevent opening the door when the switch is closed.

- 2.16.8 Ground Fault Protection:

- 2.16.8.1 A ground fault protection system shall be provided. It shall consist of a current sensor, relaying device, test/monitor panel. The system shall be UL listed. Installation of the equipment shall in all respects be in accordance with the manufacturer's recommendations.

- 2.16.8.2 A current sensor shall be provided which is of sufficient size to properly encircle all phase and neutral conductors of the circuit to be monitored. The current sensor output shall be coordinated with the input required by the ground fault relay. The current sensor shall include a test winding which allows the complete system, including the current sensor, ground fault relay, and circuit interrupting device, to be tested under simulated ground fault conditions. The frame of the current sensor shall be constructed so that one leg can be removed to prevent disturbing cables or bussing during installation or removal of the sensor.

- 2.16.8.3 The ground fault relay shall be solid state construction for maximum reliability and shall have a VA output, which shall be coordinated to operate the following:

- 2.16.8.4 An interposing relay which shall be designed to be used in conjunction with 120 volt control power. This combination shall operate the electrical tripping mechanism of an associated bolted pressure contact switch.

- 2.16.8.5 Current settings for the ground fault pickup point shall be field adjustable continuously from 200 through 1200 amperes. A calibrated dial shall be provided for setting the ground fault pickup point. Settings for individual relays shall be 1200 amperes.

- 2.16.8.6 The time delay of the ground fault relay shall be factory set .5 seconds.
- 2.16.8.7 A factory assembled test/monitor panel to be utilized in conjunction with an auxiliary power source, which uses the test winding of the current sensor to simulate a ground fault condition shall be supplied. This test system shall be UL listed to comply with the National Electrical Code requirements for performance testing. System operation as a result of a ground fault shall be confirmed by lighting a red indicating lamp.
- 2.16.8.8 Switchboard shall be separated into shipping blocks. Each switchboard section shall be capable of being handled individually with the use of removable lifting bars or rollers and be clearly labeled with proper handling procedures.
- 2.16.8.9 Main fuses shall be Bussmann Hi Cap.
- 2.16.9 The switchboard group-mounted circuit breaker devices are to be totally front accessible and front connectable. The circuit breaker connections to the distribution panel bussing shall be of a "blow-on" design such that the connections grip the bus bars firmly under high-fault conditions.
- 2.16.10 Individually Mounted Circuit Breakers: Individually mounted branch circuit breakers shall be of the molded case type and are to be positioned vertically with the operating handles extending through the hinged front cover plates of the section. Each circuit breaker shall be individually fed by connectors from the main bus of the switchboard. The load side of each circuit breaker is to be bussed to cable lugs pointed toward the rear of the switchboard.
- 2.16.11 Acceptable Manufacturers:
- a. Square D
 - b. Cutler Hammer
 - c. General Electric
- 2.17 MOTOR CONTROL CENTER (MCC)
- 2.17.1 Provide motor control center (MCC) as indicated on riser diagram and where shown on the plans. MCC shall be dead front safety type equipped with fused switches and magnetic starters of ratings as shown on the schedule. Bus shall be silver plated copper.
- 2.17.2 MCC bus structure shall have current ratings as shown. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C rise above ambient. Heat rise tests shall be conducted in accordance with Underwriter's Laboratories Standard UL67.
- 2.17.3 Fusible switches shall be equipped with individually insulated, braced, and protected connectors. The front faces of all switches shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each switch in a uniform position. Provide each switch with a circuit cardholder and typewritten card identifying the circuit.

- 2.17.4 Magnetic motor starters shall be size 1 minimum, with HOA switch, pilot lights, and reset. The door shall be interlocked with the switch.
- 2.17.5 Cabinet shall be surface mounted, NEMA 1. Endwalls shall be removable. Cabinet shall be of code gauge full-finished steel with rust-inhibiting primer and baked enamel finish.
- 2.17.6 MCC shall be listed by Underwriter's Laboratories and shall bear the UL label. MCC shall be Square D QMB, or approved equal.
- 2.17.7 Acceptable Manufacturers:
- a. Square D
 - b. Cutler Hammer
 - c. General Electric
- 2.18 DRY TYPE TRANSFORMERS
- 2.18.1 The distribution transformer shall be 60 cycle, air insulated and air cooled, two-winding, dry type, of the capacity as noted. Primary shall be 480 volts with standard taps and secondary shall be 120/208Y volts. The 480-volt supply is obtained from a grounded wye source and the secondary of the transformer shall be connected to the source neutral.
- 2.18.2 Transformers 25 KVA and above shall be 150°C temperature rise above 40°C ambient. All insulating materials to be in accordance with NEMA 5T20-1972 standards for a 220°C. UL component recognized insulation system.
- 2.18.3 Transformer coils shall be of the continuous wound construction and shall be impregnated with non-hygroscopic, thermo-setting varnish.
- 2.18.4 Enclosure shall be designed for [indoor] [outdoor] installations, and shall be designed for floor mounting. All wiring to the transformer shall be completely enclosed in conduit and the transformer case. Transformers shall meet the latest requirements of the ASA and NEMA, and shall have inorganic silicone insulation for operation of 150°C-temperature rise. Enclosure shall be finished with electrostatic deposition thermosetting polyester powder coating (baked) applied over a clean phosphatized surface. Outdoor units shall be equipped with weathershields over ventilation openings.
- 2.18.5 Noise Level: Attention is directed to the fact that the dry type transformers are mounted in the building and adjacent to occupied areas. The manufacturer shall test the transformer prior to shipment for hum and vibration and shall be responsible for providing a transformer that shall not have an operating noise that can be heard in the adjacent rooms. Any transformers that are noisy shall be removed and replaced by the contractor. Each transformer conduit connection shall have a 24-inch section of flexible "Sealtite" conduit adjacent to the transformer to help prevent vibration transmission to the building.
- 2.18.6 Isolation Mounts: Transformers shall be mounted on Korfund Type VPS elasto-rib damper isolator bases having integral load distribution top plate.

2.18.7 Acceptable Manufacturers: Square D

2.19 MOTOR STARTERS

2.19.1 Magnetic starters shall have individual melting alloy overload relay elements in each phase. Minimum size magnetic motor starters shall be NEMA Size 1, unless noted otherwise. Unless noted otherwise, starters shall have "H-O-A" selector switch, red pilot light, and one additional convertible contact.

2.19.2 Magnetic starters shall be equal to Square D Class 8536, in NEMA 1 enclosure unless noted. Combination starters shall be equal to Square D Class 8538, in NEMA 1 enclosure unless noted.

2.19.3 Manual motor starters shall be equal to Square D Class 2510 with neon pilot light, in NEMA 1 enclosure, flush or surface mounted, as noted on plans.

2.19.4 Contractor shall be charged with the responsibility to see that all motor starters have the proper thermal elements installed prior to starting of the machine.

2.19.5 Acceptable Manufacturers:

- a. Square D
- b. Cutler Hammer
- c. General Electric

2.20 TIMER

Timer shall be electronic Paragon EC 72 or 74, or equal, as required by circuiting.

2.21 ACCESSORY CONSTRUCTION APPARATUS

2.21.1 It is the intention that these specifications shall provide a complete installation, except as herein specifically excepted. All accessory construction and apparatus necessary or advantageous in the operation or testing of the work shall be provided. The omission of specific references to any part of the work necessary for such complete installation to any part of the work necessary for such complete installation shall not be interpreted as relieving the contractor from providing such work.

3.0 EXECUTION

3.1 TESTS

3.1.1 The entire system upon completion, or as directed, shall be "Meggered" for faults in accordance with methods approved by I.E.E.E. and N.E.C.

3.1.2 This test shall be in the presence of a representative of the Engineer. Equipment installed and/or connected by the contractor shall be put through their normal operating paces and

all such equipment shall be required to operate to the satisfaction of the Engineer on completion of the job.

3.2 WORKMANSHIP AND INSTALLATION

3.2.1 Contractor shall have his choice as to the location of conduits, pull boxes, etc., except for locations set by dimensions on drawings, provided his choices do not interfere with piping, fixtures, and equipment installed by other contractors working on the project, and do not interfere with the characteristic features of the building. In cases of such interferences, the Engineer will determine the locations of the interfering items.

3.2.2 The cutting of any structural member, regardless of material, shall be approved by the Engineer. Contractor shall pay for repairing damage to such members.

3.3 PAINTING

3.3.1 Contractor shall provide painting of exposed junction boxes, conduits, hangers, supports, structural supports and other miscellaneous unfinished pieces in finished areas of the building.

3.3.2 Contractor shall touch-up or refinish if so directed by the Engineer any panels, cabinets, switchboards, fixtures and other equipment furnished with a factory finish, which shall become damaged in shipment or installation.

3.4 INSTRUCTIONS

3.4.1 Contractor shall provide for instructing employees of the Owner in the operation and maintenance of the systems. Two sets of manufacturer's certified drawings, specifications, operating instructions, maintenance manuals, and maintenance instructions on all equipment shall be provided to the Owner.

END OF SECTION