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DIVISION 15 - MECHANICAL

SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

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SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

This section covers the furnishing and installing of thermal insulation for mechanical systems as shown and specified herein, complete with all necessary accessories.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY TESTING MATERIALS (ASTM)

ASTM A 580	(1998) Stainless and Heat Resisting Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 449	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 533	(1995) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Preformed Pipe Insulation
ASTM C 552	(1991) Cellular Glass Block and Pipe Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket and Felt Insulation (Industrial Type)
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 795	(1998el) Wicking-Type Thermal Insulation for Use Over Austenitic Stainless Steel
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 921	(1989, R 1996) Properties of Jacketing Materials for Thermal Insulation
ASTM C 1136	(1995) Standard Specification for Flexible, Low Permeance Vapor Retarders

for Thermal Insulation

MANUNFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, Inc. (MSS) PUBLICATION

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Standards	(1999) Commercial and Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSN (NFPA)

NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(1993) Installation of Warm Air Heating and Air Conditioning Systems
NFPA 101	(1994) Code for Safety to Life from Fire in Buildings and Structures
NFPA 251	(1995) Fire Tests of Building Construction and Materials

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Insulation Data; GA.

Manufacturer's descriptive and technical literature that include catalog cuts, performance data, certificates, and a complete list of equipment and materials shall be submitted. Adhesive systems shall be submitted for approval.

SD-07 Schedules

Insulation Instructions and Schedule; GA.

An insulation schedule shall be submitted indicating the product number, k-value, thickness, jacketing, and furnished accessories for each mechanical system requiring insulation. Manufacturer's installation instructions shall be submitted for each product to be used. The joining and adhesive systems for the insulation shall be identified.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 General

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated.

2.1.2 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Insulation products shall conform to MICA Insulation Standards.

2.1.3 Surface Burning Characteristics

Unless otherwise specified, installed insulation materials, adhesives, coatings, and other accessories shall have flame spread ratings and smoke developed ratings in accordance with NFPA 101, NFPA 90A, and NFPA 90B for the type occupancy and location that the material is installed unless the location where the material is installed is used as an air plenum in which case all materials shall have smoke developed ratings not greater than 50 and be non-combustible or limited combustible in accordance with NFPA 90A and NFPA 90B. All insulation shall be tested in the same densities and installed thicknesses as the material that will be used in actual construction applications. Compliance with the smoke developed limitation is not required and a greater flame spread rating up to 100 is permitted for insulation installed within wall assemblies or enclosures with a minimum fire resistance rating of 30 minutes in accordance with NFPA 251, which are not used as supply or return air plenums. Insulation that has been treated with a flame retardant additive to obtain the flame spread and smoke developed ratings shown above are not permitted.

2.1.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and all samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

2.1.5 Storage

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants by the Contractor.

2.2 MATERIALS AND EQUIPMENT

Material and equipment shall conform to the following requirements:

2.2.1 General Materials

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.2.1.1 Adhesives

Adhesives shall be per the manufacturer's standard design.

2.2.1.2 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.2.1.3 Corner Angles

Nominal 0.016 inch aluminum 1 inch by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209; Alloy 3003, 3105, or 5005.

2.2.1.4 Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

ASTM C 449.

2.2.1.5 Staples

Outward clinching type.

2.2.1.6 Jackets

Jackets shall meet ASTM C 1136. ASTM C 921, Type I, moisture vapor transmission maximum 0.02 perms, puncture resistance minimum 50 Beach units, tensile strength minimum 35 pound/inch width; Type II, puncture resistance minimum 25 Beach units, tensile strength minimum 20 pound/inch width. Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016-inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture barrier. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015-inch thick, 2-inch wide for pipe under 10-inch diameter and 3/4-inch wide for pipe over 10-inch diameter. Aluminum jacket circumferential seam bands shall be 2-inch by 0.016-inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4-inch by 0.020-inch thick stainless steel. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh lock or grooved seam type longitudinal joint. When the grooved seam joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place. Polyvinyl chloride (PVC) jacket and fitting covers shall be ASTM C 1136, Composition A, Type II, with minimum thickness 0.030 inch. Insulation under PVC jacket shall meet jacket manufacturer's written recommendations.

2.2.1.7 Wire

Soft annealed ASTM A 580, Type 302, 304, or 316 stainless steel, 16 gauge.

2.2.1.8 Weather Barrier Finish

Asphalt based insulation coating, water vapor permeability between 0.0027 to 0.0034 perm inches. Childers Products Company "Chil Pruf" Pittsburgh Corning "Pittcote 300" or equal.

2.2.2 Pipe Insulation Materials shall be as follows

2.2.2.1 Above Ground Cold Pipeline Insulation (Minus 30 Degrees to Plus 80 Degrees F)

Cellular Glass: ASTM C 552, Type II, and Type III inside and outside building.

Flexible Cellular Insulation: ASTM C 534, Type I inside building on water lines and refrigerant lines and outside on refrigerant lines only.

2.2.2.2 Above Ground Hot Pipeline Insulation (Above 80 Degrees F)

Mineral Fiber: ASTM C 547, Class 1. Indoor only.

Calcium Silicate: ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.

Cellular Glass: ASTM C 552, Type II and Type III.

Flexible Cellular Insulation: ASTM C 534, Type I to 200 degrees F service.

Mineral Fiber: ASTM C 547, class 1.

2.2.2.3 Below Ground Pipeline Insulation

Cellular Glass: ASTM C 552, Type II.

2.2.3 Duct Insulation Materials shall be as follows

Rigid Mineral Fiber: ASTM C 612, Class 1.

Flexible Mineral Fiber: ASTM C 553, Type I, Class B-2.

Cellular Glass: ASTM C 552, Type I.

2.2.4 Equipment Insulation Materials

2.2.4.1 Cold Equipment Insulation (Below 60 Degrees F)

Rigid Mineral Fiber: ASTM C 612, Class 1.

Flexible Mineral Fiber: ASTM C 553, Type I, Class B-4.

Cellular Glass: ASTM C 552, Type I.

Flexible Cellular Insulation: ASTM C 534, Type II.

2.2.4.2 Hot Equipment Insulation (Above 60 Degrees F)

Rigid Mineral Fiber: ASTM C 612, Class 2, 3, 4 or 5 as required for temperature encountered to 1800 degrees F.

Flexible Mineral Fiber: ASTM C 553, Type I, Class B-4 to 400 degrees F.

Calcium Silicate: ASTM C 533, Type I, indoors only, or outdoors above 250 degrees F. Pipe shape may be used on diesel engine exhaust piping and mufflers to 1200 degrees F.

Cellular Glass: ASTM C 552, Type I and Type III.

Flexible Cellular Insulation: ASTM C 534, Type II to 200 degrees F.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Installer's Qualifications

Qualified installers shall have successfully completed 50 or more similar type jobs within the last 5 years.

3.1.2 Installation

Material shall be installed in accordance with the manufacturer's written instructions and/or MICA Insulation Standards. The Contracting Officer shall be notified of any conflicts between the specifications and the manufacturers recommendations. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry at all times. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces.

3.1.3 Fire Seal

Where pipes and ducts pass through fire walls, fire partitions, fire rated pipe chase walls or floors above grade, insulation shall be interrupted and a fire seal shall be provided as specified in SECTION: FIRESTOPPING.

3.1.4 Painting and Finishing

Painting shall be as specified in SECTION: PAINTING, GENERAL.

3.1.5 Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible cellular insulation shall not be used on surfaces greater than 200 degrees F. Insulation exposed to weather and not shown to have jacketing shall be protected with minimum two coats of UV resistant weather barrier finish after the adhesive is dry.

3.1.6 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.2 PIPE INSULATION

3.2.1 Pipe Insulation - General

All piping shall be insulated unless otherwise noted. Pipe insulation shall be continuous and installed on all fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

b. Sanitary drain lines and vent piping.

c. Unions.

d. Strainers.

e. Fuel oil piping inside building.

f. Diesel engine exhaust piping outside building.

g. Compressed air piping.

3.2.2 Pipes Passing Through Sleeves

Pipe insulation shall be continuous through the sleeve except at firewall penetrations. An aluminum jacket with factory applied moisture barriers hall be provided over the insulation wherever penetrations require sealing. Where penetrating interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

3.2.2.1 Pipes Penetrating Exterior Walls

Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.2.2.2 Pipes Penetrating Roofs

Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor barrier coating. The insulations for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

3.2.2.3 Diesel Generator Piping

Diesel generator exhaust piping and muffler shall be insulated up to exterior ceiling, except for the flexible duct section. Exhaust pipe outside building shall not be insulated.

3.2.3 Pipes Passing Through Hangers

Insulation, whether hot or cold application, shall be continuous through hangers.

a. On support points where type 39 saddle or type 40 shield conforming to MSS SP-69 are permitted for a particular pipe attachment application, the type 39 saddle shall be used on all pipe 4 inches and larger. On piping under 4 inches, the type 40 galvanized protection shield may be used. Insulation or an insulation insert of a density at least 9 pcf shall be installed under each shield. The insert shall cover not less than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2

inches on each end beyond the protection shield. Inserts are not required with type 39 pipe saddles.

b. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket.

3.2.4 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 5 inches and less. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.5 Above Ground Cold Pipelines

Pipe lines operating in the temperature range of -30 degree F to + 60 degrees F shall be insulated as follows.

Pipeline	Insulation System
Domestic cold and chilled drinking water, including all water piping in well houses.	Flexible cellular with vapor barrier jacket.
Make-up water.	Mineral fiber or flexible cellular with vapor barrier jacket.
Refrigerant suction lines.	Cellular glass or flexible cellular with vapor barrier finish and aluminum jacket. Cellular glass shall be used at all pipe supports suspended under building.
Exterior fuel oil piping.	Flexible cellular or cellular glass.

3.2.5.1 Insulation Thickness

Thickness of insulation shall be as indicated in Table I unless otherwise noted.

3.2.5.2 Vapor Barrier Jacket for Fibrous and Cellular Glass Insulated Pipe

Insulation shall be covered with a factory applied vapor barrier jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor barrier jacket installed as specified herein. Aluminum jacket shall be installed on all insulated piping exposed to weather, except sealing of the laps of the aluminum jacket is not required.

3.2.5.3 Insulation for Straight Runs on Fibrous and Cellular Glass Insulated Pipe Inside Building.

a. Insulation shall be applied to the pipe with joints tightly butted. The ends of fibrous insulation shall be sealed off with vapor barrier coating at intervals not to exceed 15 feet.

b. Longitudinal laps of the jacket material shall overlap not less than

1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

TABLE I
Pipe Size (Inches)

Service or Range of Temp (Degrees F)		Run-outs* 1/4 to 1-1/2	1/4 to 1-1/4	1-1/2 to 3	3-1/2 to 5	6 to 10	11 to 24	25 to 33
60 to 35	(FC)	1/2	1	1				
	(CG)		1-1/2	1-1/2	2	2	2	2
	(MF)		1	1	1-1/2	1-1/2	1-1/2	1-1/2
34 to 0	(CG)		2-1/2	2-1/2	2-1/2	3	3	3-1/2
	(MF)		1-1/2	1-1/2	2	2	2-1/2	2-1/2
-1 to -30	(CG)		3	3	3	3-1/2	3-1/2	4
	(MF)		1-1/2	2	2-1/2	2-1/2	3	3
Domestic Cold Water and Interior Roof Drain Lines	(FC)		2	2	2			
	(CG)		1	1	1	1-1/2	1-1/2	1-1/2
	(MF)		2	2	2	1	1	1

NOTES: CG - Cellular Glass
MF - Mineral Fiber
FC - Flexible Cellular

* When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. Staples and seams, including those on self-sealing lap systems with adhesive on one side shall be coated with a vapor barrier coating. Double pressure-sensitive adhesive seams need not be coated.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating as specified for butt strips. The patch shall extend not less than 1-1/2 inches past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with two coats of vapor barrier mastic

3.2.5.4 Fibrous and Cellular Glass Insulation on Flanges, Unions, Valves, Anchors, Fittings, and Accessories

Pipe insulation shall have tapered ends thoroughly coated with a vapor barrier coating not more than 6 inches from each flange, union, valve, anchor, or fitting in all directions. Insulation may be premolded or segmented. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation should be overlapped 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Insulation for elbows less than 3-inch size shall be remolded. Insulation for elbows 3-inch size and larger shall be either premolded or segmented. Elbows insulated using segments shall not have less than 3 segments per elbow. Insulation may be secured by wire until finish is applied.

a. Upon completion of installation of insulation, two coats of vapor barrier coating with a minimum total thickness of 1/16 inch, shall be applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches.

b. Insulation terminations shall be tapered to unions at a 45-degree angle.

c. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

d. Flexible connections at pumps and other equipment shall be insulated with 1/2-inch flexible cellular insulation, unless otherwise indicated.

3.2.5.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor barrier and embedded glass tape. Factory premolded insulation segments or factory cut blanket inserts shall be used under the fitting covers for elbows. Insulation thickness for inserts shall be as recommended by the insulation manufacturer for the prescribed application temperatures. Elsewhere field cut inserts may be used. The covers shall be secured by PVC vapor barrier tape or adhesive or with tacks made for securing PVC covers. All tape seams and tacks shall then be coated with vapor barrier coating.

3.2.6 Aboveground Hot Pipelines (Above 60 Degrees F)

The following shall be insulated.

Pipeline	Insulation System
Domestic hot water.	Mineral fiber or flexible cellular.
Hot water heating.	Mineral fiber with all service jacket except mechanical room which shall have aluminum jacket.

3.2.6.1 Insulation Thickness

Insulation thickness for pipelines handling 60 degrees F to 200 degrees F domestic hot water shall be as indicated in Table III.

TABLE II

REQUIRED THICKNESS (IN INCHES) OF PIPE INSULATION
FOR HANDLING CIRCULATION OF HOT WATER
SUPPLY AND RETURN PIPING

k = thermal conductivity (average) Btu/hr. sq. ft. degree/in. thickness at a mean temperature of 75 degrees F

Thermal conductivity k	Pipe Size, Inches						
	2 or less	2-1/2 to 3	4	5 to 6	8	10	12
0.25	1.5	1.5	2.0	2.0	2.0	2.0	2.5
0.30	1.5	1.5	2.5	2.5	2.5	2.5	3.0
0.35	2.0	2.0	2.5	2.5	2.5	2.5	3.5
0.40	2.0	2.5	3.0	3.0	3.0	3.0	4.0
0.45	2.5	2.5	3.0	3.0	3.5	3.5	4.0

TABLE III

REQUIRED THICKNESS (IN INCHES) OF PIPE INSULATION
FOR PIPES HANDLING DOMESTIC HOT WATER. MF - MINERAL FIBER
CG - CELLULAR GLASS FC - FLEXIBLE CELLULAR

Range of Service (Degrees F)	Runouts* 1/4 to 1-1/2"	Pipe Size, Inches 2 or less	2-1/2 to 3	4	5 to 6	8	10	12
61 to 200 (MF)		1.0	1.0	1.0	1.0	1.5	1.5	1.5
(CG)		1.5	1.5	1.5	1.5	2.0	2.0	2.0
(FC)	1/2	1.0	1.0	1.0	1.0			

* When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

3.2.6.2 Jacket for Fibrous and Cellular Glass Insulated Pipe

Insulation shall be covered with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

3.2.6.3 Insulation for Straight Runs on Fibrous and Cellular Glass Insulated Pipe

Insulation shall be applied to the pipe with joints tightly butted. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.

a. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be

installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

b. 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 noted for butt strips. Patch shall extend not less than 1-1/2 inches past the break.

3.2.6.4 Fibrous and Cellular Glass Insulation on Flanges, Unions, Valves, Anchors, Fittings, and Accessories

The run of the line pipe insulation shall have the ends brought up to the item. Insulation of the same thickness and conductivity as the adjoining pipe insulation, either premolded or segmented, shall be placed around the item abutting the adjoining pipe insulation, or if nesting size insulation is used, overlapping 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Insulation for elbows less than 3-inch size shall be premolded. Insulation for elbows 3-inch size and larger shall be either premolded or segmented. Elbows insulated using segments shall have not less than 3 segments per elbow. Insulation may be wired or taped on until finish is applied.

a. Upon completion of installation of insulation, two coats of Class 1 adhesive shall be applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.

b. Insulation terminations shall be tapered to unions at a 45-degree angle.

3.2.6.5 Optional Polyvinyl Chloride Fitting Covers

At the option of the Contractor, factory premolded one or two piece PVC fitting covers may be used in lieu of the two coats of adhesive with tape embedded between coats. Factory premolded segment, or factory cut blanket insert insulation shall be used under the fitting covers, for elbows. Elsewhere field cut inserts may be used. Covers shall be installed over the insulation and secured by seal welding, stapling, taping with PVC vapor barrier tape, or with metal or plastic tacks made for securing PVC fitting covers.

3.2.7 Piping Exposed to Weather

Piping exposed to weather shall be insulated and as specified for the applicable service, prior to application of the jacket. All piping exposed to weather shall have aluminum jacket.

3.2.7.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12-inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an uninsulated surface,

joints shall be sealed with caulking. Joints on piping above 60 degrees F shall be sealed with a moisture barrier.

3.2.7.2 Flanges, Unions, Valves, Fittings and Accessories

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of an emulsion type weatherproof mastic recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above.

3.2.8 Below Ground Pipe Insulation

The following shall be included:

a. Fuel oil.

b. Water line between new central control station and new well house.

3.2.8.1 Type of insulation

All below ground pipe shall be insulated with cellular 3 inch glass.

3.2.8.2 Installation of below ground pipe insulation

a. Bore surfaces of the insulation shall be coated with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Coating thickness shall be sufficient to fill surface cells of insulation. Mastic type materials will not be permitted for this coating.

b. Insulation applied to the pipe shall have all joints tightly butted and bedded together with bedding compound. Butt joints shall be staggered.

c. Stainless steel bands, 3/4 inch wide by 0.020 inch thick shall be used to secure insulation in place. A minimum of two bands per section of insulation shall be applied. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 12 inches in diameter. A minimum of two bands per section of insulation shall be applied.

d. Insulation shall terminate at anchor blocks but shall be continuous through sleeves and manholes.

e. At point of entry to buildings, underground insulation shall be terminated 2 inches inside the wall or floor, shall butt tightly against the aboveground insulation and the butt joint shall be sealed with vapor barrier coating.

f. Provision for expansion and contraction shall be made in accordance with the insulation manufacturer's recommendations.

g. Flanges, couplings, valves, and fittings shall be insulated with factory premolded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Insulation sections shall be secured in place with wire,

bore surfaces coated, and joints sealed as specified.

h. Insulation, including fittings, shall be finished with three coats asphaltic mastic, with 10 by 10 glass mesh reinforcing fabric embedded between coats. Fabric shall be overlapped a minimum of 2 inches at all joints. Total film thickness shall be a minimum of 3/16 inch. As an alternate, a prefabricated bituminous laminated jacket, reinforced with 10 by 10 glass fiber mesh, shall be applied to the insulation. Jacketing material and application procedures shall match manufacturer's written instructions.

i. At termination points, other than building entrances, the mastic and cloth or tape shall cover the ends of insulation and extend 2 inches along the bare pipe.

j. Heat traced pipe lines shall be insulated as indicated on the drawings.

3.2.9 Diesel Engine Exhaust Pipe and Muffler

3.2.9.1 Calcium silicate for the muffler and exhaust piping

4 inches of insulation shall be applied in two or more layers with joints staggered. The insulation shall be held on with metal bands at a spacing recommended by insulation manufacturer but not to exceed 12 inches. The insulation shall be protected with a 0.016 inch thick aluminum jacket securely fastened around the insulation. The insulation shall conform to ASTM C 533.

3.3 DUCT INSULATION

3.3.1 Duct Insulation - General

All duct and equipment shall be externally insulated unless otherwise noted. Corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Duct insulation shall be omitted on the following:

a. Factory preinsulated flexible ducts.

b. Ducts within HVAC equipment.

c. Exhaust air ducts unless noted.

d. Ceilings which form plenums.

e. Duct portions inside walls or floor-ceiling space in which both sides of the space are exposed to conditioned air and the space is not vented or exposed to unconditioned air.

3.3.2 Insulation and Vapor Barrier for Cold Air Duct (Below 60 Degrees F)

Ducts and associated equipment shall be insulated to a thickness of 2 inches except fresh air intake ducts which shall be insulated 1-1/2 inches. The following shall be insulated:

a. Supply ducts.

b. Flexible runouts (except for factory-insulated).

c. Return ducts on the 2nd level.

d. Fresh air intake ducts.

3.3.2.1 Insulation for Rectangular Ducts

Insulation for rectangular ducts shall be rigid type minimum density 3 pcf. Insulation for all round ducts shall be flexible type, minimum density 3/4 pcf with a factory Type I jacket. Fibrous and cellular glass insulation shall be provided with either a factory-applied Type I vapor barrier jacket or a vapor barrier coating finish as specified. Fibrous and cellular glass insulation on concealed duct shall be provided with a factory-applied Type I vapor barrier jacket.

3.3.2.2 Vapor Barrier

Vapor barrier coating finish shall be accomplished by applying two coats of vapor barrier coating with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch.

3.3.2.3 Duct Insulation

Duct insulation shall be continuous through sleeves and prepared openings except fire wall penetrations. Duct insulation shall terminate at fire dampers and flexible connections. Vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation.

3.3.3 Installation on Concealed Cold Air Duct

For rectangular, oval or round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 6-inch wide strips on 12-inch centers. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18-inch centers and not more than 18 inches from duct corners.

a. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18-inch centers and not more than 18 inches from duct corners. Insulation shall be impaled on the mechanical fasteners where used and shall be pressed thoroughly into the adhesive. Care shall be taken to insure vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hanger.

b. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.

c. Jacket overlaps shall be secured under the overlap with Class 2 adhesive and stapled on 4-inch centers. Staples and seams shall be coated with a vapor barrier coating. Breaks in the jacket material shall be covered with patches of the same material as the vapor barrier. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with Class 2 adhesive and staples. Staples and joints shall be sealed with a brush coat of vapor barrier coating.

d. At jacket penetrations such as hangers, thermometers, and damper

operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor barrier coating.

e. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor barrier coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

f. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.4 Installation on Exposed Cold Air Duct Work

For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.

a. Duct insulation shall be formed with minimum jacket seams, and in no case shall a jacket seam be allowed on or within 3 inches of the duct corner. Insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

b. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over. Joints in the insulation jacket shall be sealed with a 4-inch wide strip of the same material as the vapor barrier jacket. The strip shall be secured with Class 2 adhesive and stapled. Staples and seams shall be sealed with a brush coat of vapor barrier coating.

c. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled. Staples and joints shall be sealed with a brush coat of vapor barrier coating.

d. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor barrier coating.

e. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor barrier coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

3.3.5 Insulation for Warm Air Duct (Above 60 Degrees F)

Ducts and associated equipment shall be insulated to a thickness of 2 inches except relief ducts and fresh air intake ducts which shall be insulated 1-1/2 inches. The following shall be insulated:

a. Supply ducts.

b. Return air ducts in the mechanical room.

c. Flexible runouts (except for factory insulated).

d. Fresh air intake ducts.

e. Return air ducts on the 2nd level.

f. Filter boxes.

g. Mixing boxes.

3.3.5.1 Insulation for Rectangular Ducts

Insulation for rectangular shall be rigid type minimum density 3 pcf. Insulation on exposed ducts shall be provided with factory-applied Type II jacket, or finished with Class 1 adhesive finish. Flexible type insulation shall be used for all round duct, minimum density 3/4 pcf with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket.

3.3.5.2 Adhesive Finish

Class 1 adhesive finish shall be accomplished by applying two coats of Class 1 adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch.

3.3.5.3 Duct Insulation

Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at all fire dampers and flexible connections.

3.3.6 Installation on Concealed Warm Air Duct

For rectangular, oval and round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 6-inch wide strips on 12-inch centers. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18-inch centers and not more than 18 inches from duct corner.

a. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18-inch centers and not more than 18 inches from duct corners.

b. The insulation shall be impaled on the mechanical fasteners where used and shall be pressed thoroughly into the adhesive. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

c. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

d. Insulation shall overlap not less than 2 inches at joints and the laps shall be secured with staples on 4-inch centers.

3.3.7 Installation on Exposed Warm Air Duct

For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

a. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and in no case shall a jacket seam be allowed on or within 3 inches of the duct corner. Insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

b. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin excess clipped and bent over.

c. Joints on jacketed insulation shall be sealed with a 4-inch wide strip of the same material as the jacket. The strip shall be secured with Class 2 adhesive and stapled.

d. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled.

e. Insulation terminations and pin punctures shall be sealed and flashed with a Class 1 adhesive. Two coats of Class 1 adhesive coating shall be applied with glass cloth embedded between coats. The total coating shall have a dry film thickness of approximately 1/16 inch and shall overlap the adjoining insulation and uninsulated surface 2 inches.

3.3.8 Ducts Handling Air for Dual Purpose (Below and Above 60 Degrees F)

Ducts shall be insulated as specified for cold air duct.

3.4 EQUIPMENT INSULATION

3.4.1 Equipment Insulation - General

Removable insulation sections shall be provided to cover parts of equipment which must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Handholes.

b. Cleanouts.

c. ASME stamps.

d. Manufacturer's nameplates.

3.4.2 Insulation for Cold Equipment (Below 60 Degrees F)

Insulation shall be furnished on all equipment handling media below 60 degrees F including the following:

a. Refrigeration equipment parts that are not factory insulated.

b. Roof drain bodies.

c. Air handling equipment parts that are not factory insulated.

e. 3000 gallon diesel fuel tank.

f. Pressure tanks and filter tanks in well houses.

3.4.2.1 Insulation

Insulation shall be rigid block, flexible cellular, or semirigid board, suitable for the temperature encountered. Thicknesses shall be as follows:

a. Equipment Handling Media Between 35 Degrees F and 60 Degrees F. 1-1/2 inch thick mineral fiber, 2-inch thick cellular glass, or 1-1/2 inch thick flexible cellular.

b. Equipment Handling Media Between 0 Degree F and 34 Degrees F. 2-1/2 inch thick mineral fiber, 3-1/2 inch thick cellular glass, or 2-1/2 inch flexible cellular.

c. Equipment Handling Media Between Minus 30 Degrees F and Minus 1 Degree F. 3-inch thick mineral fiber, 4-inch thick cellular glass or 3-inch thick flexible cellular.

3.4.2.2 Installation

Insulation shall be formed or fabricated to fit the equipment. To insure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12-inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

a. Cellular glass insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound. Mineral fiber insulation joints shall be filled with insulating cement.

b. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished as specified.

c. Exposed insulation corners shall be protected with corner angles.

d. Insulation on equipment with ribs shall be applied over 6- by 6- by 12-gage welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2

by 2 washers or shall be securely banded or wired in place on 12-inch centers.

3.4.2.3 Coating

A smooth coat of insulating cement shall be applied over the insulation except for removable sections of insulation.

3.4.2.4 Penetrations

Upon completion of installation of the insulation, penetrations shall be caulked and two coats of weather barrier coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16-inch. Insulation installed outside shall be weather resistant and ultraviolet-resistant.

3.4.3 Insulation for Hot Equipment (Above 60 Degrees F)

Insulation shall be furnished on all equipment handling media above 60 degrees F including the following:

a. Boilers if not factory installed.

b. Water heaters if not factory installed.

c. Diesel generator exhaust pipe and muffler. Insulation system. Two layers of calcium silicate with joints staggered and mastic coating:

3.4.3.1 Insulation

Insulation shall be rigid block, flexible cellular, or semirigid board suitable for the temperature encountered. Insulation thicknesses shall be as follows:

Temperature	Thickness
Up to 150^{O} F	2"
200^{O} F	3"
250^{O} F	3-1/2"
300^{O} F	4"
350^{O} F	5" (two layers of 2-1/2")

3.4.3.2 Installation

Insulation shall be formed or fabricated to fit the equipment. To insure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 9-inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

a. Cellular glass insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with insulating cement.

b. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female

shiplap type joint. Entire surface of the removable section shall be finished as specified.

c. Exposed insulation corners shall be protected with corner angles.

d. A smooth coat of insulating cement shall be applied over insulation, except for removable sections of insulation.

e. Upon completion of installation of insulation, penetrations shall be caulked and two coats of Class 1 adhesive shall be applied with glass cloth embedded between coats. The dry film thickness of the finish shall be 1/16 inch. Final coating for diesel engine exhaust piping and muffler shall be similar to Childers Products Company "Vi-Cvyl CP-10/CP-11". Color shall be white.

3.4.4 Equipment Handling Dual Temperature Media (Below and Above 60 Degrees F)

Equipment handling dual temperature media shall be insulated as specified for cold equipment.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15100

PLUMBING

-- End of Section Table of Contents --

SECTION 15100

PLUMBING

PART 1 GENERAL

This section covers the furnishing and installing of the plumbing systems and fixtures as shown and specified herein, complete with all necessary equipment and required accessories.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFREIGERATION INSTITUTUE (ARI) STANDARD

ARI 1010	(1994) Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS

ASNI Z21.22	(1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFREIFGERATION, AND AIR-CONDITIONING ENGINEERS, INC. (ASHRAE) STANDARD

ASHRAE 90A	(1980) Energy Conservation in New Building Design (Sections 1 through 9)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(1996) Scheme for the Identification of Piping Systems
ASME A112.6.1M	(1988) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.19.2M	(1995) Vitreous China Plumbing Fixtures
ASME A112.21.1M	(1991; R 1998) Floor Drains
ASME A112.21.2M	(1983) Roof Drains
ASME A112.36.2M	(1991; R 1998) Cleanouts
ASME A117.1	(1992) Providing Accessibility and Usability by Physically Handicapped People
ASME B1.20.1	(1983; R 1992) Pipe Threads, General

	Purpose (Inch)
ASME B16.3	(1992) Malleable-Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(1992) Cast Iron Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(1991; R 1998) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE) STANDARDS

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1011	(1995) Hose Connections Vacuum Breakers
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 53	(1999) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM B 42	(1996) Seamless Copper Pipe, Standard Sizes
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARDS

AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water
AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	(1993) Ductile Iron and Gray Iron Fittings

	3 inch through 48 inch for water and other liquids
AWWA C150	(1993) Thickness Design of Ductile Iron Pipe
AWWA C151	(1991) Ductile Iron pipe, Centrifugally Cast for water and other liquids
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

CAST IRON SOIL PIPE INSTITUTE (CISPI) STANDARDS

CISPI 301	(1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(1997) Cast Iron Soil Pipe Institute's Approved Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI HSN-85	(1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATIONS

NFPA 70	(1996) National Electrical Code

MANANUFCTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY INC. (MSS) STANDARDS

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-73	(1991; R 1996) Brazing Joints for Wrought and Cast Copper Alloy Solder Joint

	Pressure Fittings
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-84	(1990) Steel Valves - Socket Welding and Threaded Welds
MSS SP-85	(1994) Cast Iron Globe and Angle Valves - Flanged and Threaded Ends

WISCONSIN ADMINISTRATIVE CODE (ILHR)

ILHR Plumbing Code	(1956, with monthly updates) Rules of Department of Industry, Labor and Human Relations - Plumbing Code

PLUMBING AND DRAINAGE INSTITUTE (PDI) STANDARDS

PDI WH 201	(1992) Water Hammer Arresters

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Plumbing Shop Drawings; GA.

Shop drawings shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system. Shop drawings shall be provided for the complete plumbing system and shall include piping layout and location of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Shop drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support method. The following shop drawings shall be submitted:

(1) All plumbing fixtures including water closets, urinals, lavatories, carriers, faucets, flush valves, drinking fountains, wall faucets, mop basin, oil interceptor, and traps.

(2) Valves.

(3) Floor drains and cleanouts.

(4) Water heaters, including electrical requirements and wiring diagram.

(5) Water coolers.

(6) Air compressor including dryer, receiver, and motor data. Include performance data on the compressor. Include dimensional data.

(7) Sanitary piping, hot and cold water piping, compressed air piping, and vent piping shall be submitted for approval. Include certificates of compliance.

(8) Pumps for electrical vault, old central control station basement, and MH 2. Include pump capacity data, pump horsepower data, installation details, and flap valves.

SD-06 Instructions

Operating Instructions; FIO.

The Contractor shall furnish five complete copies of operation manuals on the water heater, air compressor, water coolers, pumps, and the remainder of the plumbing system. Manuals shall list instructions outlining the step-by-step procedures required for system start-up, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, a complete set of shop drawings, and brief description of all equipment and their basic operating features.

SD-09 Reports

Performance Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria.

SD-13 Certificates

Certificates of Compliance; FIO.

Where materials or equipment are required to comply with requirements of the ARI, ASHRAE, ASME, etc. proof of such compliance shall be submitted; the label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency.

SD-19 Operation and Maintenance Manuals

Maintenance Instructions; FIO.

The Contractor shall furnish five complete copies of maintenance manuals on the water heater, air compressor, water coolers, pumps, and the remainder of the plumbing system. Maintenance instructions shall list routine maintenance procedures, possible breakdowns, repairs and a troubleshooting guide. The instructions shall include equipment layout and simplified wiring and control diagrams for the system as installed. Copies of the manufacturer's standard warranties shall be included.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to award date of this contract.

2.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

2.2 MATERIALS AND EQUIPMENT

2.2.1 General

Materials for various services shall be in accordance with Tables 1 and 2. Pipe fittings shall be compatible with the applicable pipe materials. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be of the same manufacturer. Material or equipment containing lead shall not be used in any potable water system.

2.2.1.1 Pipe

Iron and steel pipe shall conform to ASTM A 53.

2.2.2 Pipe Joint Materials

Joints and gaskets materials shall conform to the following:

a. Coupling for Cast Iron Pipe: CISPI 310, AWWA C606.

b. Coupling for Steel Pipe: AWWA C606.

c. Nonmetallic Flange Gaskets for Flanges: ASME B16.21.

d. Neoprene Gaskets for Hub and Cast Iron Pipe and Fittings: CISPI HSN-85.

e. Silver Brazing Joints for Wrought and Cast Solder-Joint Fittings: MSS SP-73.

f. Rubber Gaskets for Cast Iron Soil-Pipe and Fittings: ASTM C 564.

g. Cast Iron Threaded Fittings: ASME B16.4.

2.2.3 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201.

b. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

c. Metallic Cleanouts: ASME A112.36.2M.

2.2.4 Pipe Insulation Material

Insulation shall be as specified in SECTION: THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2.5 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69.

2.2.6 Backflow Preventers

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with the Foundation for Cross-Connection Control and Hydraulic Research Manual. Backflow preventers with reduced pressure principle backflow preventers shall be in accordance with ASSE 1013. Hose connection vacuum breakers shall be in accordance with ASSE 1011. Pipe applied atmospheric type vacuum breakers shall be in accordance with ASSE 1001. Air gaps in plumbing systems shall be in accordance with Wisconsin ILHR Plumbing Code.

2.2.7 Escutcheons

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

2.2.8 Floor Drains

Floor drains shall be cast iron with integral seepage pan, integral ball check valve, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded or caulked connection. In lieu of a caulked joint between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M. The size of the drains shall be determined by the branch sizes indicated. Drains installed in connection with water-proofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

2.2.9 Oil Interceptors

The oil interceptor shall be sized as indicated and constructed of cast iron. Interceptors shall be the gravity draw-off type with flow control regulator.

2.2.10 Roof Drains and Expansion Joints

Roof drains shall conform to ASME A112.21.2M, shall be galvanized heavy pattern cast iron with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suite the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 0.134 inch. Gaskets and packing shall be of durable material. Packing shall be held in place by a packing gland secured with bolts.

2.2.11 Traps

Traps shall be adjustable tube type with slip joint inlet and swivel. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.2.12 Pumps

One pump shall be provided for the new electrical vault, one pump shall be provided for the old CCS basement, and one pump shall be provided for manhole 2. The pump for the electrical vault shall be a submersible, dewatering type pump. The other sump pumps shall be trash type pumps. Trash pumps shall be electric, centrifugal, submersible, type with closed non-clog impellers. Each pump shall be capable of pumping solids up to 1" in diameter. Impeller and volute shall be cast iron.

2.2.12.1 Capacities

(1) New Electrical Vault: Discharge not less than 100 gallons per minute against a Total Dynamic Head (TDH) of 20 feet of water. Pumps shall be minimum 75% overall efficient at the primary condition point. Discharge size shall be 2".

(2) Old CCS Basement: Discharge not less than 800 gallons per minute against a Total Dynamic Head (TDH) of 25 feet of water. Pumps shall be minimum 75% overall efficient at the primary condition point. Discharge size shall be 6". The pump shall be designed to travel on guide rails or guide cables.

(3) Manhole # 2: Discharge not less than 200 gallons per minute against a Total Dynamic Head (TDH) of 20 feet of water. Pumps shall be minimum 75%

overall efficient at the primary condition point. Discharge size shall be 3".

2.2.12.2 Speed

The speed of the pumps shall not exceed 1800 revolutions per minute. The speed of the pump for the old central control station basement shall not exceed 1200 RPM.

2.2.12.3 Shafts And Seals

Pump and drive shaft shall be a single combined shaft. The pump shaft and drive shaft shall be of ASTM A 276, Type 420 stainless steel and shall be completely isolated from the pumped liquid. Each pump shall be provided with a tandem mechanical rotating shaft seal system. Seals shall run in a oil reservoir. Lapped seal faces must be hydrodynamically lubricated at a constant rate. The lower seal unit, between the oil sump and the volute, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper seal unit, between the motor housing and oil sump, shall contain one positively driven rotating carbon ring and one stationary tungsten-carbide seal.

2.2.12.4 Pump Lifting System

Each pump shall be furnished with a lifting bar to facilitate handling. The lifting bars shall manufactured of stainless steel, chrome-nickel steel, or chrome-moly steel. The bar shall be so designed and arranged to allow safe handling of the pump as required during shipping, installation, and maintenance. The pump for the old central control station basement shall include discharge shoe, guide bars, and pump hatch.

2.2.12.5 Electrical

Pump motors shall be squirrel-cage, induction, shell type design, housed in an air filled watertight chamber, and NEMA Design B type. The pump unit and motor unit shall be closed coupled to form a single integral unit. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation which will resist a temperature of 155°C. The stator shall be dipped and baked three times in Class F varnish. The motor shall be designed for continuous duty, capable of sustaining a minimum of ten starts per hour. The rotor bars and short circuit rings shall be made of copper or aluminum. Each motor shall be wound for 3-phase, 60 Hz, alternating current, and 480 volt operation.

2.2.12.6 Pump cables, Plugs, and Receptacles

Each pump shall be supplied with 75' of electrical cable. Cables shall terminate in a horsepower rated plug and receptacle, Crouse Hinds or equal. Plugs and receptacles shall be weatherproof, heavy duty, circuit breaking type. Each motor cable shall be suitable for submersible pump application and such information shall be indicated by a code or legend permanently embossed on the cable. Cable sizing for pump motors shall conform to NFPA 70.

2.2.12.7 Installation

The sump pump for the electrical vault shall be installed as shown. The Contractor shall design the discharge system for pumps and furnish installation drawings showing the pumps and discharge piping.

2.3 VALVES

2.3.1 General

Valves shall be provided on supplies to equipment and fixtures as indicated. Valves in connection with runouts, risers, branches, and mains shall be installed where indicated. Valves shall be gate valves, unless otherwise specified or indicated. Valves 2 2 inches and smaller shall be bronze, with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Valves used for water service shall have the zinc content limited to no more than 6 percent for the stem, body, bonnet, wedge, or disk in contact with the fluid. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard.

Description	Standard
Butterfly Valves	MSS SP-67
Cast Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves	MSS SP-72
Cast Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle and Check Valves	MSS SP-80
Steel Valves-Socket Welding and Threaded Ends	MSS SP-84
Cast Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85

2.3.2 Relief Valves

Water heaters shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve must have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input by the heaters. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves rated according to ANSI Z21.22 shall be selected for systems where the input rating of the heaters is less than 200,000 Btuh. Relief valves rated according to ASME Section IV or ASME Safety Code No. CSD-1, shall be selected for systems where the input rating of the heaters is greater than 200,000 Btuh. Minimum relief valve size shall be 3/4 inch for inlet and outlet for heaters less than 200,000 Btuh, 1 inch for inlet and outlet for heaters greater than 200,000 Btuh.

2.3.3 Wall Hydrants

Wall hydrants with vacuum breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through wall and to place the valve inside the building, so that the portion of the hydrant between outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4-inch exposed hose thread on spout and 3/4-inch male pipe thread on inlet.

2.3.4 Yard Hydrants

Yard box or post hydrants shall have valve housings located below frost lines. Water from the casing shall be drained after valve is shut off. Hydrant shall be bronze with cast iron box or casing guard. "T" handle key shall be provided.

2.4 FIXTURES

2.4.1 General

Fixtures shall be water conservation type, in accordance with the Wisconsin ILHR Plumbing Code, ASHRAE 90A Energy Standards and ASME A112.19.2M. Fixtures for use by the physically handicapped shall be in accordance with ASME A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture shall be trapped. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature..

2.4.2 Flush Valves

Flush valves shall have a nonhold-open feature with backcheck angle control stop and a vacuum breaker. Flush valves shall be large diaphragm type, having a minimum upper chamber inside diameter of not less than 2-5/8 inches at the point where the diaphragm is sealed between the upper and lower chambers.

2.5 DRINKING FOUNTAINS

2.5.1 Refrigerated Water Coolers

Water coolers shall be self-contained, wall hung, mechanically refrigerated, and shall conform to ARI 1010. Water coolers shall deliver a minimum of 8 gph of 50 degree F water when supplied with 80 deg F water and a 90 deg F room temperature. Units shall be 304, 18 gauge stainless steel. When installed, drinking fountains shall meet all handicap accessibility requirements.

2.5.2 Drinking Fountains (For Outdoor Installation)

Drinking fountains for outdoor installation shall be fully exposed, wall type. Unit shall be furnished complete with drain and bubbler. Material shall be 18 gauge, Type 302 stainless steel.

2.6 WATER HEATER

The water heater shall be glass-lined electric. Unit shall be rated for 208v, 1 phase operation. Heater shall utilize two 4500 watt elements. Water heater shall bear either ASHRAE or ASME codes and be listed with the National Board as required. All internal surfaces of the tank shall be glass-lined. Tank shall be cathodically protected with an adequate extruded magnesium anode. The entire vessel shall be enclosed in a steel enclosure with baked enamel finish. Control compartment to be hinged and shall house 120 volt control circuit transformer, transformer fusing, magnetic contractor(s), immersion style operating thermostat(s), element fusing per N.E.C. High density fiberglass insulation shall exceed latest requirements of ASHRAE for heat loss efficiency. Heater shall include ASME T&P relief valve and drain valve.

2.7 COMPRESSSED AIR SYSTEM

2.7.1 Reciprocating Air Compressor

Air compressor unit shall be a factory packaged assembly, tank mounted, reciprocating type. Unit shall include UL listed three phase, 480 volt motor controls, switches, wiring, accessories, and motor controllers, in a UL listed NEMA 250, Type 1 enclosure. The air compressor manufacturer shall supply a combination starter/disconnect with the compressor. Air compressor shall have integral air cooled aftercooler, separator, and auto drain. Air compressor shall have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Compressor shall start unloaded and shall start and top automatically by an enclosed diaphragm type pressure switch mounted on the unit or in the unit mounted control cabinet. Guards shall shield exposed moving parts. Compressor motor shall be provided with a combination disconnect and across-the-line-type magnetic starter, complete with low voltage release. In addition, a three-position hand-off-automatic selector switch shall be provided. An intake air filter and silencer shall be provided with compressor. Means shall be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacity of air compressor and receiver shall be as indicated. Motors shall be premium efficiency, totally enclosed fan cooled type.

2.7.2 Design Data

Compressor shall be two-stage, V-belt drive, capable of operating continuously against designed discharge pressure, and shall operate at a speed not in excess of 1800 rpm. Compressor shall be assembled complete on a common subbase. The compressor main bearings shall be either roller or ball. The discharge passage of the high pressure air shall be piped to the

air receiver with a copper pipe or tubing. A pressure gage calibrated to 150 psi and equipped with a gage cock and pulsation dampener shall be furnished for installation adjacent to pressure switches.

2.7.3 Pressure Relief Valve

Provide a pressure relief valve at the compressor discharge. Valve shall be manually adjustable, with a bronze body, threaded connections, and set to open at 150 psig. Capacity shall be sufficient to pass full compressor discharge without developing excessive back pressure.

2.7.4 Air Receivers

Receivers shall be designed for 200 psi working pressure. Receivers shall be factory air tested to 1-1/2 times the working pressure. Receivers shall be equipped with valves and accessories, including pressure gages and automatic and manual drains. The outside of air receivers shall have a commercial enamel finish. Receivers shall be designed and constructed in accordance with the ASME Section VIII, Division 1 and shall have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME code shall be provided.

2.7.5 Intake Air Supply Filter

Dry type air filter shall be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media shall withstand a maximum 125 psi, capacity as indicated.

2.7.6 Pressure Regulators

The air system shall be provided with the necessary regulator valves to maintain the desired pressure for the installed equipment. Regulators shall be designed for a maximum inlet pressure of 125 psi and a maximum temperature of 200 degrees F. Regulators shall be single-seated, pilot-operated with valve plug, bronze body and trim, and threaded connections. The regulator valve shall include a pressure gage and shall be provided with an adjustment screw for adjusting the pressure differential from 5 to 125 psig.

2.7.7 Air-line Lubricators

Air-line lubricators shall be equipped with drip chamber and sight dome for observing oil drop entering air stream, oil-feed adjustment screw, and quick-release collar for bowl removal. Provide with automatic feed device for supplying oil to lubricator.

2.7.8 Refrigerated Air Dryer

A refrigerated air dryer shall be installed downstream of the receiver to remove moisture. The air dryer shall be the refrigerated type. Capacities and characteristics shall be as indicated on the drawings. The dryer shall be equipped with drain connection. The air shall pass through a sufficient number of tubes to effect cooling. Tubes shall be sized to give maximum heat transfer. Cooling capacity of the refrigerated dryer shall be sized for the total capacity of the compressor.

2.7.9 Compressed Air Piping

Piping for the compressed air system shall be black iron, sizes as indicated.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Code

All plumbing work shall be in accordance with the Wisconsin ILHR Plumbing Code, unless otherwise stated.

3.2 GENERAL INSTALLATION REQUIREMENTS

The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended as shown on the drawings. A gate valve on the water service line shall be installed inside the building approximately 6 inches above the floor from point of entry. Water meter shall be installed as specified in SECTION: WATERLINES. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. All exterior underground utilities shall be at least 12 inches below the average local frost depth and as specified in the Wisconsin ILHR Plumbing Code.

3.2.1 Soil, Waste, Drain and Vent Piping

Soil, waste, drain and vent piping shall be of the material indicated in Table 1. Cast-iron soil pipe joints inside buildings shall not be located closer than 6 inches above floors.

3.2.2 Water Pipe, Fittings and Connection

3.2.2.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shut-off valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, shower heads, and flush valves shall be anchored to prevent movement.

3.2.2.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.2.2.3 Protection to Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating

equipment.

3.2.2.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Care shall be taken not to weaken structural portions of the building. Above ground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings will be kept a sufficient distance from other work and other services to permit not less than 2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or prevent flexible movement of the lines. No water pipe shall be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted. Change in direction shall be made with fittings.

3.2.2.5 Pipe Drains

Pipe drains indicated shall consist of 3/4-inch hose bibb with renewable seat and gate valve or full port ball valve ahead of hose bibb. At other low points, 3/4-inch brass plugs or caps shall be provided.

3.2.2.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops where indicated and required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.2.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied. Grooved pipe couplings and fittings shall be prepared in accordance with the manufacturer's latest published specifications according to pipe material, wall thickness, and size. Mechanical couplings may be used in conjunction with grooved pipe for aboveground, ferrous, domestic hot and cold-water systems in lieu of unions, welded, flanges, or threaded joints. Mechanical couplings are permitted in accessible locations including behind access plates.

Mechanical couplings and fittings shall be of the same manufacturer. Unions and flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions.

3.2.3.1 Copper Tube Joints

Joints for copper tubing shall be made with soldered fittings. Solder for water supply lines shall be lead free. Tubes shall be cut square and reamed to remove burrs. Outside surface of the tube where engaged in the fitting, and inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before soldering. Care shall be taken to prevent annealing of tube and fittings when making connections. Solder joints shall be made with flux and wire form or paste-type solder. The flux for solder shall be mildly corrosive liquid or petroleum-based paste containing chlorides of zinc and ammonia. Core solder shall not be used. Excess solder shall be wiped from joint before solder hardens. Joints in copper tube 2-1/2 inches and larger shall be made with heat applied uniformly around the entire circumference of the tube and fittings by a multiflame torch. Excess solder flux on the inside surface of the joint shall be avoided.

3.2.3.2 Copper Tube Extracted Joint

An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Also branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed in accordance with the NAPHCC National Standard Plumbing Code using B-Cup series filler metal in accordance with MSS SP-73.

3.2.4 Dissimilar Pipe Materials

Connections to water heaters and connections between ferrous and copper pipe shall be made with dielectric unions or flanges. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.2.5 Corrosion Protection for Pipe and Fittings

Buried cast iron soil piping and ductile iron pipe and fittings, installed underground, shall be coated and lined in accordance with AWWA C203, AWWA C104 and AWWA C105.

3.2.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.2.6.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular

space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.

a. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4-inch clearance all-around between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, or cast iron pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed with lead wool or with a primer, backstop material and surface preparation as specified in SECTION: CAULKING AND SEALANTS. The annual space between pipes and sleeves may also be filled using Link-seal or an equivalent product. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

3.2.6.2 Flashing Requirements

Pipes passing through roof or floor waterproofing membrane shall be installed through a 4-pound lead flashing or a 16-ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. In addition, a waterproofing clamping flange shall be installed.

3.2.6.3 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 6 inches in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.2.7 Supports

3.2.7.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alinement, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.2.7.2 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts and supports installation shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

3.2.7.3 Types 5, 12 and 26

Types 5, 12 and 26 supports shall not be used.

3.2.7.4 Type 3

Type 3 may be used without saddles or shields on insulated pipe without vapor barrier, if the clamp bottom does not extend through the insulation and the tip clamp attachment does not contact the insulation during pipe movement.

3.2.7.5 Type 18 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

3.2.7.6 Type 19 and 23 C-clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both lockouts and retaining devices, furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.

3.2.7.7 Type 20 Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.

3.2.7.8 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.2.7.9 Type 39 Saddles

Type 39 saddles shall be used on 4 inch and larger insulated pipe.

3.2.7.10 Type 40 Shields

Type 40 shields shall be used on insulated pipe smaller than 4-inch size.

3.2.7.11 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over one foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

3.2.7.12 Vertical Pipe

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

3.2.7.13 Type 35 Support Guides

Type 35 support guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.2.7.14 Alternate Guide Method

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inch, a type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.2.7.15 Type 35 with a Pipe Cradle

Where there are high system temperatures and welding to piping is not desirable, then the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.2.8 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast brass or cast iron ferrule with countersunk cast brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee

branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspout, on each connection to building storm drain where interior downspout are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single-story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

3.2.9 Painting of Pipes, Hangers, Supports and other Iron Work

Painting of pipes, hangers, supports, and other iron work in concealed spaces or exposed, is specified in SECTION: PAINTING, GENERAL.

3.3 FIXTURES AND FIXTURE TRIMMINGS

3.3.1 General

Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets, shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed piping connections from the shut-off or stop valve to the fixture shall be polished chromium-plated copper tubing. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Exposed fixture trimmings and fittings shall be chromium-plated or nickel-plated brass, with polished bright surfaces. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown

3.3.2 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gas tight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.3 Flush Valves

Flush valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve, with approved metal bracket. Flush valves for water closets shall be installed 39 inches

above the floor. Bumpers for water closet seats shall be installed on the wall.

3.3.4 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor. Wall-hung drinking fountains, and water coolers shall be installed with rim 42 inches above floor. Wall-hung service sinks shall be mounted with rim 28 inches above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with ASME A117.1.

3.3.5 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.5.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.5.2 Support for Cellular-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the cellular wall using through bolts and a back-up plate.

3.3.5.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.5.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4-inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

3.3.5.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair carrier manufacturer.

3.3.6 Backflow Prevention Devices

No plumbing fixture, equipment, or pipe connection shall be installed that will provide a cross connection or interconnection between a potable water supply and any source of nonpotable water. The backflow prevention device shall be installed where indicated and located so that no part of the device will be submerged. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.7 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

3.3.8 Traps

Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap. Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast iron soil pipe shall be cast iron. Traps for acid-resisting waste shall be of the same material as the pipe.

3.4 IDENTIFICATION SYSTEMS

3.4.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.4.2 Color Coding

Color coding for piping identification shall be as specified by ASME A13.1.

3.4.3 Color Coding Scheme for Locating Hidden Utility Components

The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks will follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3-foot width, 2-foot 6-inch height, and 1/2-inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16-inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4-inch in diameter and the related lettering in 1/2-inch high capital letters. The color code board

shall be mounted and located in the mechanical or equipment room.

3.5 TESTS, FLUSHING, AND STERILIZATION

The Contractor is responsible for obtaining up-to-date copies of the Minnesota Plumbing Code and other regulations and providing all labor, equipment and material required for performing required tests.

3.5.1 Plumbing System

The plumbing system shall be tested in accordance with the Minnesota Plumbing Code.

3.5.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

3.5.3 System Flushing

After tests are completed, potable water piping shall be flushed. In general, sufficient water shall be used to produce a minimum water velocity of 2.5 feet per second through piping being flushed. Flushing shall be continued until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. After flushing and cleaning, systems shall be prepared for service by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building, due to the Contractor's failure to properly clean the piping system, shall be repaired by the Contractor. When the work is complete, the hot-water system shall be adjusted for uniform circulation. Flush valves and automatic control devices shall be adjusted for proper operation.

3.5.4 Operational Test

Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 4 hours for the complete system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

3.5.5 Sterilization

After pressure tests have been made, the entire domestic hot and cold-water distribution system shall be sterilized. System shall be thoroughly flushed with water of sufficient velocity until all entrained dirt and other foreign material have been removed, before introducing chlorinating material. The chlorinating material shall be either liquid chlorine conforming to AWWA B301 or hypochlorite conforming to AWWA B300. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to insure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being sterilized shall be opened and closed several times during the contact period to insure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6-hour period, no less than 50 ppm chlorine residual shall remain in the tank. The system including the tanks shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. From several points in the system the Contracting Officer will take samples of water in properly sterilized containers for bacterial examination. The sterilizing shall be repeated until tests indicate the absence of pollution for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

TABLE 1

MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item No.	Pipe Materials	SERVICE A	B	C	D
1	Cast iron soil pipe and fittings hub and spigot, ASTM A 74	X	X	X	X
2	Cast iron soil pipe and fittings no-hub pipe and no-hub fittings CISPI 301 and CISPI 310		X		X
3	Ductile Iron Pipe AWWA C150 and AWWA C151	X	X	X	X
4	Ductile iron fittings, AWWA C110	X	X	X	X

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent

TABLE 2

MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe Materials	SERVICE A	B	C
1	Malleable-iron threaded fittings, galvanized, ASME B16.3 for use with Item 2			
2	Steel pipe: a. Seamless, galvanized, ASTM A 53, Type S, Grade B			
3	Bronze flanged fittings, ASME B16.24 for use with Item 4	X	X	
4	Seamless copper pipe, ASTM B 42	X	X	
5	Seamless copper water tube, ASTM B 88	X*	X*	X**
6	Seamless and welded copper distribution pipe Type D ASTM B 641	X*	X*	X**
7	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5 and 6	X	X	X
8	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 5 and 6	X	X	

A - Cold Water Aboveground

B - Hot Water 180^{O}F Maximum Aboveground

C - Cold Water Service Below Ground

* - Type M - Hard

** - Type L - Hard or Type K

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15140

WATERLINES

-- End of Section Table of Contents --

SECTION 15140

WATERLINES

PART 1 GENERAL

1.1 SCOPE

This section covers the furnishing and installation of the water supply lines between buildings, complete with all necessary accessories. This section also covers the water meter.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 42	(1996) Seamless Copper Pipe, Standard Sizes
ASTM B 88	(1996) Seamless Copper Water Tube

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C509	(1994) Resilient Seat Gate Valves for Water and Sewage Systems
AWWA C651	(1992) Disinfecting Water Mains
AWWA C701	(1988) Cold Water Meters - Turbine Type for Customer Service

WISCONSIN ADMINISTRATIVE CODE (ILHR)

ILHR Plumbing Code	(1956, with monthly updates) Rules of Department of Industry, Labor and Human Relations - Plumbing Code

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Hydrostatic Test Wastewater Disposal Method; FIO.

The method proposed for disposal of wastewater from hydrostatic tests and disinfection shall be submitted to the Contracting Officer prior to performing hydrostatic tests.

Work Plan; GA.

The Contractor shall submit a work plan for the water service cut over from the existing building to the new CCS Building. The work plan shall include a description of construction sequencing. This sequencing shall be submitted at least 30 days prior to the beginning of system downtime.

SD-04 Drawings

Water Line Shop Drawings; GA.

Shop drawings shall be submitted and shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system. Shop drawings shall be provided for the complete waterline system and shall include piping layout and location of connections. Shop drawings shall indicate clearances required, along with operation and maintenance requirements. The following shop drawings shall be submitted:

(a) Water line. Submit certificates of compliance.

(b) Layout drawings for the water supply system.

(c) Water meter

(d) Valves, fittings, couplings, sleeves

SD-06 Instructions

Installation Instructions; FIO.

The manufacturer's recommendations for each material or procedure to be utilized shall be submitted. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions.

SD-08 Statements

Statement of Satisfactory Installation; FIO.

Upon completion of the project and before final acceptance, a statement shall be submitted regarding work conformance with contract plans and specifications, and work conformance with manufacturer's recommendations, and satisfactory or unsatisfactory portions of the work. The statement shall be signed by the principal officer of the firm directly responsible for work under this section.

PART 2 PRODUCTS

2.1 GENERAL

2.1.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products.

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used

2.1.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

2.2 MATERIALS

Materials shall conform to the respective specifications and other requirements specified below:

2.2.1 Pipe

Water supply line materials shall be as shown on the drawings. Copper tubing shall be Type K in accordance with ASTM B42 and ASTM B 88. Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 150 psi, and cement-mortar lined in accordance with AWWA C104. Linings shall be standard.

2.2.2 Pipe Sleeves

The annular space between pipes and sleeves shall be watertight. Sleeves shall be provided where piping passes through structural members or concrete. Each joint shall be sealed by a modular mechanical unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. These shall be similar to those manufactured by Link Seal. The interconnected rubber links shall be assembled with Type 316 stainless steel bolts and nuts and Type 316 stainless steel pressure plates under each bolt head and nut in order to prevent the nut from turning when the bolt is tightened. Tightening of the bolts shall cause the rubber sealing links to expand, resulting in a watertight seal between the pipe and wall sleeve opening. Pipe sleeves shall be sized according to the manufacturer's written instructions for the size of pipes shown, and shall withstand a hydrostatic head of 40 feet of water.

2.2.3 Water Meter

Water meter shall be turbine type, suitable for residential and commercial service in accordance with AWWA C701. Meter shall show instantaneous and total readings. Meter shall be cast iron or cast steel.

2.2.4 Check Valves

Check valves shall be designed for a minimum working pressure of 150 psi or as indicated. Valves shall have a clear waterway equal to the full nominal diameter of the valve. Valves shall open to permit flow when inlet

pressure is greater than the discharge pressure, and shall close tightly to prevent return flow when discharge pressure exceeds inlet pressure. The size of the valve, working pressure, manufacturer's name, initials, or trademark shall be cast on the body of each valve. Valves larger than 2 inches shall be iron body, bronze mounted, shall have flanged ends, and shall be the nonslam type. Flanges shall be the 125 pound type conforming to ANSI B16.1.

2.2.5 Gate Valves

Gate valves shall be designed for a working pressure of not less than 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening. Valves shall be iron body, bronze mounted, and shall conform to AWWA C509. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.

2.2.6 Pressure Reducing Valves

Pressure reducing valves shall maintain a constant downstream pressure regardless of fluctuations in demand. Valves shall be suitable for 45 - 60 psi operating pressure on the inlet side, with outlet pressure set for 35 psi. The valves shall be of the hydraulically operated, pilot-controlled, globe or angle type, and may be actuated either by diaphragm or piston. The pilot control shall be the diaphragm-operated, adjustable, spring-loaded type, designed to permit flow when controlling pressure exceeds the spring setting. Ends shall be threaded. Valve bodies shall be bronze, cast iron, or cast steel with bronze trim. Valve stem shall be stainless steel. Valve disks and diaphragms shall be synthetic rubber. Valve seats shall be bronze. Pilot controls shall be bronze with stainless steel working parts.

2.2.7 Miscellaneous Items

2.2.7.1 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.
Hypochlorite, Calcium and Sodium: AWWA B300.

PART 3 EXECUTION

3.1 EXCAVATION, TRENCHING, AND BACKFILLING FOR WATERLINES

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of SECTION: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITY SYSTEMS except as modified herein.

3.2 INSTALLATION

Unless otherwise required, materials and equipment shall be installed in accordance with the manufacturer's written recommendations and the Wisconsin ILHR Plumbing Code. Separation of the sewer line from the water line shall be maintained as stated in the Wisconsin ILHR Plumbing Code. No connection between the water and sewer lines will be allowed. Water line

shall be buried to a minimum depth as specified in the Wisconsin ILHR Plumbing Code and as indicated.

3.2.1 Handling

Pipe and accessories shall be handled so as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. No other pipe or material of any kind shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government.

3.2.2 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable.

3.2.3 Adjacent Facilities

3.2.3.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 6 feet from the sewer. Where waterlines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least 10 feet each side of the crossing shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 3 feet horizontally of the crossing.

3.2.3.2 Waterlines

Waterlines shall not be laid in the same trench with sewer lines, gas lines, or fuel lines.

3.2.4 Penetrations

Pipe passing through walls of valve pits and structures and through concrete floors shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with Link Seal modular sealing units. The closure shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an

absolutely water-tight seal between the pipe and wall opening. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing chances of cathodic reaction between these two members. The Contractor shall determine the required inside diameter of each individual sleeve before ordering, fabricating or installing. The inside diameter of each sleeve shall be sized as recommended by the manufacturer to fit the pipe and closure to assure a water-tight joint. Installation shall be in accordance with the manufacturer's instruction manual.

3.2.5 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

3.3 HYDROSTATIC TESTS

3.3.1 Pressure Test

The newly laid piping or any valved section of piping shall be subjected for 1 hour to a hydrostatic pressure test of 100 psi. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, and valves, discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory.

3.3.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the waterline shall be subjected to 100 psi pressure. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = 0.0001351ND * \mathrm{sqrt}(P)$$

In which:

L = allowable leakage in gallons per hour;
N = number of joints in the pipeline tested;
D = nominal diameter of the pipe in inches; and
P = average test pressure, in psi gage.

3.3.3 Time for Making Test

Except for joint material setting or where concrete reaction backing necessitates a 5 day delay, pipelines jointed with rubber gaskets, mechanical joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill.

3.3.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be satisfactory as specified. All replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

a. Pressure test and leakage test may be conducted concurrently.

b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

3.4 DISINFECTION

Disinfection shall conform to the Wisconsin ILHR Plumbing Code and AWWA C651. Before acceptance of potable water operation, each unit of completed waterline shall be disinfected as specified herein. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to PARAGRAPH: MATERIALS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the waterlines in an approved manner. In no case will the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. From several points in the unit, the Contracting Officer will take samples of water in proper sterilized containers for bacterial examination. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

3.5 CLEANUP

Upon completion of the installation of the waterlines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

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DIVISION 15 - MECHANICAL

SECTION 15149

AUXILIARY WATER SYSTEM

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SECTION 15149

AUXILIARY WATER SYSTEM

PART 1 GENERAL

This section covers the furnishing and installation of the auxiliary water system as shown and specified herein, complete with all necessary equipment and required accessories.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

FEDERAL SPECIFICATIONS (FED. SPEC.)

FED. SPEC. FF-S-325 & Int.Am-3	Shield, Expansion; Nail, Expansion; and Nail Drive Screw (Devices, Anchoring, Masonry)

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI) STANDARDS

ANSI B36.19	(1985) Stainless Steel Pipe.
ANSI B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) PUBLICATIONS

ASME B1.1	(1989) Unified Inch Screw Threads (UN and UNR Thread Form).
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch).
ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges.
ASME B18.2.1	(1996) Square and Hex Bolts and Screws Inch Series.
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts.
ASME BPV IX	(1998) Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 47	(1996) Ferritic Malleable Iron Castings
ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped,Zinc Coated Welded and Seamless.
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A 126	(1995) Gray Iron Castings for Valves, Flanges and Pipe Fittings.
ASTM A 153	(1995) Zinc Coating (Hot-Dip) on Iron Steel Hardware.
ASTM A 276	(1998) Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 psi Tensile
ASTM A 312	(1995a) Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A 325	(1997) High-Strength Bolts for Structural Steel Joints
ASTM A 403	(1996) Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 536	(1984) Ductile Iron Castings
ASTM A 575	(1989) Steel Bars, Carbon, Merchant Quality, M Grades
ASTM A 576	(1990b) Steel Bars, Carbon, Hot-Wrought, Special Quality.
ASTM D2000	(1995) Standard Specification System for Rubber Products in Automotive Applications.

AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARDS

AWWA C500	(1993) Metal Sealed Gate Valves for Water Systems.
AWWA E101	(1988) Vertical Turbine Pumps - Line Shaft and Submersible Types

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS) STANDARDS

MSS SP-44	(1996) Steel Pipe Line Flanges.

MSS SP-58	(1993) Pipe Hangers and Supports-Materials, Design and Manufacture.
MSS SP-67	(1995) Butterfly Valves.
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application.
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends.
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) STANDARDS

NEMA MG 1	(1993) Motors and Generators.

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts Data; FIO.

After approval of the shop drawings, the Contractor shall furnish spare parts data for each different item of materials and equipment specified. This list of spare parts shall be included in the operation and maintenance manual. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. The list of parts and supplies shall indicate by an asterisk (*) or other defined mark, those parts subject to severe wear that the Government should keep on hand as spare parts.

SD-04 Drawings

Shop Drawings; GA.

Shop drawings shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams and other information to illustrate the requirements and operation of the system. Shop drawings shall be provided for the complete auxiliary water system and shall include piping layout and location of connections, schematic diagrams and wiring diagrams, concrete slab details, and anchoring details. Shop drawings shall indicate clearances required for maintenance and operation at the hose cabinets. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support method. The name of the auxiliary water system supplier/installer shall be furnished.

Pump Data and Shop Drawings: The Contractor shall, within 45 days after receipt of notice to proceed, submit to the Contracting Officer for approval, the following data and shop drawings for the auxiliary water system. Shop drawings shall be submitted together in a single package.

a. Complete shop drawings of the pump, including an assembly drawing

or drawings of the pump and driving motor, cut away as necessary, including shop drawings of the driving motor itself. Provide capacity-head curves for the pump. Shop drawings shall also contain complete wiring, control, and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. All details on the control system, including the combination starter and disconnect and control panel, shall be provided. Motor power factor at full load and rated voltage, full load speed, and full load current data shall be provided.

b. Drawings and details showing the method of anchoring the base plate to the top of lock wall and pump mounting. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

c. A performance curve, whose accuracy is certified, in writing, by an officer of the company manufacturing the pump, shall be provided. The curve shall show total head, brake horsepower and efficiency as ordinates, plotted against capacity in gallons per minute as abscissa.

d. Factory test report. A complete factory test report shall be provided in accordance with Paragraph: Factory Test.

e. Literature, catalog cuts, and similar information, all numbered to agree with the list shown on the shop drawings, describing components, auxiliaries and accessories purchased by the pump manufacturer from other manufacturers, and indicating their current production status.

f. Drawings and catalogue cuts detailing the construction, design, and performance parameters of the hose stations, hose station supports, hose reels, nozzles, hose, all valving, fittings, piping, pipe supports, heat tracing, attachment of heat tracing to pumps, and gages.

g. Listing of 10 installations with the proposed pump installed.

h. Any additional drawings, covering installation and dismantling.

The shop drawings shall show in detail the materials, design, method of construction, and lubrication of the pumping unit, and such other information as may be necessary for the Contracting Officer to evaluate the proposed pump. The shop drawings shall show and/or plainly describe the procedure to be used for both assembly and disassembly of the pumping unit and shall include a complete and itemized list of all parts, showing the grade and class of material to be used or the make of standard article proposed to be furnished. Parts shall be referenced to the assembly drawings. All materials referred to on the shop drawings shall be described by reference to industry standards, ASTM specification, Federal specifications, and other applicable standard specification. Other manufacturers' products shall be identified in the shop drawings itemized list either by catalog number or an equivalent alternative method.

SD-08 Statements

Storage Plan; FIO.

Contractor shall submit a storage plan as described in Paragraph: PREPARATION FOR SHIPMENT AND STORAGE.

Warranty; FIO.

The Contractor shall furnish the Government, under separate cover, the manufacturer's standard commercial warranty for the following items:

(a) Hoses and nozzles.
(b) Hose reels.
(c) Vertical Turbine pumps.
(d) Control equipment for the pump.

SD-09 Reports

Performance Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

SD-19 Operation and Maintenance Manuals

Operating and Maintenance Instructions; FIO.

Operating and Maintenance Instructions. The Contractor shall furnish to the Contracting Officer 5 complete copies of operating and maintenance instructions outlining the step-by-step procedures required for system start-up, operation and shutdown. The instructions shall include the manufacturer's name, model number, catalog cuts, diagrams, drawings, parts list, and descriptive data covering the proper operation and testing. Manual shall list routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. The instructions shall include simplified diagrams for the system as installed. All finalized shop drawing information shall be included in the operation and maintenance manual. Factory test results and performance curves shall also be included in the manual.

Framed Instructions; FIO.

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed by the Government. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Instructions for energizing the heat tracing on the pumps shall be included. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The framed instructions shall be posted before acceptance testing of the systems.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Material and equipment shall be the standard products of a manufacturer

regularly engaged in the manufacture of such products. Equipment shall essentially duplicate equipment that has been in satisfactory operation at least 2 years prior to bid opening. Equipment shall be supported by a service organization. The pumps furnished under this contract shall be the product of a pump manufacturer who has produced at least 50 units of this type of pump. At least 10 of these units shall be in use and operating satisfactorily.

2.1.2 Coordination

The complete auxiliary water system shall be furnished and installed by a single supplier/installer. This sub-contractor shall furnish and install the pumps, piping, valving, hose cabinets, all electrical controls, starter, wiring, and electrical conduit. The auxiliary water supplier/installer may use additional sub-contractors. The combination starter/disconnect shall be furnished by the pump supplier. All shop drawings will be rejected unless the work of this section is properly coordinated.

2.1.3 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

2.1.4 Nameplates

Pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be made of corrosion resisting metal with raised or depressed lettering and contrasting background.

2.1.5 Instruction Plates

As necessary, each item of equipment shall be equipped with suitable located instruction plates, including any warnings and cautions describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Plates shall be made of corrosion-resisting metal with raised or depressed lettering and contrasting background.

2.1.6 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. Specific items to verify include the location of the existing pump guards in the tainter valve bulkhead recess slots.

2.1.7 Identification Tags

Identification tags made of brass, engraved laminated plastic or engraved anodize aluminum, indicating service and valve number shall be installed on valves. Tags shall be 1-3/8 inch minimum diameter and making shall be stamped or engraved. Indentations shall be black for reading clarity. Tags shall be attached to valves with No. 12 AWG copper wire, chrome plated beaded chain or plastic straps designed for that purpose.

2.2 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective publications and other requirements specified herein.

2.2.1 Bolts and Nuts

Squarehead Bolts and Heavy Hexagon Nuts shall be in accordance with ASME B18.2.1 and ASME B18.2.2 and material in accordance with ASTM A 307, ASTM A 325, ASTM A 575 or ASTM A 576.

2.2.2 Flanges

Dimensions in accordance with ASME B16.1 or MSS SP-44 and material in accordance with ASTM A 126.

2.2.3 Gages

ANSI B40.1, Grade B.

2.2.4 Gaskets

Flange Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thickness, full face or self centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrite butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service.

2.2.5 Lubricant

2.2.5.1 Gasket Lubricant

Gasket lubricant shall be as recommended by the pipe manufacturer.

2.2.5.2 Thread-cutting Oil

Thread-cutting oil shall be an all-purpose lubricant free from animal or vegetable compounds.

2.2.6 Pipe

2.2.6.1 Carbon Steel Pipe

Carbon steel pipe shall be galvanized, Schedule 40, seamless in accordance with ASTM A 53.

2.2.6.2 Stainless Steel Pipe

Stainless steel pipe shall be Schedule 40, Type 304 or 316 stainless steel, full annealed, pickled and passivated, as-welded grade, in accordance with ASTM A 312 and ANSI B36.19.

2.2.7 Joints

2.2.7.1 Stainless Steel Pipe

All joints shall be roll or cut grooved, except where indicated on the drawings.

2.2.7.2 Galvanized Steel Pipe

All joints shall be roll or cut grooved, except where indicated on the drawings.

2.2.7.3 Flanges

Flanges shall conform to ASME B16.1 and MSS SP-44, and shall be used only on the pump discharge connections as shown on the drawings. Flanges shall be class 150.

2.2.7.4 Pipe Threads

Pipe threads shall conform to ASME B1.20.1 and shall be used where shown on the drawings.

2.2.7.5 Flexible Connector (Pump Discharge)

Flexible connector shall be 2-inch with 304 stainless steel grooved shanks on each end. Shanks shall be fastened to the hose with permanently pressed on 304 stainless steel ferrules. Expansion joint shall be 304 stainless steel with 304 stainless steel braid and shall relieve elongation, compression, and transverse and angular movement. The expansion joint shall be rated for 150 psig service at 100 degrees F. Flexible connector shall be similar to Gustin Bacon Series 405 or approved equal.

2.2.8 Pipe Fittings

All pipe couplings and fittings shall be compatible with one another.

2.2.8.1 Galvanized Pipe Fittings

Malleable-iron fittings shall be galvanized, grooved, and conform to ASME B16.3, type to match adjacent pipe.

2.2.8.2 Stainless Steel Fittings

Stainless steel fittings shall be Schedule 40, Type 316 stainless steel with grooved ends. Fittings shall be in accordance with ASTM A 403, Class WP, Gr. 316.

2.2.8.3 Couplings

Couplings shall be of the same style and manufacturer. Provide Victaulic Style 77 standard coupling, Gustin Bacon #100, or approved equal. Housing shall be hot dipped galvanized steel conforming to ASTM A 47 and ASTM A 123 and shall have no more than two fasteners. Fasteners shall be type 304 stainless steel track head type bolts with 304 stainless steel hex nuts and washers. Fasteners shall be adjustable with a single tool without a need to restrain rotating components. Coupling gasket shall be Victaulic or equal, Grade "E" molded EPDM, per ASTM D2000. Coupling shall have an internal pressure rating of 500 psig for Sch. 10 and 750 psig for Sch. 40. The coupling design shall permit removal of pipe sections by loosening and sliding the couplings and gaskets away from the joints without the need for complete disassembly. All fasteners shall be accessible from a single transverse direction.

2.2.9 Pipe Hangers, Inserts, and Supports

Conventional pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69. Special hangers and supports shall be as shown on drawings.

2.2.9.1 Offset Clamps

All offset clamps shall be type 316 stainless steel, Grinnel Co. Figure 103, Gulf State Hanger #88A, or approved equal. The mounting holes shall match the expansion anchor size.

2.2.9.2 Expansion Anchors

All concrete expansion anchors shall be cinch type, 316 stainless steel, conforming to FED. SPEC. FF-S-325, Group II, Type 4, Class 1. Hole size shall be the bolt hole size and 316 stainless steel nuts and washers shall be provided. Lock washers shall be supplied with the expansion anchors in place of plain washers. Corresponding sizes and lengths shall be as follows:

Anchor Size	Length
1/2 in.	5-1/2 in.

2.2.10 Valves

2.2.10.1 Butterfly Valves

Provide 150 lb., flanged, butterfly valves on the pump discharge line in accordance with MSS SP-67. Valve shall have a ductile iron body, nickel or cadmium plated iron disk, and a stainless steel stem. Valve shall positively lock every 10 to 15 degrees from opening to closing position.

2.2.10.2 Gate Valves

Gate valves shall be heavy duty, iron body, 150 lb., and in accordance with MSS SP-80, MSS SP-70, and AWWA C500. Seats shall be integral with the valve and made from stellite, stainless steel, or monel.

2.2.10.3 Hose Cabinet Angle Valve

A handwheel operated, bronze-bodied, bronze-mounted, adjustable pressure restricting, angle valve shall be installed in each hose cabinet as indicated on drawings.

2.2.10.4 Relief Valve

The pressure relief valve shall be manually adjustable NPT threaded type, set to open at 150 psig and close at 142 psig minimum. Its capacity shall be sufficient to pass the full pump discharge without developing excessive pressure. The relief valve shall have a brass body, stainless steel spring, brass or stainless steel trim and a teflon seat. Valve shall be installed so that it may be removed without disturbing the overflow cone discharge piping.

2.2.10.5 Combination Air Valve (Pump)

The combination air valve shall be designed to release air at the pump discharge when the system is being filled and relieve vacuum when the system is being emptied. It shall have a cast iron body, stainless steel float, stainless steel or brass and bronze trim, threaded connections and shall be rated for 300 psig. The valve shall be piped as shown. The air release valve shall be the float operated type.

2.2.10.6 Combination Air Valve (Hose Reel)

The combination air valve shall be designed to release air at the hose reel

when the system is being filled and relieve vacuum when the system is being emptied. The valve shall have a cast iron body, stainless steel float, stainless steel or brass and bronze trim, threaded connections, and shall be rated for 300 psig.

2.2.10.7 Pressure Gage

A pressure gage shall be furnished and installed at the pump discharge for air and water service. The pressure gage shall meet the applicable requirements of ANSI B40.1. Scale range shall be as indicated on the drawings with scale graduation of 5 psi. Gage shall have a bottom connection with either a brass or phenolic case and shall be suitable for mounting in a tapped hole or on a threaded pipe nipple. Gage shall have an accuracy Grade B, with 4-1/2-inch nominal diameter.

2.2.11 Hose Station

Hose stations shall be constructed, furnished and installed for the lock as indicated on the drawings. The drawings indicate the general dimensions and construction of the hose stations. The Contractor shall be responsible for the final design and dimensioning of the hose stations. Each hose station shall consist of a weather proof red enameled steel cabinet, hose reel, 150 feet of 1-1/2" diameter hard rubber continuous flow hose, spray nozzle, and angle valve. The hose station shall allow complete hose removal and retrieval. Hose cabinet shall allow for ventilation.

2.2.11.1 Hose Reels

Hose reels shall be painted per the manufacturer's standard coating method. Color of the hose reels shall be red. Reels shall have a capacity of not less than 150 feet of 1-1/2 inch inside diameter continuous flow hose as specified in paragraph 2.2.11.2. The frame shall be designed for horizontal mounting. The reel shall have a 2 inch NPT inlet connection and a 1-1/2 inch discharge hose fitting. A removable crank shall be provided for rewinding. The Contractor shall coordinate the location of the crank with the construction of the hose cabinet for proper operation and fit.

2.2.11.2 Hose

Continuous flow hose shall be 2 braid oil resistant rubber tube type with flexibility in sub-zero Fahrenheit weather, abrasion resistance and ozone resistance. Hose shall be a fuel delivery type, 150 feet long, with a 1-1/2 inch inside diameter and have a minimum working water pressure rating of 150 psig. The hose shall be compatible with the reel specified in paragraph 2.2.11.1. Hose discharge fitting and coupling shall be provided for nozzle attachment.

2.2.11.3 Nozzle

Nozzles shall be heavy duty, industrial, aluminum alloy construction, 1-1/2 inch size, fog type, and adjustable from spray to stream to shutoff. Nozzle shall be sized for the pump rating. Threads shall be compatible with the hose discharge fitting. A molded rubber bumper shall be integral with the nozzle.

2.2.11.4 Hose Storage Cabinet

The Contractor shall be responsible for the final dimensioning of the cabinet. The hose storage cabinet shall be made of 14 ga. red enameled

steel. The cabinet shall be shipped completely assembled with hasp, door catch and continuous piano type hinges. The hose storage cabinet shall be similar to that which is shown on contract drawings. Cabinet shall be supplied with ventilation louvers. Louvers shall be screened to prevent insects from entering the cabinets.

2.2.11.5 Flexible Connector (Hose Cabinet)

Flexible connector shall be 2 inch (or sized to match the hose reel inlet pipe) with threaded union ends of cast steel. Expansion joint shall be of neoprene or butyl reinforced with multiple piles of nylon and shall relieve elongation, compression, and transverse and angular movement. The expansion joint shall be rated for 150 psig service at 100 degrees F.

2.2.12 Valve Boxes

Valve boxes shall be as specified in SECTION: WATERLINE.

2.3 PUMPING UNIT

2.3.1 General

The pump and motor shall be suitable for outdoor and unprotected service and shall be constructed in accordance with AWWA E101. The pump shall be the multi-stage, enclosed line shaft, vertical turbine type. Pumps shall be furnished complete with combination starter and disconnect and push-button start/stop control as shown on the drawings.

2.3.2 Pump Capacity

The pump shall have a capacity of not less than 90 gallons per minute against a total head of 270 feet of water at the pump discharge flange. At this capacity, the BHP requirement shall be such that the pump may be driven by a 10 horsepower motor without exceeding the name plate rating. The maximum pump speed shall be 1800 RPM.

2.3.3 Pump Head

A pump head of high grade cast-iron shall be provided for mounting the motor and supporting the pump column, bowls, suction pipe, and strainer. It shall also incorporate the flanged, aboveground, horizontal discharge outlet. The discharge outlet flange shall be drilled for 150-lb. service in accordance with ASME B16.1. The pump head shall also accommodate the stuffing box and the lubrication provisions. The pump head shall be supported by, and firmly secured to, a separate base plate having a center opening large enough to permit setting and removing the pump without disturbing the base plate. Suitable bearing plates and bolts shall be provided and installed for securely anchoring the base plate to the pump mounting bracket.

2.3.4 Pump Column

The pump column size shall be such that the friction loss will not exceed five feet per 100 feet based on the specified pump capacity. The pump column shall be of standard weight (Schedule 40) black steel pipe. The upper end of the top column section shall be factory machined and fitted for connection to the pump head and base plate in such a manner that no field cutting or machine work will be required. The bottom column section shall have a fitted connection to the pump bowls at the lower end. The

Contractor shall supply the necessary corrosion protection and/or paint system for the pump column. Paint system shall allow for underwater immersion application.

2.3.4.1 Pressure Gage

The Contractor shall provide a pressure gage as shown on the drawings at the top of the pump column. The Contractor may also elect to place the pressure gage in the pump discharge line before the relief valve.

2.3.5 Lineshaft

The lineshaft shall be ASTM A 576 Gr 1045 carbon steel and shall be furnished in interchangeable five-foot sections. Sections shall be connected by having adjoining sections butt within steel couplings, bored and threaded from solid stock, and which shall be designed for a safety factor of 1-1/2 times the shaft safety factor. The coupling shall be threaded so that they tighten during pump operation. Each five-foot section shall be straight within a total indicator reading of 0.003-inch. The butting face shall be machined square to the axis of the shaft section. The maximum possible axial misalignment of the thread axis with the shaft axis shall be 0.002-inch in six inches.

a. Each pump shall be provided with a shaft enclosing tube to cover the intermediate shaft and couplings. It shall be rigid enough to be self-supporting.

b. Each pump shall be provided with sleeve type lineshaft bearings designed for oil lubrication. Bearing shall have a bronze lining in contact with the shaft journal and shall be removable. Bearing liner shall be arranged for maximum distribution of oil at the journal surface.

2.3.6 Pump Bowls

The pump bowls shall be of close grained cast-iron without blow holes, sand inclusion, or other defects. They shall have accurately machined mating surfaces, and the interior shall be smoothly finished. They shall be capable of withstanding a hydrostatic pressure of not less than either 1-1/2 times the shutoff head or twice the specified discharge pressure, whichever is greater. An adapter casting shall be provided to connect the discharge nozzle to the column pipe. The discharge nozzle shall have vanes to deliver the flow of water with minimum turbulence. A long main bearing box, machined for accurate alignment, shall be located in the discharge nozzle to act as a shaft bearing. The intermediate stages shall be selected to provide maximum efficiency with the fewest number of stages. Bushings throughout shall be the long-sleeve type and of a suitable bronze alloy. Bowl bearings shall be neoprene and designed for water lubrication.

2.3.7 Impellers and Impeller Shaft

The impellers shall be the enclosed type, made of a suitable bronze alloy, finished all over and statically and dynamically balanced. They shall be securely fastened to the impeller shaft with either keys, tapered bushings, or locknuts. The impellers shall be adjustable vertically, as specified in Paragraph: Motor. The impeller/pump shaft shall be ASTM A 276, Type 416 or 420 stainless steel with a ground finish and supported in bearings above and below each impeller. A wear ring system shall be provided for the impeller.

2.3.8 Suction Strainer

A basket-type strainer of SAE 40 BRZ designed for use with vertical turbine pumps, shall be provided. The net inlet area of the strainer shall be a least four times the cross-sectional area of the suction connections.

2.3.9 Motor

The motor shall be a full voltage starting, 10 hp, vertical, totally enclosed fan cooled, hollow-shaft, squirrel-cage, induction type, shall operate at not more than 1,800 rpm. and shall conform to the applicable requirements of the NEMA MG 1 Publication. The motor shall be provided with an antifriction thrust bearing ample capacity to carry the full weight of all rotating parts plus the maximum hydraulic thrust. The motor shall be capable of driving the pump continuously at the specified capacity and head condition point without exceeding the name plate horsepower rating. The motor shall be capable of reverse rotation due to the maximum pump head without damage. The motor shall be suitable for operation on a 460 volt, three-phase, 60 Hz circuit. The conduit and wiring between the starter/disconnect and the pump motor shall be as indicated in SECTION: LOCK ELECTRICAL WORK. The combination starter/disconnect shall be furnished by the pump manufacturer.

2.3.9.1 Motor Starter

Combination starter shall be installed in a NEMA 4X stainless steel enclosure. See SECTION: POWER DISTRIBUTION EQUIPMENT for further requirements on the starter.

2.3.10 Heat Tracing for the Pump Column

The pump column and pump bowls shall be wrapped with parallel circuitry/constant wattage heat tape as shown on the drawings. Heat tracing(tape) shall be suitable for pipe tracing applications and conform to irregular surfaces. Provide heat tape rated at 12 watts per foot. Jacket of heat tape shall be polyolefine or a fluoropolymer material. Heat tape shall be provided with nickel plated copper overbraid and silicone rubber overjacket. Attachment of the heat tracing to the pump column and pump bowls shall be as recommended by the heat tracing manufacturer.

2.3.11 Nameplates

Pumps and motors shall have a standard nameplate securely affixed in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, the nameplate for each pump shall show the capacity in gpm at rated speed in rpm and head in feet of water. Nameplate for each electric motor shall show at least the minimum information required by NEMA MG 1-10.39. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplate.

2.3.12 Pump Fittings

Pump discharge fittings shall be arranged as shown on the drawings. Pump and motor shall be provided with lifting lugs.

2.3.13 Pump Testing

2.3.13.1 Factory Pump Test

Witness testing of the pumps shall not be required, however, a factory certification of the pumps shall be submitted. Factory pump test shall be made in conformance with AWWA E101 and Hydraulic Institute Standards. No pumps shall be delivered without approval of the factory test. The following data shall be provided:

a. Running test. Show pump curve with total head, NPSH, and efficiency as ordinates. Plot against pump discharge in gallons per minute on the abscissa. Document any pump instabilities or anomalies.

b. Provide any sample calculations from test readings.

c. Provide any data on shop inspection of the pump.

d. Hydrostatic test of bowl assembly.

e. Hydrostatic test of discharge head.

f. Describe test procedures on the pump.

g. Discuss test results and conclusions.

h. Provide any pictures of pump and test set-up.

2.3.14 Spare Parts

All spare parts shall be duplicates of the original parts furnished and shall be interchangeable with those parts. The following spare parts shall be provided:

a. One set of wear rings and set of seals for one pump.

b. One set of bowl bearings and lineshaft bearings for one pump.

c. Provide sufficient packing for one pump.

2.3.15 Equipment Appurtenances

2.3.15.1 Attachments

All necessary bolts, nuts, washers, bolt sleeves, and other types of attachments for the installation of the equipment shall be furnished with the equipment. Bolts shall conform to the requirements of ASTM A 307 and nuts shall be hexagonal of the same quality as the bolts used. Threads shall be clean-cut and shall conform to ANSI B1.1. Bolts, nuts, and washers specified to be galvanized or not otherwise indicated or specified, shall be zinc coated after being threaded, by the hot-dip process conforming to ASTM A 123 or ASTM A 153 as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel shall be Type 316.

2.3.15.2 Tools

A complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of equipment shall be furnished. Special tools are considered to be those tools which because of

their limited use are not normally available, but which are necessary for the particular equipment. Special tools shall be high-grade, smooth, forged, alloy, tool steel. One pressure grease gun for each type of grease required for motors shall also be furnished. All tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such tools until completion of the work, at which time they shall be delivered to the Contracting Officer.

2.3.15.3 Shop Painting

All motors, pump casings, and similar parts of equipment customarily finished in the shop shall be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. The pumps and motors shall have the manufacturer's standard finish. Ferrous surfaces not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

2.4 PREPARATION FOR SHIPMENT AND STORAGE

2.4.1 Preparation for Shipment

Prior to shipment from the manufacturers' and/or fabricators' plants, the Contractor shall prepare the various elements of the auxiliary water system for shipment as described herein. All large, bulky, and/or heavy items shall be mounted on skids or pallets of ample size and strength to facilitate loading and unloading. All small parts, including valves and fittings, shall be boxed in sturdy wood or heavy corrugated paperboard boxes. A packing list, indicating the contents of each such box and enclosed in a moisture proof envelope, shall be securely fastened to the outside of the box. The skid and/or pallet mounting and the boxing shall be done in a manner which will prevent damage to the equipment during load, shipment, unloading, storage, and any associated and/or subsequent handling. Weatherproof covers shall be provided during shipment to protect all items which the Contracting Officer designates as requiring such protection. Any special slings, strongbacks, skidding attachments, or other devices used in loading the equipment at the manufacturers' and/or fabricators' plants shall be furnished for unloading and handling at the destination.

2.4.2 Preparation for Storage

The pumps, hose, nozzles, racks, reels, fittings, valves, accessories, and appurtenances shall be processed in accordance with the manufacturer's normal procedure for export shipment and storage. If no such procedure exists, the manufacturer shall furnish for approval, in accordance with SECTION: SUBMITTAL PROCEDURES, a complete description of the processing method or methods he intends to use, including complete instructions for maintaining the protection during the storage period. All pipe shall have temporary pipe plugs installed on each end to protect the pipe from damage.

2.4.3 Storage

Upon delivery at the worksite, all elements of the auxiliary water system shall be stored in a weathertight building. The Contractor shall submit a detailed description of the proposed storage facilities, and a plan for storage maintenance and inspection, before any storage actually begins. Any special procedures for the pumps shall be indicated. All piping shall be stored on wood blocking.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Welding Procedures

Welding shall be done in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX, Boiler and Pressure Vessel Code, Section IX and AWS D1.1. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

3.2 INSTALLATION

3.2.1 Installation

Unless otherwise indicated or specified, all materials and equipment shall be installed in accordance with the manufacturer's recommendations. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Each pump shall be installed in accordance with the written instructions of the manufacturer.

3.2.2 Personnel Protection

Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts, shall be so located as to be fully enclosed or guarded to prevent accidental personal contact therewith.

3.2.3 Pipe and Fittings

3.2.3.1 Pipe Materials by Location

Unless otherwise indicated on the drawings, piping installed on the lock wall shall be galvanized with grooved ends. Piping embedded in concrete shall be stainless steel with grooved ends.

3.2.3.2 Joints

Flanged joints shall be provided at the pump discharge. Threaded joints shall be provided where indicated. Grooved joint coupling system shall be provided for pipe embedded and mounted on the lock wall.

a. Threaded joints shall be cut with an approved thread-cutting oil. Joints shall be made tight with a stiff mixture of litharge and glycerin or other approved thread-joint compound or tape. Not more than three threads shall show after the joint is made up.

b. Flanged joints shall be faced true, provided with gaskets and made square and tight.

3.2.3.3 Reducers

Reductions in pipe sizes shall be made with one-piece reducing fittings. Bushings will not be acceptable, except that when standard fittings of the proper size are not available, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings

shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 2 inch.

3.2.3.4 Dielectric Joints

Dielectric fittings shall be installed between threaded ferrous and nonferrous pipe, fittings and valves. Bolt insulation kits shall be used for dissimilar flanges. Dielectric joints shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

3.2.3.5 Placing and Laying

Pipe and accessories shall be carefully lowered into the trenches. Under no circumstances shall any of the water-line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Water shall be kept out of the trench and piping until joining is completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipe or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped and anchored, as shown.

3.2.3.6 Trenching

Trenching shall be performed in accordance with applicable requirements of SECTION: EXCAVATING, TRENCHING, AND BACKFILLING FOR UTILITY SYSTEMS.

3.2.3.7 Pipe Supports, Inserts, and Hangers

Piping shall be supported in accordance with the manufacturer's recommendations, MSS SP-58 and MSS SP-69, and as shown on the drawings. Where galvanized piping is being supported by stainless steel offset clamps, provide a rubber sleeve between the clamp and pipe.

3.2.4 Drains

The auxiliary water system shall be provided with complete drainage facilities and sloped as indicated.

3.2.5 Cleaning

Before acceptance of the auxiliary water system, each unit of the completed system shall be cleaned as specified. After pressure tests have been made, the unit to be cleaned shall be thoroughly flushed with water until all entrained dirt and mud have been removed.

3.2.6 Signage

Post sign on hose reel cabinet stating; "NON-POTABLE WATER."

3.2.7 Tests

After the piping is installed, but before acceptance of the installation and before any pipe is buried or entrenched, the Contractor shall operate the system to determine if it has been properly manufactured, assembled, and installed and that it meets the requirements of these plans and

specifications. Tests shall be conducted as specified herein, and the Contractor shall notify the Contracting Officer at least five days prior to commencing the testing, or any phase thereof. Tests shall be performed to demonstrate satisfactory functional operation of the vertical turbine pumps, including its lubrication system and associated motor control equipment. Each hose station shall be operated. Each drain valve shall be operated to demonstrate proper drainage of its associated system piping. Prior to these tests, the entire system shall be tested at a hydrostatic pressure of 150 psig and proved tight at this pressure for a period not less than two hours in order to permit inspection of all joints. Any portion of the system which will be embedded in concrete or otherwise concealed, shall be tested, prior to such embedment or concealment, separately in the same manner as prescribed for the entire system. Any defects in work or material discovered during tests shall be repaired. Repairs shall be made with new material.

3.2.7.1 Field Pump Test

After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly. Each pumping unit shall be given a running field test in the presence of the Contracting Officer for a minimum of 2 hours. Each pumping unit shall be operated at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. The Contractor shall provide an accurate and acceptable method of measuring the discharge flow.

3.2.8 Field Training

The auxiliary water supplier/installer shall schedule 3 hours of field training for the lock force. The training shall cover all aspects of the auxiliary water system including pumps, hose cabinets, drainage, etc. Any special requirements for the system shall be addressed. Lubrication and maintenance of the pump and operation of the heat tracing system shall be covered. Any questions from the lock forces shall be addressed.

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DIVISION 15 - MECHANICAL

SECTION 15150

SANITARY SEWER

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SECTION 15150

SANITARY SEWER

PART 1 GENERAL

The work covered by this section of the specifications consists of furnishing all materials, labor, plant and equipment, and performing all operations for installing the sewer line from new buildings to the septic tanks.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS

ASTM A 746	(1994) Ductile Iron Gravity Sewer Pipe

AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARDS

AWWA C104	Cement Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water
AWWA C110	Ductile-Iron and Gray-Iron Fittings 3-inch to 48-inch for Water and Other Liquids
AWWA C111	Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C151	Ductile Iron Pipe, Centrifugally Cast for Water and other Liquids

WISCONSIN ADMINISTRATIVE CODE (ILHR)

ILHR Plumbing Code	(1956, with monthly updates) Rules of Department of Industry, Labor and Human Relations - Plumbing Code

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Sewer Shop Drawings; GA.

Before starting installation of any materials or equipment, the Contractor shall prepare and submit to the Contracting Officer, for approval, complete shop drawings of all work covered by this section of the specifications which requires fabrication. Where materials or equipment are standard

stock products of manufacturers, full descriptive data shall be submitted, including catalog cuts and specifications. These shop drawings shall include as a minimum the following drawings and catalog cuts:

a. Pipe materials and fittings. Include certificates of compliance.

b. Layout drawings of the sewer system.

PART 2 PRODUCTS

2.1 MATERIALS

The following materials shall conform to the respective specifications and other requirements specified below.

2.1.1 Pipe

2.1.1.1 Ductile Iron Pipe

The sanitary sewer pipe shall conform to ASTM A 746 and AWWA C151. The pipe and fittings shall be cement mortar lined and said lining shall conform to AWWA C104. Piping shall be asphalt coated per AWWA C104. The joints shall be push-on and conform to AWWA C111. Fittings shall conform to AWWA C110. The loading, unloading, and installation of the pipe shall be performed so as to avoid damage to the pipe lining. Any lining which is damaged shall be satisfactorily repaired by the Contractor at no additional cost to the Government. If grappling hooks are inserted into the ends of the pipe for lifting, they shall be rubber covered and have a broad rounded surface to distribute the load over at least two square inches of the pipe lining.

2.1.2 Joints

Joints shall be push-on type.

2.1.2.1 Ductile Iron Pipe

Rubber ring gaskets conforming to AWWA C111.

PART 3 EXECUTION

All work shall conform to the Wisconsin ILHR Plumbing Code.

3.1 GENERAL

The gravity sewer, cleanout, and all appurtenances shall be installed as shown on the drawings and conform with this section of the specifications. The installation required herein and payment thereto of sewer connections and appurtenances shall begin at the point shown on the drawings. Work covered by this section will not be accepted until backfilling connected with the work has been completed satisfactorily. Any section of sewer pipe that is found defective in material, alignment, grade, or joints before acceptance shall be satisfactorily corrected by the Contractor at no additional cost to the Government.

3.2 PIPE INSTALLATION

3.2.1 General

Excavation and backfilling of trenches shall conform to the applicable provisions of SECTION: EXCAVATION, TRENCHING, AND BACKFILL FOR UTILITY SYSTEMS. The sewer line shall be installed to the elevations shown on the drawings. All piping shall be installed according to manufacturers standard procedures and recommendations. The laying of bell-and-spigot pipe with rubber gasketed joints shall proceed in the direction of flow with the spigot ends of bell-and-spigot pipe pointing in the direction of flow.

3.2.2 Cross Connections

No connection between the water line and the sewer system will be permitted.

3.2.3 Separation and Crossings of Water Lines and Sewer Lines

Crossings of water lines and sewer lines shall conform to the requirements of SECTION: WATERLINES and the Wisconsin ILHR Plumbing Code.

3.2.4 Tests

The Contractor shall perform a leakage test on the completed sewer line. Leakage test shall conform to the Wisconsin ILHR Plumbing Code. The test shall be either by hydrostatic or air testing means as described herein and shall be performed in the presence of the Contracting Officer.

3.2.4.1 Hydrostatic Test

The gravity sewer line shall be tested for leakage by either infiltration or exfiltration tests, as appropriate. Prior to testing for leakage the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is two feet or more above the top of the pipe at the upper end of the pipe line section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. When the Contracting Officer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with potable water so that a head of at least two feet is provided above both the water table and the top of the pipe at the upper end of the pipe line to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re-established. The amount of water required to maintain this water level during a two-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 200 gallons per inch diameter per mile of pipe line per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government. If the tests indicate doubt as to the tightness of the lines installed, the Contracting Officer may direct that additional tests be made. If such additional test results indicate leakage in excess of that allowed, the cost of the additional tests shall be borne by the Contractor; otherwise, the test will be paid for in accordance with Contract Clause "Changes". The Contractor shall provide all necessary equipment and labor to satisfactorily perform the

test.

3.2.4.2 Air Test

Air tests shall be performed in accordance with the provisions of SECTION: PLUMBING.

3.2.5 Flushing

All sewer lines shall be flushed with sufficient water to clean out all debris.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15190

FUEL OIL SYSTEM

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SECTION 15190

FUEL OIL SYSTEM

PART 1 GENERAL

This section covers the furnishing and installing of fuel oil systems as shown and indicated herein, complete with all necessary accessories and support equipment.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 181	(1995) Forgings, Carbon Steel, for General Purpose Piping

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATIONS

NFPA 30	(1996) Flammable and Combustible Liquids Code
NFPA 30A	(1996) Automotive and Marine Service Station Code
NFPA 54	(1999) National Fuel Gas Code & Handbook
NFPA 70	(1999) National Electrical Code (NEC)
NFPA 329	(1996) Underground Leakage of Flammable and Combustible Liquids

UNDERWRITERS' LABORATORIES, INC. (UL) PUBLICATIONS

UL 142	(1993) Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 330	(1994) Gasoline Hose
UL 674	(1994; Rev July 1995) Electric Motors and Generators for use in Hazardous Locations, Class I, Groups C & D; class II, Groups E, F & G
UL 698	(1995) Industrial Control Equipment for use in Hazardous Locations
UL 886	(1995) Outlet Boxes and Fittings for use in Hazardous Locations

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) PUBLICATIONS

ASME B1.20.1	(1992) Pipe Threads, General Purpose (inch)
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.11	(1991) Forged Steel Fittings, Socket-Welding, and Threaded.
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1988) Valves - Flanged, Threaded, and Welding End
ASME B31.1	(1998) Power Piping
ASME B31.8	(1995) Gas Transmission and Distribution Piping Systems Addenda (1990)
ASME BPV IX	(1998) Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS) STANDARDS

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges, and Unions

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; FIO.

After approval of shop drawings, the Contractor shall furnish spare parts data for each different item of equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply and a recommended spare parts list for one year of operation, and a list of the parts recommended by the manufacturer to be replaced after 3 years of service.

SD-04 Drawings

Fuel Oil Shop Drawings; GA.

Shop drawings shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance data, charts, curves, catalog cuts, certificates, and installation instructions. Shop drawings shall also contain complete piping and wiring drawings and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the system has been coordinated

and will properly function as a unit. Drawings shall indicate clearances required for maintenance and operation. Shop drawings shall be submitted on, but not limited to, the following items:

a) Flexible, double-wall, fuel piping including outer bulkhead pipe and steel pipe. Submit certificates of compliance.
b) filters/separators/strainers
c) fuel oil tanks, including day tank and storage tank. Submit certificates of compliance for the fuel tanks.
d) leak detection system for the storage tank and dispenser sumps.
e) fuel pumps
f) controls
g) complete installation drawings for the fuel tanks and piping system. include layout drawings
h) painting system for the storage and day tank.
i) fabrication and installation drawings for the concrete support slab for the storage tank. Include rebar details.
j) diesel fuel dispensing unit
k) grounding details for the storage tank

SD-08 Statements

Contractor Qualifications; FIO.

Contractor Qualifications. Proof of Contractor and subcontractor qualifications to perform the work required by this section shall be submitted within 10 days of the notice to proceed. No work shall be performed until the Contractor's and all subcontractor's qualifications have been reviewed and accepted by the Contracting Officer.

Work Plan; GA.

Work Plan. The Contractor shall develop, implement, maintain, and supervise as part of the work, a comprehensive plan for tank installation and related operations. The work plan shall be submitted within 30 days after notice to proceed. No work at the site, with the exceptions of site inspections and mobilization, shall be performed until the work plan is approved. At a minimum, the work plan shall include:

a. Scheduling and operational sequencing

b. Tank installation procedures and construction of a concrete slab and footings.

c. Identification of applicable regulatory requirements and permits.

SD-09 Reports

Performance Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

SD-13 Certificates

Certificate of Compliance; FIO.

Where materials or equipment are required to comply with requirements of the UL, NFPA, ASME, etc., proof of such compliance shall be submitted; the label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. As an alternative to the above requirements, the manufacturer may submit a standard computer product selection printout based on the manufacturer's certified testing data. The manufacturer shall certify that the computer selected equipment meets the requirements of the specified agency and meet the contract requirements. Where equipment is specified to conform to requirements of the ASME BPV IX, Boiler and Pressure Vessel Code, Section IX, the design, fabrication and installation shall conform to that code.

SD-19 Operation and Maintenance Manuals

Operating Instructions; FIO.

Operating Instructions. Contractor shall submit Operation and Maintenance manuals on the fuel oil system including the forwarding pumps, day tank, fuel tanks, piping system, leak detection system, diesel dispensing unit, and all associated controls. The O & M manual shall include servicing information, spare parts availability, complete shop drawing information, and routine maintenance schedule. Five complete copies of operation and maintenance manuals shall be provided. Manuals shall list instructions outlining the step-by-step procedures required for system start-up, operation, and shutdown.

Maintenance Instructions; FIO.

Maintenance Instructions. Maintenance instructions shall list routine maintenance procedures, possible breakdowns, repairs and a troubleshooting guide. The instructions shall include equipment layout and simplified wiring and control diagrams for the system as installed.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to the bid opening. Asbestos or products containing asbestos shall not be used. All materials shall be resistant to the effects of diesel fuel. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Valves, flanges, and fittings shall be marked in accordance with MSS SP-25. The completed installation shall conform to the applicable requirements of NFPA 30, NFPA 30A, NFPA 54 and NFPA 70 (NEC).

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate

secured to the item of equipment. Major items of equipment includes the day tank, fuel storage tank, piping, and controls.

2.1.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

2.1.4 Handling

When shipping, delivering, and installing, pipe and components shall be handled carefully to ensure a sound, undamaged condition. Particular care shall be taken not to damage pipe coating. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION.

2.1.5 Initialling Filling of Fuel System

The Contractor shall provide the initial fill of diesel fuel in the storage and day tanks.

2.2 PIPE

2.2.1 Buried Pipe

The following applies to buried piping as shown on the drawings.

2.2.1.1 Piping

Buried piping (as shown on the drawings) shall consist of a flexible double-walled system. The double-wall piping shall be contained within an outer bulkhead pipe. System shall be similar to Enviroflex or equal. Flexible double-wall pipe shall have an abrasion resistant polyurethane covering. The piping shall be continuous between sumps so that there are no underground joints and all connections are secured inside containment sumps. The pipe shall have a UL listing for use with petroleum products. All components of the piping system shall be compatible with petroleum and diesel fuel. The secondary containment system shall provide water tight containment. The exterior pipe shall be sized to contain 110 percent of the total volume of the primary inner pipe or pipes and any additional equipment required.

2.2.1.2 Pipe Fittings

Fittings shall be of the same material as pipe supplied and compatible with adhesives used for joining the pipe. Fittings for exterior pipe shall be sized to accommodate the primary inner pipe or pipes and any additional equipment required, and shall be compatible with the secondary material, compatible with adhesives used for joining the pipe and compatible with the transported fluid.

2.2.1.3 Dispenser Sumps

Dispenser sumps shall consist of the dispenser sump/pan, mounting frame, and all associated fittings for connecting the piping system. Dispenser sumps shall be compatible with petroleum products and diesel fuel. The dispenser sumps shall incorporate the electronic leak detection system.

2.2.2 Exposed Steel Pipe, Fittings, and Associated Materials

The following applies to exposed piping as shown on the drawings.

2.2.2.1 Steel Pipe

Steel pipe shall be black iron conforming to ASTM A 53, Grade A or B, Type E or S, Schedule 40.

2.2.2.2 Fittings, 1-1/2 Inches and Smaller

Fittings 1-1/2 inches and smaller shall conform to ASME B16.11.

2.2.2.3 Steel Forged Branch Connections

Steel forged branch connections shall conform to ASTM A 181, Class 60, carbon steel.

2.2.2.4 Flange Gaskets

Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21 1/16-inch thickness, full face or self-centering flat ring type. The gaskets shall contain arimid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR), suitable for maximum 600 degrees F service and meeting applicable requirements of ASME B31.8. NBR binder shall be used for hydrocarbon service.

2.2.2.5 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.2.2.6 Sealants for Steel Pipe Threaded Joints

Joint sealing compound shall be as listed in Underwriters' laboratories, Gas and Oil Equipment Directory, Class 20 or less.

2.2.2.7 Identification

Pipe flow markings and metal tags for each valve shall be provided as required by the Contracting Officer.

2.2.2.8 Insulating Joint Materials

Insulating joint materials shall be provided between flanged or threaded metallic pipe systems where shown to control galvanic or electrolytic action. Joints for threaded pipe shall be steel body nut type dielectric type unions with insulating gaskets.

a. Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts and insulating washers for flange nuts.

2.2.2.9 Flexible Connector

Flexible connectors shall be used at all engine connections. This includes the piping connection to the engine generator. Flexible piping connectors shall be standard weight corrugated hose made with annular corrugations from butt welded, Type 321, stainless steel tubing covered with stainless steel wire braid. Flexible connector length shall be suitable for the

intended service. Minimum rated test pressures shall be 225 psig.

2.2.3 Filter/Separator

Provide two stage coalescing oil filters as indicated suitable for use with fuel oil. Unit shall have 99 percent dirt removal efficiency and 99.9 percent water removal efficiency. Accessories shall include inlet and outlet pressure gages, support brackets suitable for installation arrangement, a sight glass, and a 1/2" manual drain. Provide two spare fuel oil filter elements.

2.2.4 Fuel Oil Supply Strainer

The fuel oil supply strainer shall be a 3-inch duplex, 125 pound cast-iron bodied basket strainer with 40 mesh stainless steel liner and yoke cover. The strainer shall have a maximum clean pressure drop of 1.0 psi while passing 10 gpm of No. 2 diesel fuel oil with a viscosity of 500 SSU.

2.3 VALVES

Plug valves and check valves shall be steel body valves designed and constructed in accordance with ASME B16.5 or ASME B16.34 as applicable.

2.3.1 Valves 2 Inches and Smaller

Steel body valves 2 inches and smaller shall have screwed and forged steel bodies. Class 600 steel body valves 2 inches and smaller shall be constructed as follows.

Class 600 valves shall have either pressure seal, integral, or flanged type bonnet joints.

All valves shall have seats of the integral type.

All valves shall be of loose back seat design.

Trim materials

Discs	Stainless steel
Stems	Stainless steel
Seats	Stellite faced or hardened stainless steel

2.3.2 Plug Valves

Plug valves shall be short pattern type with tapered, Teflon coated plug, position indicator, and locking device. Valves 2 inches and smaller shall be 200 psi WOB of semicarbon steel construction. Each valve below 6 inches in size shall be provided with an operating wrench. Valves 2 inches and smaller shall be screwed. All lubricant fittings and injectors required for introduction of plug lubricant shall be supplied with each valve.

2.3.3 Check Valves

Check valves shall be the guided piston type or swing disc type. Swing check valves shall be designed for installation in either horizontal piping or vertical piping with upward flow.

2.3.4 Flame Arresters

Fuel oil day tank flame arresters shall be threaded, cast-iron body with Type 316 stainless steel insert laminations conforming to requirements of NFPA 30. Pressure drop shall be less than 0.1 psig while venting 10 cfm of air.

2.4 FUEL OIL TANKS

2.4.1 Fuel Oil Storage Tank

The fuel oil storage tank shall be a 3,000 gallon capacity, double wall, horizontal, above ground tank, designed for storage of No. 2 fuel oil. Secondary containment shall provide 110% of primary storage plus related piping. The tank shall be shop welded, manufactured, tested, and installed in accordance with NFPA 30, NFPA 30A, and NFPA 54 and UL 142. Tanks shall be provided with openings and appurtenances as indicated on the drawings. Tank supports shall be manufacturer provided, zero height steel support saddles as indicated on the drawings. Tanks shall be provided with ground pads located on the tank bottom side at each end of the tank. Tank openings shall be covered during shipping and installation. Tank interior and exterior shall be primed and epoxy painted (coated) per the manufacturer's standard method.

2.4.1.1 Primary and Secondary Fuel Storage Tank Fabrication

Both the primary and secondary fuel storage tank shall be fabricated of 1/4 inch thick, minimum, carbon steel. Both the primary and secondary tank shall be tested and listed according to UL 142. Tank dimensions shall be as indicated on the drawings. The completed tank with accessories shall be factory tested and inspected in accordance with the referenced tank construction codes and standards and the manufacturer's standard procedures. Integrity of the tank shall be certified by manufacturer prior to shipment.

2.4.1.2 Storage Tank Interior

Storage tank interior bottom surface shall have wear (striker) plates installed, center-to-center, below all accessible openings, as indicated on the drawings. The plates shall be made of steel and shall be 1/4-inch thick. The plate shall be rolled to the contours of the tank and all plates shall be tack-welded in place.

2.4.1.3 Manholes

The tanks shall have one 24-inch minimum inside diameter manhole. Each manhole shall have a matching flanged watertight steel cover.

2.4.1.4 Fill Connection

The fill line shall enter at the top of the tank. The minimum diameter of the fill line shall be 3-inches and the line shall extend to within 6-inches of the tank bottom with anti-splash deflector provided at the end of the fill line in the tank. Tank fill shall be provided with a fill cap assembly constructed of cast iron body and a bronze locking cap. Fill cap assembly shall match the tank fill connection. A seven gallon overflow containment basin shall be incorporated into the fill connection.

2.4.1.5 Suction Connection

The suction fuel line connection shall extend within the tank and shall include a foot valve located within 3-inches of the tank bottom unless indicated otherwise. The foot valve shall be constructed of brass or plated cast iron body, bronze double-poppet, metal-to-metal replaceable bronze or brass seats, and 20 mesh monel or brass screen.

2.4.1.6 Electric Heaters

A low watt density, thermostatically controlled, electric immersion type fuel oil heater shall be installed in the tank. The heater shall be complete with a cast iron, water and vapor proof, electrical junction box. The heater shall be sized as indicated.

2.4.1.7 Vents

The tank shall be provided with a separate atmospheric vent with a flame arrestor conforming to the applicable requirements of NFPA 30. The vent pipe shall terminate as indicated and shall be located so that discharged vapors will not enter the building openings or downspouts. Tank shall be provided with emergency vents as indicated.

2.4.1.8 Tank Gauge Connection

A 2-inch flanged gauge connection shall be provided on top of the tank. Gauge connection shall allow for direct installation or removal of the tank gauge without draining the tank.

2.4.1.9 Tank Gauge

The tank shall be provided with a direct reading, mechanically-actuated float gauge. The movement of the float and arm assembly inside the tank shall be transmitted through a metal bellows seal which isolates the indicating mechanism from the liquid, fumes, or pressure. The indicating mechanism shall be of the dial type, approximately 6 inches in diameter, calibrated and scaled in inches (zero being the bottom of the tank), and protected from condensation by means of a dehydrating agent in the housing. The gauge shall be equipped with two fully adjustable spdt switch contacts in a weatherproof housing. Switch contacts shall be rated 15 amperes at 120 volts ac.

2.4.1.10 Control Panel

A control panel shall be provided and mounted adjacent to the tank for the tank heaters. Panel shall be NEMA 4x (stainless steel). Controls shall include temperature indicator, temperature controller, and high temperature alarm. Panel shall also include a local high level alarm and local low level alarm for the fuel storage tank. The panel shall consist of a horn, red indicating light, and test/silence switch. The indicating light shall remain on as long as the alarm condition remains. The panel shall be connected to one of the tank gauge switch contacts. The main fuel oil control panel (to monitor level, alarms, etc.) Shall be installed in the new CCS control room.

2.4.1.11 Leak Detection System

Tank shall be provided with a leak detection system located in the interstitial space between the primary tank and the secondary tank. The leak detection system shall be as specified in PARAGRAPH: LEAK DETECTION SYSTEM. Leak detection system shall be designed and furnished by the tank

manufacturer.

2.4.2 Fuel Oil Day Tank

Fuel oil day tank shall be installed on the floor of the mechanical room as shown. Tank shall be double wall construction. Secondary containment shall provide 110% of primary tank storage plus related piping. The tank shall be provided with connections and level switches as shown on the drawings. The day tank shall be constructed of minimum 12 gauge steel. The inside and outside shall be epoxy coated and shall be per the standard manufacturer design suitable for fuel oil immersion. Tank construction and installation shall be in accordance with NFPA 30 and UL 142. The day tank shall be provided with a level indicator. An access panel on top of the tank shall provide for cleaning and inspection. Tank shall be designed for floor mounting. Heavy gauge steel channels with mounting holes shall be installed on the bottom of the tank.

2.4.2.1 Tank Level Switches

Tank level switches shall be displacement type assembly with cables and displacers recommended for use with No. 2 diesel fuel. Set points and sequence of operation shall be as specified in this section. Set points shall be field adjustable. Switches shall be wide differential, dpdt type, rated 10 amperes minimum at 120 volts AC. All controls for the day tank and forwarding pump shall be installed as shown on the drawings.

2.4.2.2 Sequence of Control

The operation of the fuel oil system shall normally be automatic. A Hand-Off-Auto selector switch shall normally be set in the Auto position. High and low float switches and corresponding alarms shall be provided for the day tank. High level shall be activated when the tank is 95% full and low level shall be activated when the tank is 10% full. High level float shall shut off the forwarding pump and close the electric solenoid valve. Float switches shall be provided to start and stop the forwarding pump. Pump shall start when the tank is 20% full and shall stop when the tank is 80% full. Pump start float shall open the solenoid valve and start the forwarding pump. Pump stop float shall close the solenoid valve and stop the forwarding pump.

2.4.2.3 Alarms

Alarm circuits shall be incorporated into the control panel. All alarms shall be audible and a red indicating light shall be provided on the control panel. Alarms shall be provided for the following functions:

(a) High fuel oil level in the day tank.

(b) Low fuel oil level in the day tank.

A test/silence switch for the alarms shall be mounted in the control panel.

2.4.2.4 Vents

The tank shall be provided with a separate atmospheric vent with a flame arrestor conforming to the applicable requirements of NFPA 30. The vent pipe shall terminate as indicated and shall be located so that discharged vapors will not enter the building openings. Flame arrestor shall be

threaded with a cast iron body with 316 stainless steel insert lamination. Tank shall be provided with emergency vents as indicated. Emergency vents shall be installed as shown on the drawings.

2.4.3 Emergency Generator Day Tank

The diesel fuel oil day tank is part of the emergency generator package that will be provided by the Government. The day tank shall be installed by the Contractor under this contract. Atmospheric vents and emergency vents shall be installed as shown.

a. The Contractor shall install a supply and return pump for the generator day tank as shown on the drawings. Wiring shall be as indicated. An additional float switch shall be installed as shown on the drawings.

2.5 LEAK DETECTION SYSTEM

A complete continuous, surveillance leak detection system suitable for operation in an NFPA 70, Class 1, Division 1, Group D environment shall be provided to monitor the leak containment space between the primary and secondary walls of the 3000 gallon storage tank. A leak detection system shall also be installed in the dispenser sumps for the underground piping. The system shall detect leakage into the containment space electronically. The sensor output and transmission shall be electronic.

2.5.1 Leak Detection Panel

An control and alarm panel shall be provided in the CCS control room as shown on the drawings. Sensor cables shall be provided between the panel and the storage tank. Sensor cables shall be installed in conduit. The control panel shall include the leak detection system for the storage tank and for the dispenser sumps. The Contractor may also elect to combine the tank level control with the leak detection system. The panel shall have a single alarm (audible and visual), an acknowledgement pushbutton, an LED digital display which indicates distance to leak in feet, and a power supply with built-in battery backup. A 120 volt ac supply shall be provided to the panel power supply. The panel shall incorporate a self-test system which permits operator verification of proper operation of all the leak detection equipment.

2.5.2 Manufacturer's Data

The alarm panel, sensing cables, jumper cables, connectors, and termination accessories shall be the products of a single manufacturer. Instructions and equipment required for calibration of the leak detection system and manufacturer's recommended calibration maintenance schedule shall be provided. A graphic display map, framed and suitable for wall mounting shall be provided. The map shall show the sensing cable layout to scale in plan view, with distance markings of bends and terminations indicated. The distance markings shall match the calibrated readings of the alarm panel digital display to ensure accurate locating of leaks.

2.5.3 Piping Leak Detection System

The piping leak detection system shall include flexible double wall containment pipe enclosed in an outer containment pipe. A sump shall be provided and monitored to detect any leakage in the piping system. Piping system shall be provided complete including fittings, bulkhead fittings,

couplings, sump, and monitoring system. The piping system shall be sloped towards the sumps.

2.6 FUEL PUMPS

2.6.1 Fuel Oil Transfer Pumps

2.6.1.1 Fuel Oil Forwarding Pumps

Rotary positive displacement fuel oil forwarding pumps shall be installed as indicated on the drawings. One pump shall be provided for the generator day tank and one pump provided for the mechanical room day tank. A return pump shall also be provided for the generator day tank. The pumps shall be rated as indicated on the drawings. Fuel oil shall be No. 2 diesel with specific gravity of 0.88 and a viscosity of 50 SSU. The pumps shall have a discharge pressure relief valve. The maximum discharge pressure (setting of relief valve) shall be 15 psi. The pumps shall be self-priming. The pump shall not be damaged or experience excessive wear when operating without fluid. The pump body shall be malleable iron and equipped with integral return-to-tank pressure relief valve. The pump shall be equipped with mechanical seals and carbon graphite bushings. The pump and motor shall be frame-mounted and shall be direct-connected with a flexible coupling. Pump, motor, and coupling shall be suitable for 100 F ambient temperature.

2.6.1.2 Disconnect Switches

Disconnect switches shall be provided for the forwarding pumps and return pump. Locations shall be as shown on the drawings. Fuel oil forwarding pumps shall be controlled by the level controllers in the day tanks. Pumps shall start when the tank is 20% full and shall stop when the tank reaches the 80% full level. Contractor shall provide all necessary conduit and wiring from the day tank to the fuel oil forwarding pumps.

2.6.1.3 Two Stage Coalescing Oil Filter

A two stage coalescing oil filter shall be provided at the inlet to the fuel oil forwarding pump. Unit shall have 99% dirt removal efficiency and 99.9% water removal efficiency. Accessories shall include an inlet and outlet pressure gage, support brackets, and a manual drain.

2.7 DIESEL DISPENSING UNIT

2.7.1 General

A diesel fuel dispensing unit shall be furnished and installed by the Contractor. The dispenser shall be fed by gravity from the day tank in the mechanical room. Cabinet shall be steel and painted per the manufacturer's standard method. Registers shall be non-computer type with power reset interlock. Register shall show gallons and tenths of a gallon. Unit shall be UL listed. A 75 foot hose shall be provided.

2.7.2 Diesel Fuel Meter

The diesel fuel meter shall be a disc or wobble plate type, capable of 15 gpm minimum flow of No. 2 diesel fuel at 50 SSU with an accuracy of "3%. The meter shall have a register with manual reset and a totalizer that displays in gallons. Meter shall be capable of operation from 20NF to 165NF and 50 psig minimum. Inlet and outlet shall be 1-1/2" inch NPT and

meter shall be designed for outdoor service and exposure.

2.7.3 Nozzles

The dispensing nozzle shall be of the automatic type. The automatic type nozzle shall be the diaphragm-operated vacuum tube design and shall have as an integral part of the nozzle assembly, a latch-open device that will shut off the fuel flow when the tank is full. Nozzle shall have a maximum pressure drop of 7 psi at 15 gpm of #2 diesel fuel at 70 degees F.

2.7.4 Dispensing Hose

The dispensing hose shall conform to UL 330, gasoline and oil resistant, statically grounded, flexible in subzero temperatures. Hose shall be 1 inch inside diameter and 75 feet in length. A storage rack shall be provided for the hose.

2.7.5 Electrical Controls

Dispensing unit shall operate on 110v, 1 phase power. The nozzle hook shall be provided with an operating lever for starting and stopping the solenoid valve through a controller. The power panel box shall be equipped with an external emergency pushbutton to shut off the power at the controller and dispenser via the power panel box. The installation of electrical equipment at the dispenser, meter, and submersible pump shall be in compliance with Class 1, Group D hazardous location.

2.7.6 Diesel Fuel Filters

The diesel fuel dispenser system shall be equipped with a replaceable element coalescing type water filter. Filter shall be mounted at the dispensing hose connection and shall have a flow rating equal to the rate of the dispensing nozzle.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Coordination of Work

A single mechanical contractor shall be responsible for the coordination and installation of the work required under this section. All shop drawings will be rejected unless this work is shown to be properly coordinated. The single mechanical contractor shall be responsible for providing complete and operating systems.

3.1.2 Welding Steel Piping

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX, Boiler and Pressure Vessel Code, Section IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder of welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

3.2 EARTHWORK

Excavation and backfilling for tanks and piping shall be as specified in SECTION: EXCAVATING, TRENCHING AND BACKFILLING FOR UTILITY SYSTEMS.

3.3 STORAGE TANK INSTALLATION

The tank shall be installed in accordance with the manufacturer's written instructions and NFPA 30 and NFPA 30A. Fasten storage tank on concrete reinforced foundation as shown. Any damaged tank shall be replaced or repaired and tested under direct supervision and advice of the tank manufacturer, using the manufacturer's written procedure. Installation shall be performed and validated by a Contractor certified by the tank manufacturer. Certification shall be furnished to the Contracting Officer prior to installation and validation shall be furnished after installation.

3.3.1 Tank Calibration

The tanks shall be furnished with calibrated charts showing the liquid contents in gallons for each 1/8 inch of tank depth. Two reproductions of the gauge chart shall be enclosed in plastic envelopes and bound in hardback binders. Two gauge sticks graduated in feet, inches, and eighths of an inch shall be provided. Gauge sticks shall be of wood and properly treated after graduating to prevent swelling or damage from the fuel.

3.3.2 Grounding

Provide grounding of tanks directly through ground rods or through bonding to a grounded network in accordance with NFPA 70 (NEC).

3.4 PIPING

Aboveground piping shall be black iron. Underground piping shall be a flexible containment system and shall have metallic tracer tape above. Buried lines shall have a double-walled containment system. The full length of each section of underground pipe shall rest solidly on the pipe bed. Piping connections to equipment shall be as indicated or as required by the equipment manufacturer. Tank connections and piping through the first floor into the building shall be made with two elbow swing joints to allow for differential settlement. The interior of the pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench and shall be kept clean during installation. The pipe shall not be laid in water or when the trench or weather conditions are unsuitable. When work is not in progress, open ends of pipe and fittings shall be securely closed so that water, earth, or other substances cannot enter the pipe or fittings. Any pipe, fittings, or appurtenances found defective after installation shall be replaced. Threaded joints shall be made with tapered threads and shall be made perfectly tight with joint compound applied to the male threads only.

3.4.1 Cutting Pipe

Cutting pipe, when necessary, shall be done without damage to the pipe.

3.4.2 Installing Piping

Pipe and accessories shall be handled carefully to assure a sound,

undamaged condition. Nonmetallic pipe shall be installed in accordance with pipe manufacturer's instructions. Pipe supports, guides, and anchors for the flexible pipe shall be per the pipe manufacturer's recommendation. Underground pipelines shall be laid with a minimum pitch of 1 inch per 50 feet. Horizontal sections shall have a minimum coverage of 18 inches. Piping passing through concrete or masonry construction shall be fitted with sleeves. Each sleeve shall be of sufficient length to pass through the entire thickness of the associated structural member and shall be large enough to provide a minimum clear distance of 1/2 inch between the pipe and sleeve, except where otherwise indicated. Sleeves through concrete may be 20-gage metal, fiber, or other approved material. Sleeves shall be accurately located on center with the piping and shall be securely fastened in place. The space between the sleeves and the pipe shall be caulked and filled with bituminous plastic cement or mechanical caulking units designed for such use.

3.4.3 Pneumatic Testing

Fuel oil piping from the pumps to the generator and day tank (primary piping) shall be tested under a pneumatic pressure of at least 1-1/4 times the designed working pressure of the particular piping system, but not less than 50 psig. Fuel oil suction and return piping (secondary piping) shall be tested at a pneumatic pressure of 50 psig. Joints in double containment piping shall not be made until inner pipe is successfully pressure tested. Pressure in primary piping shall be maintained for at least 2 hours during which there shall be no drop in pressure in the line greater than that allowed for thermal expansion and contraction. Pressure in secondary piping shall be maintained for at least 1 hour. To facilitate this test, various sections of the piping system may be isolated to test each separately. Tapped flanges that can be attached to the end of the section of line being tested and that will permit direct connection to the piping from the air compressor shall be furnished. No taps in the line will be permitted. Necessary equipment for testing shall be furnished. Gages shall be subject to testing and approval. In the event leaks are detected, the line shall be repaired and the test repeated. On satisfactory completion of tests, the pressure shall be relieved and the line immediately sealed. Provision shall be made to prevent displacement of the piping during testing. Personnel shall be kept clear of the piping during pneumatic testing. Equipment such as pumps, tanks, and meters shall be isolated from the piping system during this test.

3.4.4 Equipment Installation

Necessary supports shall be provided for equipment and appurtenances as required these include frames or support for filters, pumps, tanks, valves, and other similar items requiring supports. The method of anchoring and/or fastening shall be as recommended by the manufacturer and approved by the Contracting Officer.

3.5 LEAK DETECTION SYSTEM INSTALLATION

The leak detection system shall be installed in accordance with the manufacturer's installation instructions. Jumper cable shall be provided as required for connecting the branching connector to the alarm panel, and shall be routed in 3/4" rigid steel conduit to the alarm panel.

3.6 ELECTRICAL WORK

All electrical work shall conform to NFPA 70 (NEC). Switches and devices necessary for controlling the electrical equipment shall be provided. The pumps shall be completely wired and ready for connection to the power circuit. All wiring, equipment, and fittings shall be explosion proof in conformance with the applicable requirements of UL 674, UL 698 and UL 886 for Class I, Division 1, Group C and D hazardous locations and the Contractor shall submit proof of such conformance. Electrical installations shall conform to the requirements of the NFPA 70.

3.7 FLUSHING AND TESTING

The interior of fuel storage tank shall be made clean before fuel is placed inside. The dispensing unit shall not be installed during flushing and cleaning of the piping. Temporary piping or hose equipped with a strainer having not less than a 40-mesh screen shall be installed between the supply pipe and the tank fill connection on the tank from which the fuel is being pumped. A temporary pump will be provided and installed for flushing. The dispensing system shall be flushed with the same type of fuel intended for use in the system until the out flowing fuel is "clean" and "bright": clean means the absence of any sediment or emulsion; bright refers to the fluorescent appearance of fuel that has no cloud or haze. After components of the system have been properly adjusted, the system shall be tested to demonstrate that the system meets the performance requirements for which it was designed. Fuel dispensing equipment shall be operated to demonstrate the capability of the fuel pumps to deliver the desired flow and draw the storage tank contents to the level of the pump inlet. If any portion of the system or any piece of equipment fails to pass the tests, the Contractor shall make the necessary repairs or adjustments and the test shall be repeated until satisfactory performance is achieved. All tests shall be witnessed by the Contracting Officer, and the Contractor shall notify the Contracting Officer 5 days before testing to permit arrangement for the use of Government-furnished items. All calibrated instruments and equipment, as well as the fuel, required to properly clean and flush the system and to conduct the tests shall be furnished by the Contractor.

3.8 SYSTEM LEAK TEST

After the system has been flushed and operationally tested, the underground portion of the system shall be leak tested. The test shall be the standpipe method type and shall conform to the requirements in NFPA 329. The test method shall not involve pressurization of the system in any way which could increase the rate of product escape through an established leak.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15210

COMPRESSED AIR BUBBLER SYSTEM

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SECTION 15210

COMPRESSED AIR BUBBLER SYSTEM

PART 1 GENERAL

This section covers the furnishing and installation of the compressed air bubbler system as shown and specified herein, complete with all necessary equipment and accessories. The bubbler system will be installed on the lock intermediate wall.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

FEDERAL SPECIFICATIONS (FED. SPEC.)

FED. SPEC. FF-S-325 & Int.Am-3	Shield, Expansion; Nail, Expansion; and Nail Drive Screw (Devices, Anchoring, Masonry)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS

ANSI B40.1	(1991) Gauges, Pressure Indicating Dial Type Elastic Element.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) PUBLICATIONS

ASME A13.1	(1996) Scheme for the Identification of Piping Systems.
ASME B1.20.1	(1992) Pipe Threads, General Purpose (Inch).
ASME B16.3	(1992) Malleable Iron Threaded Fittings.
ASME B16.39	(1994) Malleable Iron Threaded Pipe Unions
ASME B18.2.1	(1996) Square and Hex Bolts and Screw Inch Series.
ASME B18.2.2	(1993) Square and Hex Nuts.
ASME BPV IX	Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications (1992)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 47	(1999) Ferritic Malleable Iron Castings
ASTM A 53	(1999) Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.

ASTM A 123	(1997) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A 183	(1998) Carbon Steel Track Bolts and Nuts.
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60,000 psi Tensile.
ASTM A 575	(1996) Steel Bars, Carbon, Merchant Quality, M-Grades.
ASTM A 576	(1990) Steel Bars, Carbon, Hot-Wrought, Special Quality.
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings.
ASTM D 2000	(1995) Classification System for Rubber Products.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code.

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS) STANDARDS

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture.
MSS SP-67	(1995) Butterfly Valves.
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application.
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves.
MSS SP-89	(1985) Pipe Hangers and Supports - Fabrication and Installation Practices.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) STANDARDS

NEMA MG1	(1987, Rev 1989) Motors and Generators.

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; FIO.

After approval of shop drawings, the Contractor shall furnish spare parts data for the compressor. Spare parts data shall be included in the operation and maintenance manual. The data shall include a complete list of parts and supplies, with current unit prices and source of supply and a recommended spare parts list for one year of operation, and a list of the parts recommended by the manufacturer to be replaced after 3 years of service.

SD-04 Drawings

Bubbler Shop Drawings; GA.

Shop drawings shall be submitted and shall include a complete list of equipment and materials. Components of the bubbler system shall be submitted together as a complete package, including the electrical components. The name of the bubbler system supplier/installer shall be furnished. Other submittals shall include manufacturer's descriptive and technical literature, performance charts, and catalog cuts. Shop drawings shall also contain complete piping diagrams, wiring drawings, control and schematic diagrams. Details and data on equipment layout and anchorage, valves, hoses, couplings, and supports shall be furnished along with any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall indicate clearances required for maintenance and operation. A list of ten installations that the compressor has been installed at shall be provided. This shall include at least 5 installations with similar operating conditions. The following shop drawings shall be provided:

(a) Complete manufacturer's catalogue data on the compressor. Motor size, horsepower, outline dimensions, lubrication system, and pressure and capacity data shall be furnished. Provide data on the controls, modulation control, all filters, and cooling system. Shop drawings on the combination starter and disconnect shall be furnished.

(b) Complete shop drawings of the compressor cabinet shall be furnished. Mounting details, welding details, method of construction, and heater installation shall be shown. Details of the mounting and connection of the compressor and cabinet to the existing machinery bridge shall be provided.

(c) Provide shop drawings on the construction and welding of the bubbler system air manifold.

(d) Provide details on the connection of the existing stainless steel pipe system to the new galvanized pipe system. Provide details and drawings on the complete layout of the system.

(e) Provide shop drawings on all valves, pressure gages, couplings, fittings, pipe, and hose. Submit certificates of compliance for the piping.

SD-08 Statements

Warranty; FIO.

The Contractor shall furnish the Government, under separate cover, the manufacturer's standard commercial warranty for the following items:

(a) Air Compressors.
(b) Control System including combination starter/disconnect.

SD-09 Reports

Performance Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls. Performance test reports shall be included in the operation and maintenance manual.

SD-19 Operation and Maintenance Manuals

Operating and Maintenance Instructions; FIO.

The Contractor shall furnish the Contracting Officer 5 complete copies of operating and maintenance instructions outlining the step-by-step procedures required for system start-up, operation and shutdown. The instructions shall include the manufacturer's names, model numbers, service manuals, parts list, and brief description of all equipment and its basic operating features. All finalized shop drawing information, test reports, and spare parts data shall be included. Lubrication procedures for the compressor shall be provided. Maintenance instructions shall list routine maintenance procedures, possible breakdowns, and repairs. The instructions shall include simplified wiring and control diagrams for the system as installed.

Framed Instructions; FIO.

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted before posting. The framed instructions shall be posted before acceptance testing of the systems.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 3 years prior to bid opening. Compressors furnished under this contract shall be the product of a manufacturer that has produced at least 50 like units. At least 10 of these units shall be in use and operating satisfactorily.

2.1.2 Coordination

The complete bubbler system shall be furnished and installed by a single

supplier/installer. This single sub-contractor shall be responsible for the furnishing and installation of the compressor, all piping, compressor motor, combination starter/disconnect, all necessary electrical controls, wiring, and all valving. The bubbler supplier/installer may use additional sub-contractors. All shop drawings on the bubbler system will be rejected unless the work is shown to be properly coordinated.

2.1.3 Asbestos Prohibition

Asbestos and products containing asbestos shall not be used.

2.1.4 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be made of corrosion-resisting metal with raised or depressed lettering and contrasting background.

2.1.5 Instruction Plates

As necessary, each item of equipment shall be equipped with suitably located instruction plates, including any warnings and cautions describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Plates shall be made of corrosion-resisting metal with raised or depressed lettering and contrasting background.

2.1.6 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

2.1.7 Identification Tags

Identification tags made of brass, engraved laminated plastic or engraved anodized aluminum indicating service and valve number shall be installed on valves. Tags shall be 1-3/8 inch minimum diameter and marking shall be stamped or engraved. Indentations shall be black for reading clarity. Tags shall be attached to valves with No. 12 AWG copper wire, chrome plated beaded chain or plastic straps designed for that purpose.

2.2 PREPARATION FOR SHIPMENT AND STORAGE

2.2.1 Preparation for Shipment

Prior to shipment from the manufacturers' plants, the Contractor shall prepare the various elements of the compressed air system for shipment as described herein. All large, bulky, and/or heavy items shall be mounted on skids or pallets of ample size and strength to facilitate loading and unloading. All small parts, including valves, pipe hangers and fittings, shall be boxed in sturdy wood or heavy corrugated paperboard boxes. A packing list, indicating the contents of each such box and enclosed in a moistureproof envelope, shall be securely fastened to the outside of the box. The skid and/or pallet mounting and the boxing shall be done in a manner which will prevent damage to the equipment during loading, shipment, unloading, storage, and any associated and/or subsequent handling. Any special slings, strongbacks, skidding attachments, or other devices used in loading the equipment at the manufacturers' plants shall be furnished for

unloading and handling at the destination. All pipe shall have temporary pipe plugs installed on each end.

2.2.2 Storage

The Contractor shall submit a detailed description of the proposed storage facilities, and a plan for storage maintenance and inspection, before any storage actually begins. The pipe shall be stored on wood blocking.

2.3 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and other requirements specified below.

2.3.1 Pipe

All pipe shall be hot-dipped galvanized, schedule 40, carbon steel, conforming to ASTM A 53, Type E or Type S, Grade B.

2.3.2 Fittings

For galvanized carbon steel pipe, malleable-iron fittings, galvanized, for 150 pound service in accordance with ASME B16.3. Fittings shall be grooved except where noted.

2.3.2.1 Elbows

90 degree elbows shall be Victaulic No. 10, Gustin Bacon No. 20, or approved equal. 45 degree elbows shall be Victaulic No. 11, Gustin Bacon No. 21, or approved equal.

2.3.2.2 Tees

Tees supplied shall be Victaulic No. 20, Gustin Bacon No. 30, or approved equal.

2.3.2.3 Caps

Caps shall be Victaulic No. 60, Gustin Bacon No. 70, or approved equal.

2.3.2.4 Unions

Malleable-iron threaded pipe unions for use with galvanized carbon steel pipe shall be galvanized, Class 150, and conform to the dimensional requirements and tensile strength required by ASME B16.39.

2.3.2.5 Pipe Nipples

Threaded in accordance with ASTM A 733.

2.3.2.6 Pipe Joint Tape

Any threaded joints shall have American National Standard taper pipe threads conforming to Fed. Std. H28 with graphite or inert filler and oil, with an approved graphite compound, or with polytetrafluoroethylene tape.

2.3.2.7 Mechanical Grooved Couplings

Mechanical grooved couplings shall be of the same style and manufacturer,

Victaulic Style 77 standard coupling, Gustin Bacon #100 or approved equal. Housing shall be hot-dipped galvanized carbon steel conforming to ASTM A 47 & ASTM A 123 and shall have no more than two (2) fasteners. All fasteners shall be 316 stainless steel track head type bolts, per ASTM A 183, with 316 stainless steel hexagonal nuts and lock washers, and shall be adjustable with a single tool, without need to restrain rotating components. Coupling gasket shall be Victaulic or equal, Grade "E" molded EPDM, per ASTM D 2000. Coupling shall have an internal pressure rating of 500 psig for Sch. 10 and 750 psig for Sch. 40. The coupling design shall permit removal of pipe sections by loosening and sliding the couplings and gaskets away from the joints without the need for complete disassembly. All fasteners shall be accessible from a single transverse direction.

2.3.3 Dielectric Joints

Dielectric joints for use between ferrous and nonferrous materials shall be insulating nipples, couplings or unions designed and manufactured to prevent corrosion.

2.3.4 Valves

2.3.4.1 Check Valves

Check valves shall be of the compact silent type design with grooved ends. Valves shall be similar to Victaulic Series 712. Valves shall be equally effective installed vertically, horizontally or at any angle. Body shall be bronze constructed with material conforming to ASTM B 62 and with stainless steel springs. Valves shall be rated for 150 psig minimum working pressure and shall conform to MSS SP-80.

2.3.4.2 Butterfly Valves

Provide butterfly valves in accordance with MSS SP-67. Valves shall be rated for 150 psig working pressure. Ends shall be grooved. Latch type handle shall be provided. Valves shall be similar to Victaulic Series 700, Gustin Bacon 300AL, or approved equal.

2.3.4.3 Pressure Relief Valve

Provide a pressure relief valve on the bubbler manifold and at the compressor discharge. Valve shall be manually adjustable, bronze body, threaded connections, set to open at 160 psig. Capacity shall be sufficient to pass full compressor discharge without developing excessive back pressure.

2.3.5 Hose

2 inch, industrial quality, multi-purpose, hose, suitable for compressed air service, shall be provided and installed at each miter gate bubbler supply. Hose shall be suitable for outdoor use, flexible in sub-zero Fahrenheit temperatures, resistant to abrasion, sunlight, water, oil and grease, and shall have a minimum bending radius not exceeding 12 inches. Hose shall be nonconductive, all synthetic, high tensile braided textile carcass with a 3/16" rubber cover with brightly colored stripes for high visibility. Hose shall have a oil resistant neoprene tube that handles working pressures up to 150 psig. Hose ends shall be 304 stainless steel Victaulic groove shank types along with and fastened to the hose with permanently pressed on 304 stainless steel ferrules.

2.3.6 Bolts and Nuts

Squarehead bolts and heavy hexagon nuts shall conform to ASME B18.2.1 and ASME B18.2.2 and ASTM A 307, ASTM A 575 or ASTM A 576.

2.3.7 Pressure Gages

A pressure gage shall be furnished and installed at the air compressor discharge and on the bubbler manifold. The pressure gage shall meet the applicable requirements of ANSI B40.1. Scale graduation shall be 2 to 5 psi. Gage shall have a bottom connection with either a brass or phenolic case and shall be suitable for mounting in a tapped hole or on a threaded pipe nipple. Gage shall have an accuracy Grade B, with 4-1/2-inch nominal diameter.

2.3.8 Pipe Supports, Anchors, and Guides

Pipe hangers and supports shall conform to MSS SP-58, MSS SP-69, MSS SP-89.

2.3.8.1 Offset Clamps

All offset clamps shall be type 316 stainless steel, Grinnel Co. Figure 103, Gulf State Hanger #88A, or approved equal.

2.3.8.2 U-Bolts

All U-bolts, nuts, and lock washers shall be type 316 stainless steel. U-bolts shall be of the sizes shown on the attached sketches. Each U-bolt shall be provided with 4 hex nuts and 2 lock washers.

2.3.8.3 Extension Split Clamps

Extension splits clamps shall be used for mounting the bubbler piping onto the handrailing (as shown on the drawings). Split clamps shall be galvanized steel. Clamps shall be a hinged design with a single closure screw similar to Grinnel Figure 138. Gasketing material shall be provided between the clamp and aluminum handrail to prevent corrosion.

2.3.8.4 Expansion Anchors

All concrete expansion anchors shall be cinch type, 316 stainless steel, conforming to Fed. Spec. FF-S-325, Group II, Type 4, Class 1 except as shown on the drawings. Hole size shall be the bolt hole size and 316 stainless steel nuts and washers shall be provided. Lock washers shall be supplied with the expansion anchors in place of plain washers. Corresponding sizes and lengths shall be as follows:

Anchor Size	Length
1/2 in.	5-1/2 in.

2.3.9 Heat Tracing

Heat tracing shall be the parallel circuitry and constant wattage design rated at 12 watts per foot. Heat tracing shall be suitable for pipe tracing. Jacket shall be polyolefine or a fluoropolymer material.

2.4 AIR COMPRESSOR

2.4.1 Air Compressors

Compressors provided shall be industrial duty, electric, rotary screw type, single stage, oil-flooded, and be designed for continuous and intermittent duty operation. Compressor shall be completely assembled, wired, and piped from the factory. Compressor shall be baseplate mounted. A combination motor starter and disconnect shall be furnished by the compressor manufacturer. Starter shall be provided with terminals for incoming power cable connections. Compressor shall be provided with a complete cooling system for the compression module and rotors

2.4.1.1 Air Delivery

The compressor shall be designed to deliver 70 cfm free air delivery (FAD) at 100 psig and 80 cfm FAD at a minimum pressure of 45 psig.

2.4.1.2 Regulator Valve

Compressor shall be provided with necessary regulator valves to maintain the desired pressure. Regulator shall be designed for the maximum outlet pressure of the compressor. Regulator valve shall include a pressure gage and shall be provided with a method of adjustment. Adjustment of regulator valve shall be from 0 psig to the maximum pressure of the supplied compressor.

2.4.1.3 Air Filter

Compressor shall be provided with a dry type intake air filter. Collection efficiency shall be 99 percent of particles greater than 10 microns.

2.4.1.4 Oil/Water Separator

A coalescing oil/water separator shall be provided at the compressor discharge. Separator shall be sized for the pressure and capacity of the compressor. Filters shall be replaceable and the separator shall be provided with an automatic drain. Coalescer elements shall be compatible with both natural and synthetic lubricants.

2.4.1.5 Flexible Connectors

Flexible connectors with grooved ends shall be provided at the discharge of each compressor. Connectors shall be constructed of 304 stainless steel with 304 stainless steel braid. Flexible connectors shall be line size and shall be suitable for continuous operation at 150 psig and 180 degrees F. Connectors shall be similar to Gustin Bacon Series 405 or approved equal.

2.4.1.6 Rotors

Rotors shall be forged steel. Rotors shall be supported by tapered roller bearings. Area around the bearings shall be free of any obstructions to the flow of lubricant.

2.4.1.7 Compressor

Compressor shall be belt driven. System design shall facilitate maintenance and removal of the belt. Tensioning device utilizing an adjustable motor platform or an idler system shall be provided.

2.4.2 Compressor Motor

Motor shall be squirrel cage induction, totally enclosed fan cooled, 480 volts, 60 Hertz, 3-phase, 1.10 service factor, and conform to NEMA MG1. Maximum horsepower shall be 15 hp. Motor shall be integrally wired and mounted in the compressor package.

2.4.3 Combination Starter and Disconnect

A combination starter and disconnect shall be furnished by the compressor manufacturer and mounted in a NEMA 4x (stainless steel) enclosure. The starter and disconnect shall be designed for mounting on the outside of the compressor cabinet. Starter shall be full voltage and incoming line terminals shall be clearly marked.

2.4.4 Control System

Microprocessor based control system shall be provided to monitor capacity, for operating control, and diagnostics. Compressor shall have on-line/off-line and modulation control. Modulation shall be from 50% to 100% of compressor capacity.

2.4.4.1 Diagnostic Information

Diagnostic information shall include motor starter malfunction, motor malfunction, low voltage, and high discharge air temperature and pressure. Gauges shall be provided for discharge pressure and temperature, running hours, power on, and phase monitor indicator.

2.4.5 Safety Guards

The compressor shall be equipped with safety guards that meet all OSHA requirements. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts shall be so located as to be fully enclosed or guarded to prevent a person coming in contact therewith.

2.4.6 Compressor Lubricant

The compressor manufacturer shall recommend the types of lubricant required for the compressor. This information shall be included in the Operation and Maintenance manual. Each compressor shall be provided with initial fill of all lubricants and sufficient spare lubricant shall be provided to fill two compressors.

2.4.7 Compressor Cabinet

The drawings show the general dimensions and layout of the compressor cabinet. The Contractor shall be responsible for the final design and dimensioning of the cabinet. The air compressor cabinet shall be made of steel (gauge per manufacturer), be insulated, and be weathertight. The cabinet shall be furnished by the compressor manufacturer. A 110 volt, 1 phase, 500 watt heater shall be installed and wired inside the cabinet. The cabinet shall provide for outdoor and unprotected service of the compressor unit. The cabinet shall be shipped completely assembled as a unit with the compressor. Hardware shall be stainless steel or cadmium plated. All panels and latches shall be quick releasing. Maximum decibel rating shall be 85 db when the compressor is operating. Cabinet shall be welded construction and primed and finished per manufacturer's recommendations. Cabinet shall allow complete access for maintenance to the compressor and motor.

a. Vibration isolation mounting pads shall be provided between the compressor unit and the lock machinery base. Mountings shall be as recommended by the compressor manufacturer.

b. A 110 volt, 500 watt, heater shall be provided for the compressor cabinet.

c. A combination motor starter and disconnect shall be mounted on the outside of the compressor cabinet.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Connections to Existing Piping

The Contractor shall connect the new galvanized piping system to the existing stainless steel piping system as shown on the Contract Drawings and as described herein. An inspection of the existing bubbler pipe system shall be performed as described in Paragraph: Connection of New Piping to Existing Piping.

3.1.2 Welding Procedures

Welding shall be done in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with Section IX, ASME Boiler and Pressure Vessel Code and AWS D1.1. The Contracting Officer shall be notified at least 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

3.2 INSTALLATION

3.2.1 Installation

Unless otherwise indicated or specified, all materials and equipment shall be installed in accordance with the manufacturer's recommendations.

3.2.2 Pipe and Fittings

The piping shall be carefully laid out in advance, and unnecessary cutting of construction and materials shall be avoided. Pipe openings shall be closed with caps or plugs during installation. Equipment shall be tightly covered and protected against dirt, water, chemicals and mechanical injury.

3.2.3 Connection of New Piping to Existing Piping

At the locations shown on the drawings, mechanical or grooved couplings will be used to connect the new galvanized piping to the existing stainless steel piping. Before starting this work, the Contractor shall inspect the existing pipe at all four gate corners. The condition of the pipe, number of temporary fittings and valves, and the type of pipe connections shall be reported to the Contracting Officer.

a. The Contractor shall remove all temporary pipe, valves, fittings, and reducers that are installed in each corner of the lock. This

piping shall be turned over to the Contracting Officer. The Contractor shall remove pipes and fittings down to the 3" stainless steel crossover, 3" stainless steel screen supply, 2-1/2" stainless steel recess supply, and 2" stainless steel gate supply in each gate corner. These existing pipes all have grooved ends. The Contractor shall reduce from these existing pipes to the sizes shown on the drawings. The Contractor may accomplish this reduction in two stages. Connection to the galvanized piping shall be a grooved joint.

3.2.4 Joints

Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Threaded joints shall have American National Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied. Dielectric fittings shall be installed between threaded ferrous and nonferrous pipe, fittings and valves. Dielectric joints shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure. They shall be used where indicated on the drawings or wherever ferrous and nonferrous piping or piping components are joined.

3.2.5 Assembly

Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. A thin, uniform coat of manufacturers lubricant shall be applied by brush or by hand by: 1) brushing lubricant on the gasket lips (ID) and the entire exterior of the gasket; 2) brushing lubricant on the pipe ends around the entire pipe circumference. The gasket shall be placed over one pipe end, the pipe ends aligned and brought together and the gasket positioned between the groove on each pipe end. The housing shall be assembled over the gasket with the housing key section engaging both grooves. The bolts shall be inserted, nuts started and uniformly tightened until the housing bolt pads are firmly together, metal-to-metal.

3.2.6 Heat Tracing

Contractor shall remove all existing heat tracing in each gate corner. This heat tracing shall be turned over to the Contracting Officer. New heat tracing shall be installed in the existing stainless steel crossover pipe (landside and riverside), screen supply pipe, recess supply pipe and gate and quoin supply pipe as shown on the drawings.

3.2.7 Electrical Work

Starting and stopping of the compressors shall be provided in the downstream control stand as shown on the drawings. Electric wiring shall be in accordance with SECTION: LOCK ELECTRICAL WORK. Conduit, wiring, control, signal devices, and all associated equipment required for the work herein specified, shall be provided under this section of the specifications.

3.2.8 Labels

Compressed air piping shall be identified with stick on labels. Labels

shall be applied at the manifold area. Labels shall be similar or equal to Brady Pipe Markers as manufactured by W. H. Brady Co. of Milwaukee, Wisconsin. Labels shall be preprinted, self-sticking with printing in contrasting colors, and be suitable for exposure to rain, sun, heat, and cold. Flow direction arrow labels shall be of the same material and color with contrasting arrows. Length of labels shall be as necessary to contain printing and provide 1/2 inch margin at each end. Length of color field and width of labels shall be as shown in ASME A13.1. Printing shall be in heavy block letters in sizes shown in ASME A13.1. Banding tape shall be 1-1/2 inches wide for pipes 3 inches and under, and 2-1/4 inches wide for pipes 3-1/2 inches and over. Banding shall encircle pipe and overlap not less than 1/4 inch on circumference. Tape color shall be the same as the label. Color-code tape shall be applied around the pipe at both ends of label and overlap the label 1/4 inch.

3.2.9 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.2.10 High Pressure Test

After the piping is installed and the joints completed (but before connections to the compressor and the existing piping are completed) piping shall be subjected for 1 hour to a pneumatic pressure test of 150 psig. Before starting the one hour time period, each valve shall be opened and closed several times while subject to 150 psig. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, hose, joints, fittings, and valves, discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory. The Contractor shall supply all equipment and materials for this test.

3.2.11 Low Pressure Test

After the high pressure test and final connections to the compressor and existing piping are completed, a low pressure test shall be conducted. The test shall consist of raising the system pressure to the highest pressure possible using the system air compressor, with the water level at the upper pool and holding the pressure for 1 hour. During the test, each final connection joint shall be checked for leaks with a soap solution.

3.2.12 Compressor Test

All the compressors shall be operated for a period of one hour. Operation of the compressor control system shall be demonstrated. Operation of the disconnects shall be demonstrated. Access to the compressor for maintenance and to check diagnostic information shall be demonstrated.

3.2.13 Field Training

The bubbler system supplier/installer shall schedule 3 hours of field training for the lock force. The training shall cover all aspects of the bubbler system including the compressor, heat tracing, valve operation, etc. All questions from the lock forces shall be addressed. A summary of

the operation and maintenance manual shall be given. Complete information on service and parts availability shall be provided to the lock forces.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15410

PRECAST SHOWER RECEPTORS AND JANITOR'S SINK

-- End of Section Table of Contents --

SECTION 15410

PRECAST SHOWER RECEPTORS AND JANITOR'S SINK

PART 1 GENERAL

This section covers the furnishing and installation of precast shower and janitorial mop basins with terrazzo finish.

1.1 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Sink Literature; FIO.

Manufacturer's data including catalogue information and installation instructions shall be submitted.

PART 2 PRODUCTS

Receptors shall be reinforced, one piece units of the sizes indicated with integrally cast drain body, stainless steel strainer plate, and terrazzo finish. Receptors shall be fabricated with integral 16 gauge galvanized steel tiling flanges at all receptor edges adjacent to walls. Terrazzo finish shall be in accordance with SECTION: TERRAZZO. The contracting officer shall select color from available standard or optional colors provided by the manufacturer.

2.1 PRECAST SHOWER (Rooms 106 and 108)

Shower receptor curb design shall meet handicap accessibility requirements.

2.2 JANITRIAL MOP BASINS (Rooms 110 and 207)

Janitorial mop basins shall be 12 inches high.

PART 3 EXECUTION

3.1 INSTALLATION

Install unit as shown and in accordance with manufacturer's instructions. Work shall be straight, level, well anchored, and sightly. The Contractor shall coordinate all details and dimensions. Sealants shall be as specified in SECTION: CAULKING AND SEALING. Hook-up to supply and waste piping shall be as specified in SECTION: PLUMBING.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15556

HEATING SYSTEMS

-- End of Section Table of Contents --

SECTION 15556

HEATING SYSTEMS

PART 1 GENERAL

This section covers the heating system components, oil-fired, hot water, and electric. The system includes the equipment, equipment controls, testing, and venting of appliances.

1.1 RELATED WORK OF OTHER SECTIONS

The following items of related work are covered under other sections:

(1) Field Painting. SECTION: PAINTING, GENERAL.

(2) Equipment. SECTION : AIR-CONDITIONING SYSTEM.

(3) Controls. SECTION: HEATING, VENTILATING AND AIR CONDITIONING CONTROL SYSTEMS.

(4) Electrical combustion and safety controls connections: SECTION: LOCK ELECTRICAL WORK.

(5) Structural attachments material and installation: SECTION: STRUCTURAL STEEL.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS

ANSI Z223.1	(1999) National Fuel Gas Code (NFPA 54)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 53	(1999B) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
ASTM B 32	(1996) Standard Specification for Solder Metal
ASTM B 62	(1993) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 75	(1997) Standard Specification for Seamless Copper Tubing
ASTM B 88	(1996) Seamless Copper Water Tube

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) PUBLICATIONS

ASME A13.1	(1996) The Scheme for Identification of Piping Systems
ASME B1.20.1	(1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings Class 150 and 300
ASME B16.4	(1998) Cast Iron Threaded Fittings, Classes 125 and 250
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.18	(1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Gaskets for Pipe Flanges
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.33	(1990) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psi (Sizes 1/2" through 2")
ASME B31.1	(1998) Power Piping
ASME BPV IV	(1998) Boiler and Pressure Vessel Code; Section IV, Rules for Construction of Heating Boilers
ASME BPV VIII	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1992) Controls and Safety Devices for Automatically Fired Boilers

HYDRONICS INSTITUTE (HYI)

HYI-03	Testing and Rating Standard for Heating Boilers

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS) STANDARDS

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design, and Manufacture

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-83	(1993) Steel Pipe Unions Socket-Welding and Threaded

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATIONS

NFPA 30	(1996) Flammable and Combustible Liquids Code
NFPA 31	(1999) Standard for the Installation of Oil Burning Equipment
NFPA 54	(1999) National Fuel Gas Code
NFPA 70	(1999) National Electrical Code (NEC)
NFPA 85A	(1987) Explosion Prevention Single Burner Boiler - Furnaces, Oil or Gas Fired
NFPA 90B	(1996) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 211	(2000) Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances

UNDERWRITERS' LABORATORIES, INC. (UL) PUBLICATIONS

UL Gas and Oil Equipment Dir	(1989) Gas and Oil Equipment Directory
UL 103	(1994) Chimneys, Factory-Built, Residential Type and Building Heating Appliance
UL 567	(1992) Pipe Connections for Flammable and Combustible Liquids and LP-Gas
UL 726	(1986) Oil Fired Boiler Assemblies
UL 860	Pipe Unions for Flammable and Combustible Fluids and Fire Protection Service

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts Data; FIO.

After approval of the shop drawings, the Contractor shall furnish spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by

the manufacturer to be replaced after 1 and 3 years of service. Provide a copy of this data in the Operating and Maintenance Instructions.

SD-04 Drawings

Heating System Shop Drawings; GA.

Shop drawings shall show location, size, and all branches of pipeline; location of all shutoff valves; typical details for supports and instructions necessary for the installation of connectors and supports. Schematics and wiring diagrams for the heating equipment shall be provided. The hot water heating system shall be shown in a schematic diagram. Shop drawings shall include installation details for heating equipment. Shop drawings shall be submitted as a single package. Shop drawings shall include the following:

(a) furnaces
(b) boilers
(c) hot water pump
(d) hot water heating system layout
(e) electric heaters
(f) hot water unit heaters
(g) fin tube radiators
(h) piping, valves, fittings, air vents. Submit certificates of compliance for the piping
(i) expansion tank
(j) flues for the oil burning appliances. Submit installation details.

SD-06 Instructions

Framed Instructions; FIO.

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, including equipment, ductwork, dampers, and control sequence, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The framed instructions shall be posted before acceptance testing of the systems.

SD-09 Reports

Performance Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust all the heating system equipment and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

SD-13 Certificates

Certificate of Compliance; FIO.

Where materials or equipment are specified to comply with requirements of

the ARI, ASHRAE, ASME, etc., proof of such compliance shall be submitted. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. As an alternative to the above requirements, the manufacturer may submit a standard computer product selection printout based on the manufacturer's certified test data. Manufacturer shall certify that the computer selected equipment meets the requirements of ARI or ASHRAE and will meet the capacity indicated on drawings. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication and installation shall conform to the code.

SD-19 Operation and Maintenance Manuals

Operation Instructions; FIO.

Operating Instructions. The Contractor shall furnish six complete copies of Operation and Maintenance manuals on the heating equipment. Manuals shall list instructions outlining the step-by-step procedures required for system start-up, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, a complete set of shop drawings, and brief description of all equipment and their basic operating features. All finalized shop drawings shall be incorporated into the manual.

Maintenance Instructions; FIO.

Maintenance Instructions. The Contractor shall furnish six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns, repairs and a troubleshooting guide. The instructions shall include equipment layout and simplified wiring and control diagrams for the system as installed.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used.

2.1.2 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

2.1.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.4 Delivery and Storage

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Pipe and Pipe Fittings

Fuel oil piping shall be black iron conforming to ASTM A 53. Hot water heating system piping shall be either black iron or galvanized steel conforming to ASTM A 53, or copper tubing type L in accordance with ASTM B 88. Malleable iron threaded fittings shall conform to ASME B16.3. Pipe connections shall conform to UL 567.

2.2.2 Sealants for Pipe Threaded Joints

Joint sealing compound shall be as listed in the UL Gas and Oil Equipment Directory and suitable for use in fuel oil systems.

2.2.3 Identification

Identify all exposed piping and piping in accessible plenums and chases with factory printed labels or one inch high black stencil letters on pipe or insulation consisting of pipe identification and flow direction arrow. Apply marker where view is unobstructed. Markers or stenciling shall be applied close to valves and changes in direction, branches, or where pipes pass through walls or floors and at intervals on straight pipe not exceeding a spacing of 50 feet. Markers shall conform with "The Scheme for Identification of Piping Systems", ASME A13.1. Valves shall be identified per MSS SP-25.

2.2.4 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.2.5 Escutcheons

Escutcheons shall be chromium-plated steel or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

2.2.6 Insulating Joint Material

Insulating joint material shall be provided between threaded metallic pipe systems where shown to control galvanic or electrical action.

a. Joints for threaded pipe shall be steel body nut type dielectric unions with insulating gaskets.

2.2.7 Valves

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.2.7.1 Valves 2 Inches and Smaller

Valves 2 inches and smaller shall conform to ASME B16.33 and shall be of materials and manufacture compatible with system materials used.

2.2.7.2 Valves

Valves in non-boiler external piping shall meet the material, fabrication and operating requirements of ASME B31.1. Flow control valves shall be designed for easy cleaning without disconnecting piping.

2.2.7.3 Drain Valves

Air charging and drain valves shall be designed for air to flow to top of tank and for the displaced water to flow back to the system. Air valves shall be key-operated, heavy-pattern type.

2.2.7.4 Angle, Gate, Check and Globe Valves

Angle, gate, check, and globe valves shall be the type and class required. Where suitable, iron body with bronze trim may be substituted for bronze body and bronze trim valves.

2.2.7.5 Balancing Valves

Balancing valves 2 inches or smaller may be bronze with threads for black steel pipe and sweat connections for copper tubing. The valve shall have provisions for connecting a portable differential pressure meter. Each meter connection shall have positive shut-off valves. The valve shall be globe style design and all metal parts of nonferrous, pressure die cast, nonporous copper alloy. Each valve can be installed in any direction without affecting flow measurement and shall provide four functions; precise flow measurement, precision flow balancing, positive shut-off with no drip seat and Teflon disc, and drain connection with protective cap. The valve shall have four 360 degree adjustment turns of the handwheel, memory settings, and tamper proof balancing setting. The valve shall come standard with removable insulating container.

2.2.7.6 Fire Shut-off Valve

Oil supply line to each oil burner shall be equipped with an automatically operated valve designed to shut off the oil supply in case of fire in the immediate vicinity of the burner. Valve may be of the thermoelectrically actuated or thermomechanically actuated type. Valve shall be located immediately downstream of manual shut-off valve at storage tank inside of building, or immediately downstream of other shut-off devices where oil supply line enters the building. Thermoelectrical or thermomechanical detection device shall be located over the oil burner. Fire shut-off valve may be combined with other automatic shut-off devices if listed in the Factory Mutual Approval Guide of the Factory Mutual System or in the Gas and Oil Equipment List of the Underwriters' Laboratories.

2.2.8 Hangers and Supports

Pipe hangers and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 HOT WATER BOILER

2.3.1 General

Boiler equipment shall include the oil burner, motor, ignition equipment,

controls, oil pipe and fittings, and all the other items necessary for the complete installation of a fully automatic oil-burning heating system. The oil-burning equipment shall conform to the requirements of the Gas and Oil Equipment List of the Underwriters' Laboratories, Inc., or as approved equipment of the Factory Mutual System, and shall be installed in accordance with National Fire Protection Association Standards No. 30 and 31.

2.3.1.1 Boiler

The boiler shall have the output capacity in British thermal units per hour (Btuh) as indicated when fired with No. 2 fuel oil. The boiler shall be furnished complete with the oil burning equipment, boiler fittings and trim, automatic controls, forced draft burner, electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boiler shall be designed, constructed, and equipped in accordance with ASME BPV IV, Boiler and Pressure Vessel Code; Section IV, and American Boiler Manufacturers Association (ABMA). The boiler shall be of the cast iron type and designed for water service as specified herein. The boiler capacity shall be based on the ratings shown in the HYI-03 or as certified by the American Boiler Manufacturers.

2.3.2 Capacity

The boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. The boiler design conditions shall be as follows:

a. Boiler design pressure 30 psig.

b. Operating pressure at boiler outlet 20 psig.

c. Hot water temperature 180 degrees F.

d. Temperature differential between boiler outlet and inlet 20 degrees F.

e. Room ambient air temperature 105 degrees F (max), 45 degrees F (min.).

f. Site elevation 700 feet.

g. Minimum continuous capacity as specified.

h. Boiler shall have an Annual Fuel Utilization Efficiency of at least 83 percent.

2.3.3 Fittings and Accessories

Boiler fittings and accessories shall be installed with each boiler in accordance with the ASME BPV IV, Boiler and Pressure Vessel Code, Section IV, unless otherwise specified.

2.3.3.1 Thermometers

Thermometers for inlet water and outlet water shall be provided for the boiler in a visible location on the boiler.

2.3.3.2 Pressure Gage

A pressure gage shall be provided for the boiler in a visible location on the boiler.

2.3.3.3 Safety Valves

Boiler relief safety valves of proper size and of the required number shall be so installed that the discharge will be through piping extended to four inches above finished floor. Boiler shall have at least one valve set to discharge at or below the maximum allowable working pressure of the boiler. Additional valves may be set within a range not to exceed 6 psi above the maximum allowable working pressure for boilers having working pressures up to and including 60 psi or 5 percent above the maximum allowable working pressure for boilers having working pressures exceeding 60 psi.

2.3.3.4 Drain Valves

Drain valves in tandem shall be provided at each drain point of blowdown as recommended by the boiler manufacturer. Piping shall conform to ASME B31.1 and shall be extra-strong weight black steel pipe conforming to ASTM A 53.

2.3.3.5 Water Temperature Controller

The controller regulating the boiler-water temperature shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed in the upper part of the boiler near the water outlet. The controller shall operate on a 10 degree F. differential over an adjustable temperature range of approximately 100 to 220 degrees F. The water temperature controller shall control the fuel burning equipment to maintain set temperatures as specified in paragraph COMBUSTION CONTROL EQUIPMENT.

2.3.4 Combustion and Safety Controls and Equipment

Control systems and safety devices for automatically fired boilers shall conform, as a minimum, to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz. A 4-inch diameter alarm bell shall be provided with a suitable transformer and shall be located on boiler control panel. The alarm bell shall ring when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure and a green light shall indicate that the main fuel valve is open. The following shut-down conditions shall require a manual reset before the boiler can automatically recycle:

a. Flame failure.

b. Failure to establish pilot flame.

c. Failure to establish main flame.

d. High temperature cutoff.

e. Low water cutoff.

2.3.5 Oil Burners and Controls

Oil-fired burners and controls for oil-fired units firing No. 2 oil shall be atomizing, forced-draft type in conformance with UL 726. Boiler shall be provided with on-off or high-low-off combustion control as scheduled. Controls shall be provided to include protection for high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown.

2.3.6 Boiler Treatment Feeders; One Shot

Provide as indicated, one-shot feeder sized by the contractor for the chemicals required.

a. Tank. Construct of cast iron, tapped for 3/4" feed inlet and outlet in top and bottom, 3/8" drain at bottom, and 3/8" vent and fill at top.

b. Specialties. Provide 1/2" stainless steel petcock in vent opening, 1/2" stainless steel drain valve in drain opening, two 3/4" isolation valves, 2 unions, and 1/2" funnel with hinged cover and globe valve in fill opening.

2.3.7 Combustion Control Equipment

Combustion control equipment shall be provided as a system by the boiler manufacturer. The boiler water shall be maintained at a fairly constant temperature by a water temperature controller. The water temperature controller shall monitor the boiler leaving water temperature and shall start or stop the burner as required to maintain setpoint. The equipment shall operate electrically. Operating and limit controls shall be wired to interrupt the ungrounded circuit conductor.

2.3.8 Hot Water Circulating Pumps

The circulating pump for hot water shall be an electrically-driven single-stage centrifugal type. The pump shall be in-line type supported by the piping on which installed. The pump shall have a capacity as scheduled and shall be either integrally mounted with the motor or direct-connected by a flexible-shaft coupling on a cast-iron or steel subbase. The pump shaft shall be constructed of corrosion resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. The motor shall have sufficient power for the service required, shall be of a type approved by the manufacturer of the pump, shall be suitable for the available electric service. Each pump suction and discharge connection shall be provided with a pressure gauge. The pump discharge header shall be provided with a pressure switch and a flow metering system. Pressure switch unit shall be a self-contained snap action type to indicate fluid pressure. Switch shall be a SPDT with 120-volt, 15-ampere rating. Flow element shall be of the averaging pitot differential pressure type constructed of 316 stainless steel and shall consist of a fabricated sensing tube with internal chamber(s) and an instrument head to transmit the pressures to a portable

flow indicating meter. Meter shall be direct reading, indicating units of gpm, and shall have an indicating range of twice the design flow rate. One portable flow meter shall be provided. See SECTION: HEATING, VENTILATING AND AIR CONDITIONING CONTROL SYSTEMS for sequence of operation. Pump shall be designed to continuously operate at 240 degrees F without external cooling.

2.3.9 Breaching and Flue

2.3.9.1 Breaching

The boiler shall be connected to the flue by breaching constructed of black steel sheets not less than 0.0478-inch thick nor less than thickness of stack whichever is larger. The clear distance between any portion of the breaching surface and any combustible material shall not be less than that specified in the NFPA 211. Joints and seams shall be securely fastened and made airtight. Suitable hinged and gasketed cleanouts shall be provided which will permit cleaning the entire smoke connection without dismantling. Flexible type expansion joints shall be provided as required and shall not require packing.

2.3.9.2 Flue

Flue for the boiler shall be as specified in Paragraph: Venting of Oil Burning Appliances. The flue shall be in accordance with ANSI Z223.1 and NFPA 54.

2.3.10 Expansion Tank

2.3.10.1 General

The pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. The expansion tank shall have capacity as scheduled.

2.3.10.2 Design

The expansion tank shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII, Boiler and Pressure Vessel Code, Section VIII, for a working pressure of 125 psi and pre-charged to the minimum operating pressure. The tank's air chamber shall be fitted with an air charging valve. The tank shall be supported by steel saddles for horizontal installations. The tank shall have lifting rings and a drain connection. All components shall be suitable for a maximum operating temperature of 240 degrees F.

2.3.11 Materials for Heating Plant Installation

Materials and equipment, except as otherwise specified, shall conform to the following requirements:

2.3.11.1 Gaskets

Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thickness, full face or self-centering flat ring type.

The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service.

2.3.11.2 Pipe, Tubing and Fittings

Pipe threads shall conform to ASME B1.20.1.

2.3.11.3 Cast-Iron Fittings

Cast-Iron fittings shall conform to ASME B16.4, Class 125, type required to match connecting piping. Pipe flanges and fittings shall conform to ASME B16.5.

2.3.11.4 Unions

Brass or bronze, type and material as required to match adjacent piping. Steel unions shall conform to MSS SP-83. Fuel piping unions shall conform to UL 860.

2.3.11.5 Copper Tubing

ASTM B 88, Type K or L. Adapters for copper tubing shall be brass or bronze for soldered fittings. Solder shall conform to ASTM B 32.

2.3.11.6 Fittings for Copper Tubing

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.3.12 Anchors and Expansion Provisions

Provide anchors for all piping subject to thermal expansion/contraction or other movement to permit free expansion and prevent binding or buckling. This shall be accomplished for all such piping even when not shown on the drawings. Anchors shall be provided at points indicated and as directed by the Government. Provide an anchor between each loop, or offset. Expansion provisions shall be provided on all heated or chilled lines including domestic hot, circulating hot, tempered, hydronic heating where shown and wherever lines run straight for 150 feet for water.

a. Expansion provisions shall consist of loops or offsets. Where a particular type of expansion provision is shown on the drawing or specified in a subsequent section, the substitution of loops for joints or vice verse shall not be made without the Government's approval.

b. Provide pipe alignment guides before and after each expansion joint or loop to guide expanding pipe to permit free movement without binding. Two guides are required on each site of the expansion device. The first guide shall be located from 3 to 4 pipe diameters away from the joint or loop; the second guide shall be 10 to 14 diameters away. Guides shall not be used to substitute for hangers or other pipe supports, unless approved for this purpose by the manufacturer.

2.3.13 Backflow Prevention Devices

Backflow prevention devices shall be as specified in SECTION: PLUMBING. A backflow prevention device shall be installed between the potable water supply and the boiler makeup water connection. The backflow prevention device shall be installed where indicated and located so that no part of the device will be submerged. Access shall be provided for maintenance and testing. The device shall be a standard commercial unit.

2.3.14 Strainers

Basket or "Y" type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be heavy and durable, fabricated of cast iron, and shall have bottoms drilled and plugged. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The basket shall be made of 22-gage brass sheet, monel or corrosion-resistant steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the basket and out through the perforations and the inlet side shall be fitted with a blow-down pipe line to an accessible location and provided with a blow-down valve.

2.3.15 Air Separator

An air separator shall be furnished and installed as shown on the drawings. The separator shall be constructed for 125 psi working pressure, stamped and supplied with written compliance with the ASME Boiler and Pressure Vessel Code. The unit shall have flanged inlet, outlet, and strainer removal connections. The removable strainer shall be of stainless steel with 3/16 inch diameter perforations and a free area of not less than five times the cross-sectional area of the connection pipe. A blowdown connection shall be provided for routine cleaning. Separator shall be provided with a "float" type automatic air eliminator with operating pressure range from 2 psig to 50 psig. The separator shall be an Amtrol, Inc. model 2 1/2-AS or approved equal.

2.4 OIL FIRED FURNACE

2.4.1 General

Oil furnace equipment shall include the oil burner, motor, ignition equipment, controls, oil pipe and fittings, and all the other items necessary for the complete installation of a fully automatic oil-burning heating system. The oil-burning equipment shall conform to the requirements of the Gas and Oil Equipment List of the Underwriters' Laboratories, Inc., or as approved equipment of the Factory Mutual System, and shall be installed in accordance with National Fire Protection Association Standards NFPA 30 and NFPA 31.

2.4.1.1 Oil-fired Furnaces

Oil-fired furnaces shall be U.L. listed and shall be complete, packaged units which include burner, heat exchanger, blower, filters, and controls, all factory assembled and wired. Combustion chamber access door and service panels shall be provided.

2.4.1.2 Cabinet

Cabinet shall be constructed of heavy gauge steel insulated with spun glass and aluminum foil as required to limit cabinet temperature from exceeding 120^{O} F. Cabinet shall completely enclose flue collector box and shall include top flue outlet and access doors for easy access to burner section, controls, and blower.

2.4.1.3 Heat Exchanger

Heat exchanger shall be heavy gauge hot rolled alloy steel, welded inside and out, and pressure tested for leaks. Radiator shall be wrap-around type with interior baffling for maximum heat transfer.

2.4.1.4 Blower

Blower shall be direct-drive, squirrel cage type, permanently lubricated and resiliently mounted. Blower motor shall be at least 2-speed, designed for continuous operation and thermally protected. Entire blower assembly with motor shall be easily removed for servicing.

2.4.1.5 Filters

Filters shall be 1" throwaway installed in a side return filter frame between furnace casing and return air plenum.

2.4.2 Oil Burner

Oil burner shall be air atomizing type, suitable for handling No. 2 commercial fuel oil without preheating the oil. The burner shall be quiet in operation and shall operate with a balanced flame so as not to localize heat in any part of the combustion chamber. The burner shall be capable of completely atomizing and effectively mixing the oil with air so as to insure complete combustion. The air admitted shall be of sufficient quantity for complete combustion, but not of such quantity as to produce an undue percentage of excess air with attendant high stack loss. The oil burner shall operate without clogging or failure, and shall have sufficient capacity to develop not less than the specified heating capacity. The oil burner shall conform to the Department of Commerce, Commercial Standard CS75 as applicable. The burner units shall be easily removed from firing position and readily accessible for inspection, cleaning, and other purposes. Each burner shall be provided with synchronized control of the quantity of oil, primary air, and secondary air supplied. Burners for No. 2 commercial fuel oil shall be equipped with either direct electric ignition or electric-spark-ignited pilot-ignition systems. Burner shall be factory pre-wired, pre-assembled and tested. Burner shall be shipped assembled in furnace ready to connect to fuel oil supply line.

2.4.3 Motors

Motors shall be of the totally enclosed, fan-cooled type and shall have sufficient capacity to operate the oil pump and fan so as to develop the specified rating.

2.4.4 Automatic Draft Regulator

Automatic draft regulator shall be installed in the side of each smoke pipe when No. 2 fuel oil is used. The regulator shall consist of a weighted and balanced damper of proper size for the actual capacity. The damper shall open or close automatically as the chimney draft varies, so as to maintain

a constant draft at the furnace outlet.

2.4.5 Controls

Safety controls shall conform to and shall be installed in accordance with the requirements of the Underwriters' Laboratories, Inc, or of the Factory Mutual System. Controls shall include constant ignition primary control and combination blower and limit control, all factory connected, installed, tested, and ready to connect. Accessories shall include a cad cell operated primary oil burner control, and heating/cooling programmable thermostat.

a. Safety stack switch or other approved device shall automatically shut off the burner in case of flame failure either when starting or during normal operation of the burner.

2.4.6 Cooling Coil Enclosure

Accessories shall include a combination cooling coil enclosure, plenum, and economizer box in accordance with SECTION: AIR-CONDITIONING SYSTEM. Field install with proper transitions if coil plenums are smaller or larger than matching furnace.

2.4.7 Finish

The exterior surface of all exposed surfaces of all ferrous metal appurtenances such as supports, bracing and the like which are not factory finished shall be cleaned, primed and painted as specified in SECTION: PAINTING, GENERAL.

2.5 UNIT HEATERS AND FIN TUBE RADIATION

2.5.1 Unit Heaters

Unit heaters shall be rated and tested in accordance with AMCA 210 and shall have Btu capacities not in excess of 125 percent of that scheduled. The noise level of each unit heater shall be appropriate for the space in which the heater is installed.

2.5.1.1 Propeller Type Unit Heaters

Propeller unit heaters shall be designed for suspension. The casings shall be constructed of not less than 16 gage steel. Suitable stationary or rotating air deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes shall not be permitted. Discharge shall be arranged for horizontal and vertical flow of air as indicated on plans. Fan or vertical discharge heaters shall operate at speeds not in excess of 1200 rpm, except that units with 50,000 Btu output capacity or less may operate at speeds up to 1,800 rpm. Horizontal discharge unit heaters shall have discharge or face velocities not in excess of the following:

Unit capacity, cubic feet per minute	Face velocity, feet per minute
Up to 1000	800
1001 to 3000	900
3001 and over	1000

2.5.1.2 Heating Elements

Heating coils and radiating fins shall be of suitable nonferrous alloy. The heating elements shall be free to expand or contract without developing leaks and shall be properly pitched for drainage. The elements shall be tested under a hydrostatic pressure of 200 psi and a certified report of the test shall be submitted to the Contracting Officer. Coils shall be suitable for use with water up to 250 degrees F.

2.5.1.3 Motors

Motors shall be permanently split capacitor type and shall be equipped with thermal overload protection.

2.5.2 Fin Tube Radiation

Fin tube shall be copper tube, aluminum fin with capacity as scheduled. Fin tube shall be provided with aluminum enclosure and clear anodized finish. The enclosure shall have a continuous grille.

2.6 ELECTRIC SPACE HEATING EQUIPMENT

2.6.1 Safety

The Contractor shall submit proof to the Contracting Officer, that the materials, appliances, equipment or devices that he furnishes and installs under this contract, meet the Underwriters' Laboratories, Inc. requirements regarding fire and casualty hazards. The label of, or listing by, the Underwriters' Laboratories, Inc. will be accepted as conforming with this requirement.

2.6.2 Codes

Unless otherwise specified, all work shall be in accordance with the NEC, NFPA 70.

2.6.3 Electric Heaters

2.6.3.1 General

Electric heaters shall have wattage, voltage, phase, and Btu/hr output as shown on the drawing. Electric wall heaters shall be floor mounted. Complete heater assembly shall comply with the requirements of the Underwriters' Laboratories, Inc. and the requirements hereinafter specified. Each unit heater shall be provided with terminals for control circuits as necessary and for a single source of power supply. Maximum leaving air temperature shall not exceed 160^{O}F with 70^{O}F entering air. Length of wall heaters shall be as shown on the drawings.

2.6.3.2 Heating Elements

Heating elements shall consist of steel-finned metal sheath. Elements shall be free from expansion noise and 60-cycle hum.

2.6.3.3 Enclosure

Architectural design grille, 16-gauge bar grille with duronodic brown baked enamel finish. Wall housing shall be 20-gauge zinc-coated steel. Provide

surface-mounted frame accessory for installation.

2.6.3.4 Fans and Motors

Fans shall be propeller type direct connected to fan motor, dynamically balanced. Fan motor shall be totally enclosed, continuous duty with built-in automatic reset thermal overload protection. Motor speed shall not exceed 1,800 RPM. Motors shall be wired to the heater power supply source.

2.6.3.5 Limit Controls

Thermal overheat protection of unit shall be provided and located to protect against overheating of unit from any cause.

2.6.3.6 Contractor

Magnetic contractors, where required, shall be factory installed, which shall disconnect all ungrounded conductors to the heater. Contractor shall be rated for 100,000-cycle duty. A control transformer shall be provided when necessary to supply 120-volt thermostat control circuit for each heater.

2.7 TOOLS

Special tools shall be furnished; including all uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems and other equipment. Small hand tools shall be furnished and stored where directed.

2.7.1 Smoke Pipe Cleaner

A cleaner shall be provided to clean the breeching. The cleaner shall have a jointed handle of sufficient length to clean the breeching without dismantling.

2.7.2 Tube Cleaner

A water driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and all other appurtenances necessary for operation shall be provided. The tube cleaner and rotary brush shall be provided for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings shall be provided to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

2.7.3 Tube Brush

A tube brush, with steel bristles and jointed handle of sufficient length to clean full length of firetubes, shall be provided.

2.8 VENTING OF OIL-BURNING EQUIPMENT

Venting shall be as indicated; design, type, materials, size, location and installation of vents shall conform to the requirements of ANSI Z223.1.

2.8.1 Oil-Burning Equipment

Equipment shall be vented using U.L. listed double-wall, stainless steel, factory built Class A chimney, Metalbestos or equal.

a. The chimney shall be capable of continuous operation at 1,000°F flue gas temperatures at two inches clearance, in accordance with UL 103.

b. The stainless steel inner liner shall have a #430 or equal corrosion resistance.

c. An annular one-inch space between the outer casing and the flue pipe shall be completely filled with non-combustible, high-temperature insulating fill having a thermal conductivity (K factor) not greater than 0.41 BTU/Hr/sq ft/deg F/inch of thickness at 450°F mean insulating temperature.

d. The chimney supports shall be specifically designed for the chimney and U.L. listed, the supports shall be capable of supporting four times the combined weight of the chimney installation, without the use of guy wires for support on the roof.

e. Accessories shall include all necessary supports, flashings, storm collar and round top as detailed on drawings to provide a complete installation.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Welding

Boilers and piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX, Boiler and Pressure Vessel Code, Section IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

3.1.2 Coordination of Work

One contractor shall be responsible for coordinating and installing both the heating and air conditioning systems, ducting, and controls.

3.1.3 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall coordinate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly.

3.1.4 Field Training

Contractor shall conduct a training course for the operating staff, as

designated by the Contracting Officer, on the operation and maintenance of the heating equipment. The training period shall consist of a total three hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

3.1.5 Field Painting

Ferrous metal not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in SECTION: PAINTING, GENERAL. Exposed pipe covering shall be painted as specified in SECTION: PAINTING, GENERAL. Aluminum sheath over insulation shall not be painted.

3.2 EQUIPMENT INSTALLATION

3.2.1 General

Work shall be installed as shown on drawings in accordance with the manufacturer's diagrams, recommendations, and instructions. Boiler installation shall be in accordance with manufacturer's written instructions. Installation shall comply with NFPA 90B

3.2.2 Isolators

Unless otherwise noted, equipment driven by motors 2 HP and smaller shall be isolated by means of Type RVD elastomeric mounts or Type BRD elastomeric hangers properly sized for 1/2 inch deflection. All elastomeric isolators shall be of neoprene of high quality synthetic rubber with anti-ozone and anti-oxidant additives.

3.2.2.1 Type RVD Mount

An elastomeric mounting having a steel baseplate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately 1/2 inch deflection.

3.2.2.2 Type BRD Hanger

An elastomeric hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation and an elastomeric isolation element. The elements shall be designed for approximately 1/2 inch deflection.

3.2.3 Wall Heaters

Wall fin heaters shall be mounted utilizing a surface-mounting frame accessory at a maximum of 12 inches above finished floor or from adjacent wall surface.

3.3 PIPING INSTALLATION

Unless otherwise specified, non-boiler external pipe and fittings shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the job site, shall be worked into place without springing or forcing, and shall properly clear windows, doors, and

other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipes shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damaging the building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted. Vent pipes shall be carried through the roof as directed and shall be properly flashed. Unless otherwise indicated, horizontal supply mains shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unless otherwise specified or shown, final connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter and with flanges for pipe 3 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Reducing fittings shall be used for changes in pipe sizes. In horizontal hot water lines reducing fittings shall be eccentric type to maintain the top of the lines at the same level to prevent air binding.

3.3.1 Cold Water Connections

Cold water fill connections shall be made to the water supply system as indicated. Necessary pipe, fittings and valves required for water connections between the boiler and cold water main shall be provided as shown.

3.3.2 Heating Water Piping

Pipe shall be Schedule 40 galvanized steel or black iron or type "K" copper tubing. Copper tubing shall be rated for the temperature and pressures of the system.

3.3.3 Fittings

Fittings adjacent to valves shall suit valve material.

3.3.4 Vent Piping

Vent piping shall be Sch. 40 black steel.

3.3.5 Gage Piping

Piping shall be type "K" copper tubing.

3.3.6 Joints

Joints between sections of steel pipe and between steel pipe and fittings shall be threaded, grooved, flanged or welded as indicated or specified. Except as otherwise specified, fittings 1 inch and smaller shall be threaded; fittings 1-1/4 inches and up to but not including 3 inches shall be either threaded, grooved or welded; and fittings 3 inches and larger shall be either flanged, grooved, or welded. Pipe and fittings 1-1/4 inches and larger installed in inaccessible conduits or trenches beneath concrete floor slabs shall be welded. Connections to equipment shall be made with black malleable iron unions for pipe 2-1/2 inches or smaller in

diameter and with flanges for pipe 3 inches or larger in diameter. Joints between sections of copper tubing or pipe shall be flared or sweated.

3.3.6.1 Threaded Joints

Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.

3.3.7 Flanges and Unions

Flanges shall be faced true, provided with 1/16-inch thick gaskets, and made square and tight. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Dielectric pipe unions shall be provided between ferrous and nonferrous piping to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, brazed or soldered to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

3.3.8 Branch Connections

Branches from the main shall pitch up or down as shown to prevent air entrapment. Connections shall be carefully made to ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Branches shall pitch with a grade of not less than 1 inch in 10 feet.

3.3.9 Flared and Sweated Pipe and Tubing

Tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with steel wool before sweating. Care shall be taken to prevent annealing of fittings and hard-drawn tubing when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for soldered fittings shall be made with silver solder or wire solder of 95 percent tin and 5 percent antimony composition. Cored solder will not be permitted. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Adapters shall be provided where necessary for joining threaded pipe to copper tubing.

3.3.9.1 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints

shall be brazed in accordance with the NAPHCC National Standard Plumbing Code. Soldered joints will not be permitted.

3.3.10 Supports

3.3.10.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alinement, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.3.10.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein:

a. Types 5, 6, 9, 10, 11, 12, and 26 shall not be used.

b. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.

c. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

d. Where type 39 saddle or type 40 shield are permitted for a particular pipe attachment application, the type 39 saddle shall be used on all pipe 4 inches and larger.

e. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

f. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

g. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

1. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

2. Where there are high system temperatures and welding to piping is not desirable, then the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation,

whichever is greater.

h. Insulated Pipe. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. Cellular glass insulation shall be provided at each pipe support.

i. Structural Attachments. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under SECTION: STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist between panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.

3.3.11 Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.3.12 Valves

Valves shall be installed at the locations shown, where specified and where required for the proper functioning and servicing of the system as directed. Gate valves shall be used unless otherwise shown, specified or directed. Valves shall be installed with their stems horizontal or upright. Valves used with ferrous piping shall have threaded or flanged ends.

3.3.13 Pipe Sleeves

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated where membranes are involved. Sleeves shall not be installed in structural members except where indicated or approved. All rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor or roof, and shall be cut flush with each surface, and sleeves through floors and roofs shall extend above the top surface at least 6 inches for proper flashing or finishing. Unless otherwise indicated, sleeves shall be sized to provide a minimum clearance of 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in waterproofing membrane floors, bearing walls and wet areas shall be galvanized steel pipe or cast-iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls shall be sealed as indicated and specified in SECTION: CAULKING AND SEALING. Metal jackets shall be provided over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs, shall not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.016-inch thick aluminum, if smooth, and shall be secured with aluminum or stainless steel bands not less than 3/8-inch wide and not more than 8 inches apart. When

penetrating roofs and before fitting the metal jacket into place, a 1/2-inch wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 36 inches above the roof. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the backup material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above the floor; when passing through walls above grade, the jacket shall extend at least 4 inches beyond each side of the wall.

3.3.13.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, pipes passing through waterproofing membranes shall be provided with a 4-pound lead flashing or a 16-ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the membrane in a troweled coating of bituminous cement. The flashing shall extend above the roof or floor a minimum of 10 inches. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket covered insulation shall be sealed as indicated. Pipes up to and including 10 inches in diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

3.3.13.2 Optional Sealing of Uninsulated Pipes or Conduits Passing Through Waterproofing Membrane

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between pipe and sleeve or conduit and sleeve in place of a waterproofing clamping flange and caulking and sealing specified above. The seals shall include interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.3.13.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 6 inches in diameter, lead flashing sleeve for dry vents with the sleeve turned down into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe sealed as indicated.

3.3.13.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal

shall be provided as specified in SECTION: FIRESTOPPING.

3.3.14 Balancing Valves

Balancing valves shall be installed on return lines from each circuit branch and on return lines from each space heating unit and as indicated on drawings. Balancing valves shall be Armstrong Series CBV or approved equal.

3.3.15 Thermometer Wells

A thermometer well shall be provided in the return line and supply line near the boiler.

3.3.16 Air Vents

Air vents shall be installed where shown or directed. Air vents shall be installed in piping at all system high points and at all coils, unit heaters, and fin tube heating. The vent shall remain open until water rises in the tank or pipe to a predetermined level at which time it shall close tight. An overflow pipe from the vent shall be run to a point designated by the Contracting Officer's representative. The inlet to the air vent shall have a gate valve or ball valve.

3.3.17 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls or ceilings except in boiler, utility or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or setscrews.

3.3.18 Drains

A drain connection with 1-inch hose gate valve or 3/4-inch hose bib shall be installed at the lowest point in the return main near the boiler, on the heat exchanger coil, on each unit heater. In addition, threaded drain connections with threaded cap or plug shall be installed wherever required for thorough draining of the system.

3.4 HEATING SYSTEM TESTS

3.4.1 Hot Water Piping

Before any covering is installed, the entire heating system's piping terminal heating units and fittings shall be hydrostatically tested and proved tight under a pressure of 1-1/2 times the design working pressure. Upon completion and before acceptance of the installation, the Contractor shall subject the heating system to the operating tests to demonstrate satisfactory functional and operational efficiency. The operating test shall cover a period of at least 24 hours for each system, and shall include the following specific information in a report together with conclusions as to the adequacy of the system:

1. Time, date, and duration of test.
2. Outside and inside dry bulb temperatures.
3. Temperature of hot water supply leaving boiler.
4. Temperature of heating return from system at boiler inlet.
5. Boiler make, type, serial number, design pressure, and rated

capacity.
6. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.
7. Circulating pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.
8. Flue-gas temperature at boiler outlet.
9. Percent carbon dioxide in flue-gas.
10. Grade or type and calorific value of fuel.
11. Draft at boiler flue-gas exit.
12. Draft or pressure in furnace.
13. Quantity of water circulated.
14. Quantity of fuel consumed.
15. Stack emission pollutants concentration.
16. Description of instruments and certificates of calibration.

All indicating instruments shall be read at half-hour intervals unless otherwise directed. The report of the test shall be supplied in quadruplicate to the Contracting Officer. The Contractor shall furnish all instruments, test equipment, and test personnel required for the tests. Operating tests shall demonstrate fuel burners and combustion and safety controls meet the requirements of NFPA 85A. Test instruments and equipment shall be calibrated within the last 6 months.

3.4.2 Fuel Oil Pipe

Before any section of the piping system is put into service, it shall be carefully tested. Prior to testing, the system shall be blown out, cleaned and cleared of all foreign material. Each joint shall be tested by means of an approved detector, soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed or concealed. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Oxygen shall not be used as a testing medium.

3.4.2.1 Pressure Tests

Before appliances are connected, piping systems shall be filled with air or an inert gas and shall withstand a minimum pressure of 10 pounds gage for a period of not less than 10 minutes as specified in ANSI Z223.1 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gage, or an equivalent device so calibrated as to be read in increments of not greater than 0.1 pound. The source of pressure shall be isolated before the pressure tests are made.

3.4.2.2 Purging

After testing is completed, and before connecting any appliances, all piping shall be fully purged. Piping shall not be purged into the combustion chamber of an appliance. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are ignition sources unless the safety precautions recommended in ANSI Z223.1 are followed.

3.4.2.3 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

3.4.3 Cleaning Boilers and Piping

After the hydrostatic tests have been made and before the operating tests, the boilers and feed water piping shall be thoroughly cleaned by filling the system with a solution consisting of wither 1 pound of caustic soda or 3 pounds of trisodium phosphate per 100 gallons of water. The water shall be heated to approximately 150 degrees F and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15653

AIR-CONDITIONING SYSTEM

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SECTION 15653

AIR-CONDITIONING SYSTEM

PART 1 GENERAL

This section covers the furnishing and installing of the air conditioning systems as shown and specified herein, complete with all necessary equipment and required accessories.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFREIGERATION INSTITUTUE (ARI) STANDARD

ARI 210/240	(1994) Unitary Air-Conditioning Equipment
ARI 270	(1995) Sound Rating of Outdoor Unitary Equipment
ARI 440	(1994) Room Fan Coil Air Conditioners
ARI 710	(1995) Liquid-Line Driers
ARI 720	(1997) Refrigerant Access Valves and Hose Connectors
ARI 730	(1986) Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers
ARI 750	(1994) Thermostatic Refrigerant Expansion Valves

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 525	(1993) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A 527	(1990) Steel Sheet Zinc Coating (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM A 528	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality
ASTM A 642	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality, Special Killed
ASTM A 733	(1993) Standard Specification for Welded and Seamless Carbon Steel and Austenitic

	Stainless Steel Pipe Nipples
ASTM B 75	(1997) Seamless Copper Tube
ASTM B 117	(1995) Salt Spray (Fog) Testing
ASTM B 209	(1995) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 280	(1997) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM C 1071	(1998) Thermal and Acoustical Insulation (Mineral Fiber, Duct Lining Material)

AMERICAN SOCIETY OF HEATING, REFREIFGERATION, AND AIR-CONDITIONING ENGINEERS, INC. (ASHRAE) STANDARD

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 16	(1988) Rating Room Air Conditioners and Packaged Terminal Air Conditioners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) PUBLICATIONS

ASME B1.20.1	(1992) Pipe Threads, General Purpose (Inch)
ASME B16.18	(1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME BPV IX	(1998) Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS) STANDARDS

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and

	Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle, and Check Valves
MSS SP-110	(1996) Ball Valves, Threaded, Socket-Welding Solder Joint

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATIONS

NFPA 70	(1999) National Electrical Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; FIO.

After approval of shop drawings, the Contractor shall furnish spare parts data for each different item of materials and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after one and three years of service. Provide a copy of this data in the Operating and Maintenance Instructions.

SD-04 Drawings

AC Shop Drawings; GA.

Shop drawings shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the equipment and systems. Shop drawings shall be provided for cooling coils/plenums, condensing units, controls, and associated appurtenances. Drawings shall include an electrical connection diagram for each piece of mechanical equipment; schematic automatic temperature control diagrams and control sequences; descriptive data of equipment and installation details. Installation details shall include fabrication details for cooling coil plenum. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Shop drawings shall be submitted as a single package. Drawings shall include the following:

(a) Evaporator coils and condensing units. Include performance data, dimensional data, and wiring diagrams.

(b) Roof top air conditioning unit. Include performance data, dimensional data, installation details for the roof curb, and wiring diagrams. Include data on the compressor, cooling coil, and fan. Include installation details for the disconnect switch for the air conditioning unit. Include conduit installation

details.

(c) Window air conditioning unit.

(d) Refrigerant Piping. Submit certificates of compliance. Submit layout drawing of the piping and air conditioning system.

(e) Valves, fittings, filters, driers, supports.

SD-06 Instructions

Framed Instructions; FIO.

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The framed instructions shall be posted before acceptance testing of the systems.

SD-09 Reports

Performance Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

SD-13 Certificates

Certificate of Compliance; FIO.

Where materials or equipment are specified to comply with requirements of the ARI, ASHRAE, or ASME, etc., proof of such compliance shall be submitted. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. As an alternative to the above requirements, the manufacturer may submit a standard computer product selection printout based on the manufacturer's certified test data. Manufacturer shall certify that the computer selected equipment meets the requirements of ARI or ASHRAE and will meet the capacity indicated on drawings. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

UL Listing; FIO.

UL Listing. The Contractor shall submit proof to the Contracting Officer, that the electrical appliances, equipment or devices that he furnishes and installs under this contract, meet the Underwriters' Laboratories, Inc. requirements regarding fire and casualty hazards. The label of, or listing

by, the Underwriters' Laboratories, Inc. will be accepted as conforming with this requirement.

SD-18 Records

Service Organization; FIO.

The Contractor shall submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

SD-19 Operation and Maintenance Manuals

All information from this section shall be incorporated with same information from SECTION: HEATING SYSTEMS to form one Operating and Maintenance Instructions manual for the heating/cooling system.

Operating Instructions; FIO.

Operating Instructions. The Contractor shall furnish to the Contracting Officer six complete copies of an Operation and Maintenance manual on the supplied cooling equipment. Manual shall include operating instructions outlining the step-by-step procedures required for system start-up, operation and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, a complete set of shop drawings, and brief description of all equipment and its basic operating features.

Maintenance Instructions; FIO.

Maintenance Instructions. The Contractor shall furnish to the Contracting Officer six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides. The instructions shall include simplified wiring and control diagrams for the system as installed.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory use for at least 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2 years field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturers' factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of

qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.1.2 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

2.1.3 Delivery and Storage

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt, dust, or other contaminants.

2.1.4 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to contact by personnel shall be fully enclosed or guarded.

2.1.5 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, serial and model numbers and catalog number on a plate securely attached to the item.

2.2 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective publications and other requirements specified below.

2.2.1 Flanges

ANS1 B16.1, Class 125.

2.2.2 Gaskets

Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16-inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service.

2.2.3 Pipe

2.2.3.1 Copper Tubing, Refrigeration Service

ASTM B 75 and ASTM B 280, seamless copper tubing; ASME B31.5, and ASME B31.5A, refrigeration piping, annealed or hard drawn as required.

2.2.4 Pipe Fittings

2.2.4.1 Copper and Alloys

ASME B16.22, wrought copper solder-joint pressure fittings; ASME B16.26,

flared copper tube fittings; ASME B16.18, cast copper alloy solder-joint fittings.

2.2.5 Pipe Nipples

ASTM A 733, type and material to match adjacent piping.

2.2.6 Pipe Supports

MSS SP-58 and MSS SP-69.

2.2.7 Strainers for Liquid Refrigerant

Brass or cast iron body, Y-pattern, cleanable, not less than 60-mesh noncorrodible screen large enough to provide a net-free area not less than ten times the pipe cross sectional area. Strainers shall have pressure rating compatible with the refrigerant service.

2.2.8 Threads

ASME B1.20.1.

2.2.9 Refrigerant Valves

ARI 720 and ARI 750.

2.2.9.1 Gate Valves Sizes 2-1/2 Inches and Smaller

MSS SP-80, bronze, rising stem, threaded, soldered or flanged ends.

2.2.9.2 Check Valves

Sizes 1-1/2 Inches and Smaller. MSS SP-80, bronze, threaded, soldered or flanged ends.

2.2.9.3 Angles Valves

Sizes 2-1/2 Inches and Smaller. MSS SP-80, bronze, threaded, soldered or flanged ends.

2.2.9.4 Ball Valves, Sizes 2 Inch and Larger

MSS SP-110, ductile iron or bronze, threaded, soldered or flanged ends.

2.2.10 Refrigerant

Compatible with refrigerant equipment supplied and as approved. All refrigerants used shall have an Ozone Depletion Potential of less than or equal to 0.05.

2.2.11 Sheets, Metal

2.2.11.1 Aluminum Sheets

ASTM B 209, Alloys 3003, 7072, half hard condition, H14, or H24 temper. Gauge numbers specified for aluminum sheets refer to Brown and Sharpe gage.

2.2.11.2 Steel Sheets, Galvanized

ASTM A 527, ASTM A 528 or ASTM A 642 with general requirements conforming to ASTM A 525; flat sheets, commercial quality. Gage numbers specified for steel sheets refer to Manufacturers' Standard gage.

2.2.12 Solder for Refrigerant Lines

Silver brazing solder.

2.2.13 Electrical Work

All electrical work shall comply with NFPA 70 (NEC). Electric motor-driven equipment specified shall be provided complete with motors, motor starters, and controls. Disconnect switches for the condensers shall be furnished by the condenser supplier. Electrical equipment and wiring shall be in accordance with SECTION: LOCK ELECTRICAL WORK. Electrical characteristics shall be as indicated. Motor starters shall be provided complete with properly-sized thermal-overload protection and other appurtenances necessary for the motor control indicated. Each motor shall be of sufficient power to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices but not shown on the electrical plans, shall be provided under this section of the specifications.

2.3 AIR-COOLED CONDENSING UNITS

2.3.1 DX Split Type Units

Units shall be split, factory assembled, package type, provided with specified functions and accessories, tested and rated in accordance with applicable provisions of ARI 210. All interconnecting refrigeration piping and electrical power and control wiring between condensing units and the evaporator units shall be provided. Starters shall be integral with the condensing units. Condensing units shall be designed for outdoor installation. Removable panels shall be provided for access to compressor controls, condenser fans, motors, and drives. Provide lifting lugs on the condenser units. Condensing units shall be provided with vibration isolators. Entire unit shall be isolated from the building structure. Disconnects for the condensers shall be provided by the condenser manufacturer.

2.3.1.1 Capacity and Performance Criteria

Unit shall produce an EER as indicated when rated in accordance with ARI 210.

2.3.1.2 Performance Rating

Cooling capacity of each unit shall meet the sensible and total heat requirements. Allowances shall be made for the effective sensible heat factor to satisfy the required sensible cooling capacity.

2.3.1.3 Sound Rating

Sound test and rate units in accordance with ARI 270. Units shall bear Certified Rating Seal.

2.3.1.4 Condenser Fans

Fans shall be manufacturer's standard for unit specified of the propeller types.

2.3.1.5 Propeller Type Fans

Fans shall be direct-drive type, dynamically balanced, with adjustable or fixed pitch, blades. Drive bearings shall be protected with water slingers or shields. Each coil or circuit within the condensing unit shall be furnished with its own condensing fan. Motors shall be direct drive, two-speed with thermal overload protection.

2.3.1.6 Condensing Unit Casing

Casing shall be weatherproof and shall enclose all unit components. Casing shall be constructed with galvanized steel metal. Casing shall be fitted with access panels, fan and heat rejection coil guards. Galvanized steel surfaces shall be additionally protected with a multiple-coat, weather-resistant protective coating which shall be certified as passing a minimum 500 hour salt spray fog test in conformance with ASTM B 117.

2.3.1.7 Compressors

Compressors shall be direct drive. Compressors shall be provided with vibration isolators, crankcase heater, thermal overloads, and high and low pressure safety cutoffs.

2.3.1.8 Evaporator and Condenser Coils

Evaporator coils shall be direct expansion type. Units shall have nonferrous tubes of 3/8-inch minimum diameter with aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and shall be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evacuation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Units shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit, and a filter-drier shall be installed in each liquid refrigerant line circuit. Refrigerant shall be HCFC-22 or HFC-134A and non-ozone depleting as regulated by the Montreal Protocol and the Clean Air Act.

2.3.1.9 Evaporator Coils

Evaporator coils shall be installed in the furnace plenums or in the air handling units as indicated.

2.3.1.10 Controls

Provide operating and safety controls including high and low pressure cut-outs, oil pressure cut-out, and compressor winding thermostat cut-out. Provide 3-leg compressor overload protection and protect condenser fan motors with thermal and overload cut-outs. Provide magnetic contractors for compressor and condenser fan motors. Provide the following control features:

(a) Reset relay circuit for manual resetting of cutouts from remote thermostat location.
(b) Automatic, non-recycling pumpdown, and timing device to prevent excessive compressor cycling.
(c) Internal pressure control to maintain required suction temperature at the coils.

2.3.2 Window Air Conditioners

2.3.2.1 Type

Unit capacity shall be as scheduled. Unit shall be factory fabricated, assembled, operationally tested, and precharged. Unit shall be ready for full capacity operation after terminal point connection. Unit shall conform to the requirements of UL 484 and produce an EER of not less than 7.8 when rated in accordance with ARI 440, with a Coefficient of Performance (COP) not less than 2.28 when rated in accordance with ASHRAE 16. Function and temperature controls shall be integral to unit.

2.3.2.2 Enclosure

The unit shall be designed for installation in the wall as indicated. The mounting accessories shall result in a water and airtight assembly. The enclosure exterior portions shall have a weather-resistant protective coating. Louver shall be stormproof type, constructed of anodized extruded aluminum. The interior section of cabinet shall be free of visible fasteners, sharp protuberances and edges. Enclosure sheet metal shall be a minimum of 18-gage steel with a protective coating. Face panels shall be removable and shall provide full access to unit appurtenances. Access to controls shall be without removal of the face panel. Conditioned air shall discharge through adjustable louvers. Cabinet shall be thermally and acoustically insulated with materials which conform to NFPA 90A.

2.3.2.3 Compressor

Compressor shall be hermetically sealed reciprocating type. Compressor shall be fitted with permanent split capacitor motor, overload protection, and vibration isolators. Compressor shall be protected against high discharge pressure, loss of charge, low voltage, and short cycling. Electrical connections shall be polarized plug type.

2.3.2.4 Cooling Section

Cooling section shall include self-contained, precharged, slide-in or removable chassis-mounted, air cooled refrigeration system. Unit shall be suitable for rated capacity cooling operation with 92 degrees F outdoor air temperature. Cooling section shall be equipped with a filter-drier on the suction line.

2.3.2.5 Condenser and Evaporator Coils

Coils shall be nonferrous tubes of 3/8-inch minimum diameter with copper or aluminum fins mechanically bonded or soldered to the tubes. A condensate removal system shall be provided.

2.3.2.6 Fans

Room air fans shall be centrifugal type, dynamically balanced and direct driven. Condenser fans shall be manufacturer's standard type. Fan motors

shall have built-in thermal overload protection, permanent split-capacitor type.

2.3.2.7 Filters

Filters shall be of the sectional or panel cleanable type, and shall filter the entire air supply.

2.3.2.8 Function Controls

Controls shall include an on-off switch and high and low cool selector switch, multiple speed fan cooling mode, room air fan switch, outside air damper control, and an adjustable cooling only thermostat.

2.3.2.9 Equipment Installation

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for equipment, appurtenances, as required; these include frames or supports for air conditioners, and other similar items requiring supports.

2.3.3 Roof Top Air Conditioning Unit (RTU)

Unit capacity shall be as scheduled. Unit shall be factory fabricated, assembled, operationally tested, internally wired, and pre-charged. Unit shall be tested and rated in accordance with applicable provisions of ARI 210. All interconnecting refrigeration piping and electrical power and control wiring between condensing units and the evaporator units shall be provided. Starter shall be integral with the unit. Removable panels shall be provided for access to compressor controls, condenser fans, motors, and drives. Provide lifting lugs on the roof top unit. Roof top air conditioner shall be provided with vibration isolators. Entire unit shall be isolated from the building structure. All controls except for space thermostat shall be provided as part of the unit. Disconnects shall be provided with the roof-top conditioning unit by the manufacturer. Disconnect shall be mounted on the roof-top unit.

2.3.3.1 Capacity and Performance Criteria

Unit shall produce an EER as indicated when rated in accordance with ARI 210. Cooling capacity of each unit shall meet the sensible and total heat requirements. Allowances shall be made for the effective sensible heat factor to satisfy the required sensible cooling capacity. Sound test and rate units in accordance with ARI 270. Units shall bear Certified Rating Seal.

2.3.3.2 Condenser Fans

Fans shall be manufacturer's standard for unit specified of the propeller types. Fans shall be direct-drive type, dynamically balanced, with adjustable or fixed pitch, blades. Drive bearings shall be protected with water slingers or shields. Each coil or circuit within the condensing unit shall be furnished with its own condensing fan. Motors shall be direct drive, two-speed with thermal overload protection.

2.3.3.3 Air Conditioning Unit Casing

Casing shall be weatherproof and shall enclose all unit components. Casing shall be constructed with galvanized steel metal with standard factory

enamel paint. Casing shall be fitted with access panels, fan and heat rejection coil guards. Galvanized steel surfaces shall be protected with a multiple-coat, weather-resistant protective coating which shall be certified as passing a minimum 500 hour salt spray fog test in conformance with ASTM B 117. Unit shall be designed for curb mounted roof top installation.

2.3.3.4 Compressors

Compressors shall be direct drive, hermetically sealed. Compressors shall be provided with vibration isolators, crankcase heater, thermal overloads, and high and low pressure safety cutoffs.

2.3.3.5 Evaporator and Condenser Coils

Units shall have nonferrous tubes of 3/8-inch minimum diameter with aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and shall be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evacuation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil. Separate expansion devices shall be provided for each compressor circuit, and a filter-drier shall be installed in each liquid refrigerant line circuit. Refrigerant shall be HCFC-22 or HFC-134A and non-ozone depleting as regulated by the Montreal Protocol and the Clean Air Act.

2.3.3.6 Controls

Provide operating and safety controls including high and low pressure cut-outs, oil pressure cut-out, and compressor winding thermostat cut-out. Provide 3-leg compressor overload protection and protect condenser fan motors with thermal and overload cut-outs. Provide magnetic contractors for compressor and condenser fan motors. Provide the following control features:

(a) Reset relay circuit for manual resetting of cutouts from remote thermostat location.
(b) Automatic, non-recycling pumpdown, and timing device to prevent excessive compressor cycling.
(c) Internal pressure control to maintain required suction temperature at the coils.

2.3.3.7 Economizer Section

Roof top air conditioning unit shall be provided with an economizer. Economizer dampers and controls shall be integral with the air conditioning unit. Economizer shall be factory assembled, adjusted, and tested. Enthalpy control on the air conditioning unit shall allow up to 100% outside air in lieu of cooling. Minimum outdoor air shall be as scheduled.

2.3.3.8 Electric Resistance Heating

Provide electric heating coil with heating/cooling thermostat as indicated.

2.4 REFRIGERANT PIPING, INSULATION AND ACCESSORIES

2.4.1 General

Refrigerant tubing, supports, fittings, valves, insulation, and accessories assembled in the field shall conform to the requirements of ASHRAE 15 and ASME B31.5 unless otherwise specified.

2.4.2 Copper Tubing

Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. All copper tubing shall be cleaned, dehydrated, and capped and suitable for refrigeration service.

2.4.3 Supports

Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain.

2.4.4 Fittings

Fittings shall be forged brass or wrought copper and brazed. Fittings shall be suitable for refrigeration service.

2.4.5 Valves

2.4.5.1 Refrigerant Shut-Off Valves

Refrigerant shut-off valves shall be designed for use with the refrigerant used and shall have pressure ratings compatible with system working pressures encountered. Stop valves shall be installed to isolate individual units or sections of a multiple unit installation. Valves for copper and steel tubing shall be all brass, hand wheel operated, diaphragm packless type globe or angle valves in sizes up to and including 5/8-inch. In sizes over 5/8-inch the valves shall be brass or bronze globe or angle type, wrench operated with ground-finish stems, packed especially for refrigerant service, back-seated, and provided with seal caps.

2.4.5.2 Check Valves

Provide brass body, lift or swing type suitable for refrigerant liquid or gas service as required.

2.4.5.3 Solenoid Valves

Provide bronze or brass body, packless type, with stainless steel trim, rated for continuous-duty service, direct or pilot operated, with manual lift stem and designed for type refrigerant used. Valves shall have a safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Operating pressure differential and valve pressure drop shall be suitable for the refrigerant used.

2.4.5.4 Expansion Valves

Provide valves designed for the type of refrigerant used with a pressure rating suitable for pressure encountered. Furnish thermostatic type valves, diaphragm or bellows operated, with an adjustable external superheat adjustment set at the factory for 10 degrees F superheat. Furnish power elements and valve size per manufacturer's recommendation.

2.4.6 Insulation

Refrigerant suction lines shall be insulated. Use fiber-glass insulation with factory applied, all service reinforced vapor barrier jacket having integral laminated aluminum vapor barrier. A maximum thermal conductivity of 0.29 (BTU x in. per hr. x sq. ft. x degrees F) at 75 degrees F is required. Supply in thickness as shown:

Insulated Unit	Thickness (Inches)
Refrigerant Suction Piping	1-1/2

2.4.6.1 Flange, Valve and Fitting Insulation

Provide molded or mitered covers for flanges, valves and fittings.

2.4.6.2 Insulation Shield

Use sections of high density fiberglass or calcium silicate insulation that will support the bearing area at hangers and supports. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 4 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference. Adhere metal shield to insulation so that metal will not slide with respect to insulation.

Pipe Diameter	Insulation Section Length in Inches	Minimum U.S. Standard Gage of Metal Shield
3 in. & smaller	12	18

Insulation should extend at least one inch beyond metal. Select proper shield for service and pipe span.

2.4.6.3 Sealant, Adhesive and Finish

Use a flexible butyl elastomer based vapor barrier, with a temperature range of -100^{O}F to 250^{O}F, at the valve covers, anchors and hangers. Provide a nonflammable, fire-resistive synthetic elastomer adhesive, with a temperature range of -20^{O}F to 180^{O}F, to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers. Provide a flexible, fire resistive, high build vapor barrier finish with a temperature range of 0^{O}F to 180^{O}F, for use with glass fabric reinforcement.

2.4.7 Filter-Driers

Filter-driers shall conform to ARI 7l0. Sizes 1/2 inch and larger shall be the full flow, replaceable core type. Sizes smaller than 1/2 inch shall be the sealed type. Cores shall be a desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. A strainer shall be an integral part of the unit and the assembly shall be fabricated of copper. The dryer shall be constructed so that none of the desiccant will pass into the refrigerant lines. The minimum bursting pressure shall be 1500 psi. Filter-drier shall be provided with a three-valve bypass, and shall meet the

requirements of ARI 730.

2.4.8 Discharge-Line Oil Separator

Oil separator of rated capacity equal to or greater than the compressor capacity shall be provided in the discharge line from each compressor when recommended by the compressor manufacturer. Separator shall be provided with an oil-float valve assembly or needle valve and orifice assembly, drain-line shutoff valve, and sight glass. Oil-return line shall be connected to the compressor as recommended by the compressor manufacturer.

2.4.9 Moisture Indicator Sight Glasses

Sight glasses shall be provided in the liquid line preceding each expansion valve. Sight glass and moisture indicating element shall be removable. Moisture indicator shall have a reversible color indicator which has an easily distinguished color change. Sight glass shall be provided with a protective cover.

2.4.10 Pressure Gages

Gages shall be provided where indicated and shall be accessible and easy to read. Gages shall be connected by brass pipe and fittings with shutoff cocks. Stand-off mounting devices shall be provided for gages for insulated piping as specified for thermometers.

2.5 TEMPERATURE CONTROLS

2.5.1 General

Temperature controls shall be electric. A schematic diagram of the automatic temperature control system shall be submitted showing relays, control valves, control dampers, switches, wiring, or other items not specified or shown.

2.5.2 Transformers and Wiring

Transformers shall be provided for electric controls when required. For temperature control system, each transformer shall be connected to an electric circuit which serves no other equipment. Spare circuits in electric panels shall not be used for controls. Control wiring shall not be connected to lighting circuits. Power circuits are excluded except when controls serve an individual air-handling unit, in which case, transformers may be connected to fan-motor leads of the unit controlled. Electrical equipment and wiring shall be in accordance with SECTION: LOCK ELECTRICAL WORK.

2.5.3 Air-Cooled Condensing Units

Units shall be internally prewired with a 24 volt control circuit powered by an internal transformer. A terminal block shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high and low pressure. Adjustable-cycle timers shall prevent short-cycling. Unit shall be internally protected by fuses or a circuit breaker.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

The contract drawings indicate the extent and general arrangement of the air-conditioning system. Equipment, ductwork, and piping arrangements shall fit into space allotted and shall allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Disconnect switches for the air conditioning units shall be provided by the manufacturer.

3.1.1 Welding

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX, Boiler and Pressure Vessel Code, Section IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

3.1.2 Contractor

One Contractor shall be responsible for coordinating and installing both the heating and air-conditioning systems, ducting and controls.

3.1.3 Field Training

Contractor shall conduct a training course for the operating staff, as designated by the Contracting Officer, on the air conditioning equipment. The training period shall consist of a total three hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

3.2 INSTALLATION

3.2.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for equipment, appurtenances, pipe, and plenum transitions as required; these include frames or supports for air conditioners. Condensers shall be set on not less than a 6-inch concrete foundation pad. Unless otherwise indicated, all equipment shall be installed in accordance with the manufacturer's recommendations providing for minimum clearances for airflow and service access.

3.2.2 Factory Coating

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish except that items located outside the buildings shall have weather-resistant finishes that will withstand 125 hours of exposure to the salt spray test specified in ASTM B 117 using a 20 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no sign of blistering,

wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint.

3.2.3 Field Painting

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory, shall be as specified in SECTION: PAINTING.

3.2.4 Refrigerant Piping

Pipe shall be cut accurately to measurements established at the jobsite and worked into place without springing or forcing, properly clearing all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and detailed. Pipes shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide-sweep bends are formed. The center line radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted. All piping shall be installed with sufficient pitch to insure adequate drainage and venting. Piping connections to equipment shall be provided with unions or flanges. Open ends of pipelines or equipment shall be properly capped or plugged during installation to keep dirt and other foreign material out of the system. Connections between ferrous piping and copper piping shall be electrically isolated from each other with dielectric couplings or fittings.

3.2.4.1 Joints in Copper Tubing

Joints in copper tubing shall be brazed with silver solder. Surplus brazing material shall be removed at all joints in lines not insulated. Tubing shall be protected against oxidation during brazing by using nitrogen in the tubes.

3.2.4.2 Unions

Unions shall be faced true. Union joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance.

3.2.4.3 Refrigerant Shut-Off Valves

Install valves in gas lines with stems horizontal. Install stop valves on each side of each piece of equipment such as compressors, condensers, evaporators, receivers, and other similar items of multiple-unit installation, to provide partial system operation as required for maintenance or repair. Provide vibration isolating flexible connectors on suction and discharge lines at compressors connection. Anchor each line immediately adjacent to the flexible connector.

3.2.5 Pipe Supports

Chain, wire, strap, or other makeshift devices will not be permitted as hangers or supports. Type 13 or 15 turnbuckles shall be used where required for vertical adjustment of piping. Concrete inserts shall be firmly secured to concrete forms in correct locations and installed before concrete is poured where applicable.

3.2.5.1 Suspended Horizontal Piping

Pipe hangers or supports shall be spaced not over 5 feet apart at heavy fittings and valves. Hangers shall be installed at locations not more than 3 feet from the ends of each runout and not over 1 foot from each change in direction of piping. Where necessary to prevent vibration transmission, the support closest to the source of vibration shall be spring cushion, or other approved type isolation hanger. Where pipes are not insulated, succeeding hangers, as required after the isolation hanger, shall be provided with sheet metal protection shields with 2-inch thickness of pipe insulation insert material in order to isolate the pipe from the supports.

3.2.5.2 Vertical Piping

Vertical piping shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, except that pipe will be supported not more than 8 feet from ends of risers.

3.2.6 Valve Identification

Each valve, except check valves, shall be identified with not less than a 1-3/8 inch diameter brass or aluminum tag stamped to explain the valve function and with a number for identification. Tags shall be secured to the valve with not lighter than No. 12 AWG copper wire.

3.2.7 Pipe Sleeves

3.2.7.1 General

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Unless otherwise indicated, sleeves shall be of such size as to provide a minimum of 1/4-inch all around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated. Closure collars shall be installed tight against the surface and shall fit snugly around the pipe. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls shall be sealed as indicated and specified in SECTION: CAULKING AND SEALANTS.

3.2.7.2 Pipes Passing Through Wall Waterproofing Membranes

Pipes passing through wall waterproofing membrane shall be sleeved as described in the foregoing paragraph. In addition, a waterproofing

clamping flange shall be installed as indicated.

3.2.7.3 Optional Sealing of Uninsulated Pipes or Conduits Passing Through Waterproofing Membrane

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing, as specified above, of annular space between pipe and sleeve or conduit and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to fill continuously the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.2.7.4 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in utility or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.2.8 Transformers and Wiring

The automatic equipment shall be installed in accordance with manufacturer's instructions, and approved by the Contracting Officer. All wiring shall conform to the National Electric Code.

3.2.9 Pipe Insulation

Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purposes. Install insulation on pipe systems subsequent to testing and acceptance of tests. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Apply insulation to clear, dry pipes. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant. Where piping is interrupted by fittings, flanges, valves or hangers and at intervals not to exceed 25 feet on straight runs, an isolating seal shall be formed between the vapor barrier jacket and the bare pipe by liberal application of the sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to and along 2 inches of the jacket. This shall be done only on chilled water service. Protect outdoor insulation from weather by installing outdoor protective finish or jacketing as recommended by manufacturer.

3.2.10 Access Panels

Access panels shall be provided for all concealed valves, controls,

dampers, or any items requiring inspection or maintenance. Access panels shall be of sufficient size and so located that the concealed items may be serviced and maintained or completely removed for replacement.

3.3 CLEANING AND TESTING

3.3.1 Cleaning

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. Strainers and valves shall be thoroughly cleaned. Ducts, plenums, and casings shall be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and after all construction dirt has been removed from the building, new filters shall be installed. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. All control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.3.2 Testing of Refrigerant Piping

After all components of the refrigerant system have been installed and the piping connected, the system shall be subjected to a pneumatic test. Precharged, quick coupling piping need not be leak tested but shall be checked for visible or audible leaks. The pneumatic leak testing shall be done with dry nitrogen before any refrigerant pipe is covered. The high and low side of the refrigerant system shall be tested for the minimum refrigerant-leak field-test pressure specified in ASHRAE 15, for the refrigerant employed in the system. The system shall be proven tight under pneumatic test pressure by checking each joint with soap solution and after charging with refrigerant, system shall be checked with a halide torch or by electronic leak detection. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and remade as a new joint. Joints repaired by caulking or remelting and adding more brazing material will not be acceptable. The system shall be proven tight and free of leaks by successfully completing the soap solution test and by allowing the pneumatic leak-test pressure to remain on the system for 24 hours with no drop in pressure. Correction of 0.3 pound per square inch will be allowed for each degree change in the initial and final temperature of the surrounding air, plus for an increase and minus for a decrease. After the foregoing tests have been satisfactorily completed and the pressure relieved, the entire system shall be evacuated to an absolute pressure of 300 microns. During evacuation of the system the ambient temperature shall be higher than 35 degrees F. The vacuum line shall be closed, and the system shall stand for 1 hour. After this period, the absolute pressure shall not exceed 500 microns. During this test, pressures shall be recorded using a thermocouple-type, electronic-type, or a calibrated micron gage.

3.3.3 Refrigerant and Oil Charging

3.3.3.1 Refrigerant

Upon completion of the evacuation test, the vacuum shall be broken by completely charging with dry refrigerant for which the system is designed and shall be subjected to the performance tests specified. Upon

satisfactory completion of the tests, any refrigerant that has been lost from the system shall be replaced. Loss of refrigerant during the first season of operation shall be guaranteed not to exceed 10 percent of the full charge of the system, and all refrigerant required above this amount shall be furnished if the loss is the result of defective equipment or installation.

3.3.3.2 Lubricating Oil

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. Oil shall be of a type recommended by the manufacturer of the equipment. One charge shall be used during the performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

3.3.4 Performance

After the foregoing tests have been completed and before each refrigeration system is accepted, tests to demonstrate the capacity specified and general operating characteristics of all equipment shall be conducted by the Contractor. Testing shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be reconducted to demonstrate that the entire system is functioning as specified. Performance test reports shall cover the test period indicated above, and shall include all applicable information required under Paragraph SUBMITTALS, with conclusion as to the adequacy of the system.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15895

DISTRIBUTION, VENTILATION AND EXHAUST AIR SYSTEMS

-- End of Section Table of Contents --

SECTION 15895

DISTRIBUTION, VENTILATION AND EXHAUST AIR SYSTEMS

PART 1 GENERAL

This section covers the furnishing, installing, testing and balancing of duct distribution for air conditioning, heating, ventilating and exhaust air systems as shown and specified herein, complete with duct insulation and all necessary accessories.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR DIFFUSION COUNCIL (ADC) TEST CODE

ADC 1062:GRD	(1984) Test Codes for Grills, Registers, and Diffusers

AIR MOVEMENT AND CONTROL ASSOCIATION, INC. (AMCA) PUBLICATIONS

AMCA 210	(1985) Laboratory Methods of Testing Fans for Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans; Errata

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 525	(1993) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A 527	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM A 528	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality
ASTM A 642	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality, Special Killed

AMERICAN SOCIETY OF HEATING, REFREIFGERATION, AND AIR-CONDITIONING ENGINEERS, INC. (ASHRAE) STANDARD

ASHRAE 68	(1986) Laboratory Method of Testing In-Duct Sound Power Measurement Procedure

for Fans Handbook (AMCA 330-86)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) PUBLICATIONS

ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASSOCIATED AIR BALANCE COUNCIL (AABC) PUBLICATION

AABC National Standards	(1982) National Standards for Total System Balance (4th Ed.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) STANDARDS

NEMA MG 1	(1993) Motors and Generators

NATIONAL ENVIRONMENT BALANCING BUREAU (NEBB) PUBLICATION

NEBB Procedural Standards	Procedural Standards for Testing-Adjusting-Balancing of Environmental Systems (5th Edition)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATIONS

NFPA 70	(1999) National Electrical Code
NFPA 90A	(1996) Installation of Air-Conditioning and Ventilating Systems
NFPA 91	(1995) Exhaust Systems for Air Conveying of Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION INC., (SMACNA) PUBLICATIONS

SMACNA Fibrous Glass Duct	(1992) Fibrous Glass Duct Construction Standards (6th Ed.)
SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA HVAC Duct Construction	(1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA HVAC Systems Testing	(1993) HVAC Systems Testing, Adjusting and Balancing

UNDERWRITERS' LABORATORIES, INC. (UL) PUBLICATIONS

UL Building Materials Directory	(1998) Building Materials Directory
UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Connectors
UL 2l4	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1999) Fire Dampers and Ceiling Dampers

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts Data; FIO.

After approval of the shop drawings, the Contractor shall furnish spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service. Provide a copy of this data in the Operating and Maintenance Instructions.

SD-04 Drawings

Ventilation Shop Drawings; GA.

Shop drawings shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system. Shop drawings shall be provided for fans, filters, controllers, and associated appurtenances. Drawings shall include an electrical connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device; schedule of all air diffusers, registers, and grilles indicating location, size, type, specified air quantity, velocity, throw, sound power level values, and static pressure; ductwork layout drawings showing the location of all supports and hangers, typical details for hangers, gauge reinforcement, reinforcement spacing rigidity classification and seal classification in accordance with SMACNA standards; and a schedule of damper sizes with leakage and flow characteristic charts. Drawings shall show any other details required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for maintenance and operation. Specific shop drawings shall include the following:

(a) Make-Up-Air Unit. Include performance data, dimensional information, and installation details. Provide shop drawings on the factory roof curb. Complete wiring and control diagrams and schematics shall be provided.

(b) Roof Exhaust Fans, Wall Ventilators, and Ceiling Fans. Include performance data and installation details. Include wiring and control data.

SD-06 Instructions

Framed Instructions; FIO.

Framed Instructions. Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, including equipment, ductwork, dampers, and control sequence, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the

system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The framed instructions shall be posted before acceptance testing of the systems.

SD-09 Reports

Performance Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

SD-13 Certificates

Certificates of Compliance; FIO.

Where materials or equipment are specified to comply with requirements of the ARI, ASHRAE, ASME, etc. proof of such compliance shall be submitted. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. As an alternative to the above requirements, the manufacturer may submit a standard computer product selection printout based on the manufacturer's certified test data. Manufacturer shall certify that the computer selected equipment meets the requirements of ARI or ASHRAE and will meet the capacity indicated on drawings. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

SD-19 Operation and Maintenance Manuals

Operating Instructions; FIO.

Operating Instructions. The Contractor shall furnish six complete copies of instructions outlining the step-by-step procedures required for system start-up, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, a complete set of shop drawings, and brief description of all equipment and their basic operating features.

Maintenance Instructions; FIO.

Maintenance Instructions. The Contractor shall furnish six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns, repairs and a troubleshooting guide. The instructions shall include equipment layout and simplified wiring and control diagrams for the system as installed.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in a satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organization and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period of the contract. Installation of equipment shall conform to NFPA 90A and NFPA 91.

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

2.1.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.4 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of a type specified for the service.

2.1.5 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing work.

2.1.6 Delivery and Storage

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Flexible Duct Connector

Fibrous glass fabric coated with inorganic elastomeric compound suitable for installation in locations as indicated. The composite system shall comply with UL 214 and be classified as flame retarded fabrics in the UL

Building Materials Directory.

2.2.2 Nonmetallic Gaskets

Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16-inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service.

2.2.3 Iron and Steel Sheets

2.2.3.1 Corrosion Resistant Sheets

ASTM A 167, Class 304 or Class 316, Finish 1. Gauge numbers refer to United States Standard Gauge.

2.2.3.2 Galvanized Sheets

ASTM A 527, ASTM A 528, or ASTM A 642, with general requirements conforming to ASTM A 525. Gauge numbers refer to Manufacturer's Standard Gauge.

2.2.4 Electrical

Electrical motor-driven equipment specified shall be provided complete with motor and accessories listed under equipment description. Roof exhaust fans shall be provided with combination motor starter and disconnect mounted on the fan. Make-Up-Air Unit shall also be provided with a combination motor starter and disconnect mounted on the unit. Electric equipment and wiring shall be in accordance with SECTION: LOCK ELECTRICAL WORK. Electrical characteristics shall be as indicated or specified. Motor starters shall be provided, when specified, complete with thermal overload protection and other appurtenances necessary for the motor control indicated on the drawings and in accordance with SECTION: LOCK ELECTRICAL WORK. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be in accordance with NEMA MG 1. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. All electrical work shall conform to the National Electrical Code, NFPA 70.

2.2.5 Make-Up Air Unit MAU-101

(MAU-101) shall be an indirect fired, packaged unit consisting of; heat exchanger, blower, casing, burner, induced draft fan, controls, pre-wired control cabinet, louvered and screened inlet hood (rainhood), and filter section. MAU shall be horizontal with supply air discharge from the bottom of the unit. Provisions for return air (from bottom) shall be incorporated. For temperature controls see SECTION: HEATING, VENTILATING AND AIR CONDITIONING CONTROL SYSTEMS. Unit shall be designed to be installed on a pre-fabricated roof curb. Roof curb shall be provided by the MAU manufacturer.

a. Burner shall be designed to operate on #2 fuel oil. Burner shall be two stage power type with spark ignition. Heat transfer shall be stainless steel.

b. Unit shall be weatherproof and designed for outdoor installation.

Casing shall be 18 gage double walled, rigidly reinforced by means of an angle iron frame. Casing shall be painted with two coats of epoxy primer with final coat of polyurethane. Final color shall be gray. All fasteners shall be stainless steel.

c. Blower compartment shall be constructed of an angle iron frame and provided with DWDI forward curved multi blade fans, turned and tapered polished shaft, with two bearings per shaft, self aligning pre-lubricated pillow block bearings, access door, adjustable motor base, fan statically and dynamically balanced. Bearings shall have a minimum L-10 life of 80,000 hours. Fan shall be tested in accordance with AMCA standards and shall bear AMCA seal.

d. Control cabinet shall be NEMA 4X supplied with dead front combination main disconnect switch and magnetic motor starter, fuses, fuse blocks, overloads, relays, burner service switch, terminal strips, power transformer, burner safety relay, pre-purge control, flame supervision control, fan and limit switch, draft switch, fan toggle switch, photo cell, combustion air proving switch and an ignition transformer.

e. Economizer option shall be provided with the make-up-air unit. Economizer shall allow up to 75% of the total air volume of the fan to be returned from the building space.

2.2.6 Economizer Boxes

Economizer boxes shall be provided for control of outside air and return air on furnaces F-101 and F-102 as shown. Economizer boxes shall be factory assembled. All control systems for operation shall be furnished along with the unit. Temperature and enthalpy control shall be provided. Economizer box shall provide minimum outside air volume up to 100% outside air.

2.3 DUCTWORK AND ACCESSORIES

2.3.1 Sheet Metal Ductwork

Ductwork shall be constructed of galvanized steel sheets. Unless otherwise indicated or specified, sheet metal ductwork shall comply with SMACNA HVAC Duct Construction Standards; refer specifically to Tables 1-3 through 1-19 for sheet metal gage. Ductwork sizes indicate inside clear dimensions and shall be straight and smooth on the inside with joints neatly finished. Ducts shall be secured and anchored to the building structural components and framing, and shall be fabricated and supported in such a manner as to prevent vibration and pulsation under operating conditions. All duct joints shall be constructed and sealed in accordance with the applicable SMACNA HVAC Duct Construction Standards. All ductwork shall be substantially airtight with no audible leaks, no dust marks showing at duct joints, connections to equipment, grilles, registers, and diffusers. All duct joints and transverse and longitudinal seams shall be sealed as required for sheet metal work specified in PARAGRAPH: EQUIPMENT/SHEET METAL INSTALLATION.

2.3.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 20 degrees, for an included angle of 40 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum

of 30 degrees, for an included angle of 60 degrees, or shall be as indicated.

2.3.1.2 Fittings

Square elbows, fittings, and branch take-offs shall be designed and constructed as specified in SMACNA. Wherever practicable, elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct. Where space does not permit, the use of short radius elbows having a minimum radius of 1.0 times the width or diameter of the duct, or square elbows with factory fabricated turning vanes may be used.

2.3.2 Flexible Duct Connections

A flexible duct connector approximately 6 inches in width shall be provided where sheetmetal connections are made to fans or where ducts of dissimilar metals are connected. For round ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using SMACNA duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Building Materials Directory.

2.3.2.1 Flexible Duct

Flexible duct is required for making final connections to equipment as indicated on the drawings. Flexible ducts shall be factory preinsulated type composed of a corrosion-resistant reinforcing wire helix permanently bonded and enclosed in an airtight polyester film, then covered with a 1-1/2 inch thick, 3/4-pound per cubic foot density glass fiber insulation blanket sheathed in a vapor barrier of metalized polyester glass mesh material. Flexible duct shall comply with requirements of SMACNA Fibrous Glass Duct Construction Standards and/or NFPA 90A and be listed as Class 1 Air Duct Material per UL 181. Flexible duct shall be Wiremold Type WK, or equal.

2.3.3 Duct Access Doors

Access doors shall be provided in ductwork at all automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to applicable SMACNA HVAC Duct Construction Standards. Access doors shall be provided upstream and downstream of coils. Doors shall be minimum 15 by 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 by 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type. Leakage around access doors shall be limited to 5 percent or less of the design flow.

2.3.4 Fire Dampers

Fire dampers shall be provided where indicated and in ducts passing through fire rated partitions or walls. Fire dampers shall conform to UL 555. Fire dampers shall be the automatic operating type approved for the protection of openings in fire rated walls and partitions and shall be installed in accordance with the conditions of their approval and the manufacturer's instructions. Furnish low velocity fire dampers labeled for Class B, 1-1/2 hour protection; frame Type B for rectangular duct. Hinged access doors shall be provided in the ducts to make all fire dampers

accessible for inspection and maintenance, and shall be as specified for duct access doors. Other designs that have been tested by an independent nationally recognized testing organization and comply with the requirements set forth in NFPA 90A are acceptable. Unless otherwise indicated, the installation details given in NFPA 91 and in SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems (SMACNA Install Fire Damp HVAC) for fire dampers shall be followed.

2.3.5 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.3.5.1 Duct Sleeves

Duct sleeves shall be provided for all round ducts 15 inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and all square and rectangular ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20-gauge galvanized steel, unless otherwise indicated. Sleeve shall provide 1-inch clearance between the duct and the sleeve or 1-inch clearance between the insulation and the sleeve for insulated ducts.

2.3.5.2 Framed Prepared Openings

Openings shall have 1-inch clearance between the duct and the opening or 1-inch clearance between the insulation and the opening for insulated ducts.

2.3.5.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20-gauge galvanized steel. Collars for round ducts larger than 15 inches and all square, and rectangular ducts shall be fabricated from 18-gauge galvanized steel. Collars shall be installed with nails on maximum 6-inch centers, except that not less than four nails shall be used.

2.3.6 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of corrosion-resistant steel and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified in accordance with ADC 1062:GRD. Inlets and outlets shall be sound rated and certified in accordance with ADC 1062:GRD in sound power level, dB referenced to 10 to the minus twelfth-power watt, in octave bands 2 through 8. Diffusers and registers shall be provided with volume damper with accessible operator as scheduled on drawings. Volume dampers shall be opposed blade type for all diffusers and registers. Where the inlet and outlet openings are located

less than 7 feet above the floor, they shall be protected by a grille or screen in accordance with NFPA 90A. Finish shall be factory standard baked-on enamel finish; coordinate color with architect.

2.3.6.1 Diffusers

Diffusers shall be square or rectangular type, with fixed or adjustable air discharge pattern, as indicated by model type on drawing schedules. Ceiling mounted units shall be furnished with antismudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.3.6.2 Registers and Grilles

Units shall be single deflection, fixed horizontal or vertical louver type. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Grilles shall be as specified for registers, without volume control damper. Eggcrate exhaust grille shall have a 1/2" x 1/2" x 1/2" grid size.

2.3.7 Louvers

Louvers shall be furnished for installation in exterior walls which are directly connected by ductwork to air handling equipment. Louvers shall be anodized aluminum construction. Louvers shall be all welded construction, 16 gauge minimum.

2.3.8 Dampers

Blank-off plates, transitions, or heavy-duty, flexible, fiberglass fabric connectors required to install the dampers in the duct system shall be provided as part of the ductwork. Damper frames shall be constructed of 13-gauge galvanized sheet metal and shall have flanges for duct mounting. Blades shall be galvanized, parallel or opposed, as required, and suitable for the air velocities and use to be encountered in the system. The dampers shall be provided with replaceable edge seals, installed along the top, bottom and sides of the frame and each blade. Neoprene seals and bronze sleeve, nylon or ball bearings shall be able to withstand temperatures ranging from minus 20 degrees F to plus 200 degrees F. Dampers shall be rated for low leakage in the full closed position, at 50 inch-pound torque applied by the control operator. Dampers shall not leak air in excess of 6 cfm per square foot at 4 inches water gauge static pressure.

2.3.8.1 Dampers

Dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers

shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated on drawings.

2.3.9 Damper Operators

Operators shall be provided for each automatic damper. The operator shall be of sufficient capacity to operate the damper or valve under all conditions, as specified, against system pressure encountered. Each operator shall be full-proportioning or two position type as specified under sequence of control and shall be provided with spring-return for normally closed or normally open position, as indicated, for fire, freeze, or moisture protection on power interruption. All proportioning operators shall be provided with positive positioning devices or indicators, as specified for control indicating devices. For large dampers requiring several operators, a pilot on one actuator supplying all operators shall be provided for proper operation when recommended by the manufacturer of the damper. Damper operating speeds shall be selected or adjusted so that the operators will remain in step with the controller without hunting, regardless of load variations. Operators acting in sequence with other operators shall have adjustment of the control sequence as required by the operating characteristics of the system. Electric and electronic modulating operators shall be of the hydraulic or oil-immersed gear-train type.

2.3.10 Intake Hoods

Intake hoods shall be constructed from galvanized steel with minimum 16 gauge base and 18 gauge hood. All surfaces shall be coated with polyester reinforced fiberglass or an equivalent coating system. Bird and insect screen shall be provided. Bird screen shall be minimum 16 gauge galvanized steel. Bird and insect screen shall be installed in a removable frame. The Contractor shall be responsible for the design of this system, including any necessary supports for the insect screen. All fasteners shall be stainless steel. Intake hoods shall be designed and installed for snow load of 40 psf and wind load of 80 mph.

2.4 DUCT INSULATION

Refer to SECTION: THERMAL INSULATION FOR MECHANICAL SYSTEMS for duct insulation specifications.

2.4.1 Exposed Rectangular Duct

Provide 1-1/2 inch thick, 3 lb/cu. ft. density fiberglass rigid insulation with a FSK vapor barrier and an all purpose (AP) bleached outer paper suitable for external painting. A minimum thermal resistance of 5.5 (sq. ft. x degrees F x hrs. per BTU) at 75 degrees F is required.

2.4.2 Standing Seams

Insulate standing seams and stiffeners which protrude through the insulation with 0.6 lb/cu. ft. density, 1-1/2 inch thick, unfaced, flexible blanket insulation. As a vapor seal, use 8 ounce canvas with vapor barrier coating. Insulation should not prevent adjustment of damper operators.

2.5 FANS

2.5.1 General

Roof exhaust fans shall be provided with combination motor starter and disconnect mounted on the frame of the fan. Fans shall be tested and rated in accordance with AMCA 210, AMCA 300 and ASHRAE 68. Fans shall be connected to the motors either directly or indirectly with V-belt drive as specified below or as scheduled on the drawings. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity, and motor sheaves shall be adjustable to provide not less than 20 percent fan speed variation. Sheaves shall drive the fan at such speed as to produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings. Vibration-isolation units shall be standard products with published loading ratings, and shall be single rubber-in-shear, double rubber-in-shear, or springs unless otherwise indicated. Each fan shall be selected to produce the capacity required at the fan total pressure indicated. Fan performance curve for each fan shall be submitted at the time the proposed testing program is submitted. Sound power data for each fan in all octave bands at mid-frequencies shall be submitted. The sound power level values shall be obtained in accordance with AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.5.2 Ceiling-Mounted Exhaust Air Fan

Ceiling-mounted exhaust air fans shall be of the centrifugal direct drive type as scheduled. The fan housings shall be constructed of steel. Grille, duct collar and integral backdraft damper shall be constructed of steel. The fan wheel shall be galvanized steel, forward curved, statically and dynamically balanced. Fan shall include an acoustically insulated housing and be designed for low sound levels. Motor shall be shaded pole with built-in thermal overload protection.

2.5.3 Power Roof Ventilators

Power roof ventilators shall be of the centrifugal type with a weathertight housing and turned down rectangular base constructed of aluminum. Fan discharge openings shall be provided with framed and removable 2-inch stainless steel wire mesh bird screens suitable for the weathertight housings. All fasteners shall be stainless steel. Sealed, permanently lubricated sleeve, roller, or ball bearings with provision for end thrust shall be provided. Motor enclosures shall be totally enclosed type. Combination motor starters and disconnects shall be provided with the fans. Motor-operated backdraft dampers shall be provided as indicated. Motors shall be provided with factory installed and wired safety disconnect switch mounted under the fan housing adjacent to the motor.

2.5.4 Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans shall be furnished with wall mounting collar. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be totally enclosed type. Motor-operated control dampers shall be provided where indicated. Wall fans shall be provided with motor side guard conforming to OSHA standards.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Welding

All welding of piping and general welding shall be done in accordance with qualified procedures in accordance with Section IX, ASME Boiler and Pressure Vessel Code or AWS Structural Welding Code. Contracting Officer shall be furnished with a list of qualified procedures and a list of names and identification symbols of qualified welders.

3.1.2 Field Training

Contractor shall conduct a training course for the lock personnel in the operation of all mechanical equipment. The training time shall cover a total of four hours of normal working time. Training shall cover all aspects of the maintenance and operation of equipment. Training course shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

3.1.3 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall coordinate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required ductwork offsets, fittings, and accessories to meet such conditions.

3.1.4 Contractor

One contractor shall be responsible for coordinating and installing both the heating and air conditioning systems, ducting, and controls.

3.2 PAINTING AND FINISHING

3.2.1 Factory Coating

Ferrous metal items shall be factory finished with the manufacturer's standard finish. Items located outside the building shall have weather resistant finishes.

3.2.2 Field Painting

Finish painting of items only primed at the factory and surfaces not specifically noted otherwise are specified in SECTION: PAINTING.

3.3 INSTALLATION OF DUCT INSULATION

3.3.1 Ducts Without Insulation

Duct insulation shall be omitted on the following, unless otherwise noted:

(a) Exhaust air ducts.

(b) Return air ducts for the 1st level of the building. Return air ducts on the second level shall be insulated.

3.3.2 Ducts With Insulation

3.3.2.1 Fresh Air Intake Ducts

Ducts for fresh air intake shall be insulated to a thickness of 1-1/2 inches.

3.3.2.2 Rectangular Ducts

For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.

3.3.3 Installation

Duct insulation shall be formed with minimum jacket seams, and in no case shall a jacket seam be allowed on or within 3 inches of the duct corner. Insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

a. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.

b. Joints in the insulation jacket shall be sealed with a 4-inch wide strip of the same material as the vapor barrier jacket. The strip shall be secured with Class 2 adhesive and stapled. Staples and seams shall be sealed with a brush coat of vapor barrier coating.

c. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extent not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled. Staples and joints shall be sealed with a brush coat of vapor barrier coating.

d. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the

penetrations sealed with a brush coat of vapor barrier coating.

e. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor barrier coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

3.4 EQUIPMENT/SHEET METAL INSTALLATION

Work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations. Equipment and sheet metal to be coordinated and installed by the same heating and cooling subcontractor.

3.4.1 Equipment

Frames and supports shall be provided for fans, dampers, and other similar items requiring supports. Contractor shall refer to and follow the General Notes on structural drawings when adding additional steel for installation. Fans shall be ceiling or wall hung, as indicated on drawings. The method of anchoring and fastening shall be as suggested by manufacturer according to fan position indicated on drawing. Isolators shall be selected and sized, based on load-bearing requirements and the lowest frequency of vibration to be isolated.

3.4.2 Access Panels

Access panels shall be provided for all concealed fans, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and so located that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be in compliance with SMACNA standards.

3.4.3 Sheetmetal Work

3.4.3.1 Flexible Connectors

Components of the air distribution system shall be mechanically fastened to flexible connectors with equally spaced drivescrews, and joints shall be sealed with sealing compound and duct tape as recommended in SMACNA HVAC Duct Construction Standards for the appropriate pressure class. Preinsulated flexible connectors and flexible duct shall be attached to other components in strict accordance with the latest printed instructions of the manufacturer to insure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.4.3.2 Duct Test Holes

Holes with patches or threaded plugs and holes in ducts and plenums shall be provided where directed or necessary for using pitot tubes for taking air measurements to balance the air systems. At each of these locations where ducts or plenums are insulated, extension shall be provided with plug fittings.

3.4.3.3 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct

insulation shall be packed as specified in SECTION: CAULKING AND SEALANTS.

3.4.3.4 Duct Supports for Sheet Metal Ductwork

Duct supports for sheet metal ductwork shall be in accordance with SMACNA HVAC Duct Construction Standards, unless otherwise specified. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and detailed. Where C-clamps are used, retainer clips shall be provided. Friction beam clamps indicated in SMACNA HVAC Duct Construction Standards, will not be used.

3.4.3.5 Rectangular Duct Joints

Joints between sections of duct and between ducts and fittings shall be made with either gasketed flanged connection, welded flanged joints, or other joints recommended in SMACNA HVAC Duct Construction Standards, and shall be reinforced at the joints and between the joints as recommended. All joints and all transverse and longitudinal seams shall be made airtight with maximum leakage as recommended in SMACNA, or as specified, using the sealants and methods listed in the SMACNA HVAC Duct Construction Standards for the appropriate pressure class.

3.5 ADJUSTING, BALANCING, TESTING AND INSPECTIONS

3.5.1 Testing, Balancing, and Adjusting

Testing, balancing and adjusting shall be performed by firms certified by the Associated Air Balance Council or the National Environment Balancing Bureau or by firms qualifying in compliance with the paragraph on performance.

3.5.2 Performance

Performance of this work by firms specializing in the testing, balancing, and adjusting of heating, ventilating, and air-conditioning systems will be acceptable provided that adequate documentation attesting to the testing firm's competence has been submitted to and approved by the Contracting Officer. The testing firm shall have on its staff a registered professional engineer who shall be responsible for the accuracy of the balancing procedure and test data. Testing and balancing procedures shall be in accordance with AABC National Standards for Total Systems Balance or NEBB Procedural Standards for Testing-Adjusting-Balancing of Environmental Systems or SMACNA HVAC Systems Testing, Adjusting and Balancing. Firm shall provide proof of having successfully completed a minimum of five projects of similar size and scope.

3.5.3 Procedure

Testing, balancing, and adjusting shall be performed in accordance with AABC National Standards for Total Systems Balance or NEBB Procedural Standards for Testing-Adjusting-Balancing of Environmental Systems, using approved field instruments specified and rendering a concise, certified report of results.

3.5.4 Field Tests

Proposed testing program shall be submitted to the Contracting Officer at least 2 weeks prior to the scheduled test to assure agreement as to personnel and instrumentation required and the scope of testing program. Tests shall be conducted in the presence of the Contracting Officer who shall be given 2 days notice before any test is to be conducted. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the tests shall be provided by the Contractor.

3.5.4.1 Ductwork

Supply, return and exhaust ducts, plenums, and casings shall be leak tested and made substantially airtight with no audible leaks, and maximum leakage of 5 percent of system operating air flow at static pressure indicated for the system. Joints shall be sealed as described by the SMACNA HVAC Duct Construction Standards.

3.5.5 Cleaning and Adjusting

Inside of fans, ducts, plenums, and casing shall be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.5.6 Performance Tests

After cleaning, adjusting, and testing are completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than one (1) day for each system and shall demonstrate that the entire system is functioning in accordance with the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, and the ambient temperature and humidity in a shaded and weather protected area.

3.5.7 Balancing

3.5.7.1 Duct Systems

Duct systems shall be balanced to provide not less than their design cfm. Terminal units, registers, and grilles shall be balanced to plus or minus 10 percent of their design cfm.

3.6 TEST DATA

Space temperature and ambient temperature and chart recordings shall be furnished with the test data to verify proper operation of the environmental control system. Typewritten schedules of readings taken during the balancing and testing operations indicating the required or specified reading, the first reading, and the final balanced reading shall be provided for the following:

3.6.1 Fans

Test per ASHRAE 68. Size, type, speed in rpm, outlet velocity in fpm, static pressure in inches water gauge, air quantity in cfm, and motor load in amperes.

3.6.2 Furnaces

Size, type, fan speed in rpm, outlet velocity in fpm, external static pressure in inches water gauge, total static pressure in inches water gauge, air quantity in cfm, and motor load in amperes.

3.6.3 Air Balance

3.6.3.1 Air Outlets and Inlets

Size, velocity in fpm, and air quantity in cfm.

3.6.3.2 Ducts

Size, velocity in fpm, and air quantity in cfm and leakage rate, static pressures in duct.

3.6.4 Air-cooled Condensers

Entering air temperature, leaving air temperature, condensing and suction pressures, compressor voltage and amperage, condenser voltage and amperage.

3.6.5 Control Settings

Onsite settings of all automatic controls, including thermostats, safety controls, minimum damper settings, fire-safety thermostats, pressure controls, temperature controls, and other similar items shall be provided in the form of a typed tabulated list indicating type of control, location, setting, and function.

3.6.6 Test Data Format

Final tests reports shall be on prepared forms required by AABC or NEBB, or in case of firms approved by the Contracting Officer, the certified tests reports shall be on recognized forms similar to those of AABC or NEBB. The test report shall include space temperature and ambient temperature and humidity chart recordings.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING CONTROL SYSTEMS

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SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING CONTROL SYSTEMS

PART 1 GENERAL

This section provides requirements for installing HVAC control systems and the particular sequence of operation for all heating, cooling, and ventilating systems.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500	(1983; Rev thru Jul 1986) Test Methods for Louvers, Dampers and Shutters

AMERICAN SOCIETY OF HEATING, REFREIFGERATION, AND AIR-CONDITIONING ENGINEERS (ASHRAE) STANDARD

ASHRAE GUIDELINE 1	(1989) Guideline for Commissioning of HVAC Systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts Data; FIO.

After approval of the shop drawings, the Contractor shall furnish spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current

unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service. Provide a copy of this data in the Operating and Maintenance Instructions.

SD-04 Drawings

HVAC Shop Drawings; GA.

Submit items of temperature control equipment, wiring, flow diagrams, sequences of control, instrument mounting and related details for review. HVAC controllers shall be submitted for approval. Shop drawings shall be submitted as a single package. Manufacturer's equipment data and product specific catalog cuts shall be submitted. Catalog cuts shall be in booklet form indexed by device type. Where multiple components are shown on a catalog cut, the application-specific component shall be marked. Diagrams shall include the following information:

HVAC control system drawings shall include: a drawing index; a list of symbols; a series of drawings for each HVAC control system using abbreviations, symbols, nomenclature and identifiers as shown on the contract drawings; damper and valve failure positions; valve schedules; damper schedules on 34-inch by 22-inch sheets. All detail drawings shall be delivered together as a complete package. Valve and damper schedules may be submitted in advance but shall be included in the complete submittal. Each control-system element on a drawing shall have a unique identifier.

Each series of drawings for an HVAC control system shall include a schematic, a ladder diagram, an equipment schedule as shown, a wiring diagram, a list of equipment with manufacturer and model number, a control-panel arrangement drawing, and an HVAC control-system sequence of operation.

The wiring diagram shall show the interconnection of conductors and cables to HVAC control-panel terminal blocks and to the identified terminals of starters and packaged equipment, with all necessary jumpers and ground connections. The wiring diagram shall show the labels of all conductors. All sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panelboard circuit breaker number, HVAC system control panel, magnetic starter, or packaged control equipment circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

The HVAC control-panel arrangement drawing shall show nameplate legends, fabrication details, and enclosure operating temperature rise calculations. Fabrication details shall include interior door front and rear views, back panel layout and terminal block layout.

The sequence of operation for each HVAC control system shall be in the language and format of this specification. No operational deviations from specified sequences will be permitted without prior written approval of the Contracting Officer. The sequence of operation shall refer to each device by its unique identifier.

The damper schedule shall contain each damper's and each actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate,

positive-positioned ranges, locations of actuators and damper end switches, arrangement of sections in multisection dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum expected velocity through the damper at the intended location, static pressure across the damper, and the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements.

SD-09 Reports

Testing and Balancing; FIO. Commissioning Procedures; FIO. Commissioning Documentation for HVAC Control System; FIO.

Testing and Balancing. Six copies of the site testing procedures shall be submitted. The site testing procedures shall identify each item to be tested and shall clearly describe each test. The test procedures shall include a list of the test equipment to be used for site testing, manufacturer and model number, and the date of calibration and accuracy of calibration within 6 months of the test date. Documentation of test results for the entire HVAC control system, complete and in booklet form and indexed, shall be submitted within 30 days after testing. The report shall include the calibration and adjustment of controller setpoints and proportional, integral and derivative-mode constant settings, calibration data for all instruments and controls, and all the data resulting from adjusting the control-system devices and commissioning HVAC control systems.

Commissioning Procedures. Commissioning Procedures for each HVAC control system shall be submitted as specified in this section and in SECTION: COMMISSIONING HVAC AND PLUMBING SYSTEMS. Commissioning shall conform to ASHRAE Guideline 1 for commissioning of HVAC Systems. The commissioning procedures shall refer to the devices by their unique identifiers as shown. Commissioning procedures shall include step-by-step configuration procedures for each controller. The configuration procedures shall be product specific and shall include a check sheet showing all configuration parameters, dip switch settings, initial recommended P, I and D constants. Commissioning procedures shall include general instructions on how to set control parameters, including: setpoints; proportional, integral, and derivative mode constants; contact output settings for the specific devices provided.

Commissioning Documentation for HVAC control system. Contractor shall maintain commissioning documentation, as described in SECTION: COMMISSIONING HVAC AND PLUMBING SYSTEMS, in three ring binders and Contractor shall maintain commissioning documentation until final acceptance of project. Commissioning documentation shall include the following:

a) All pre-commissioning checklists initialed by indicated personnel related to the control system.

b) All functional performance test checklists signed by indicated personnel related to the control system.

SD-13 Certificates

Certificates of Compliance; FIO.

Proofs of compliance shall be submitted for all electrical equipment as

specified in this Section. Provide electrical products which have been tested, listed, and labeled by Underwriters' Laboratories (UL), and comply with NEMA Standards. Where applicable, control systems shall comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."

SD-18 Records

Service Organization; FIO.

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name and telephone number.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance Manual; FIO.

Operation and Maintenance Manuals. All operation and maintenance manuals for the HVAC controls shall be combined in one booklet. The manual shall be indexed, outlining the step-by-step procedures required for each HVAC control system's startup, operation, and shutdown. The manual shall include all detail drawings, equipment data, each controller's configuration check sheet and manufacturer supplied operation manuals for all equipment. The maintenance instructions shall include a maintenance check list for each HVAC control system. Maintenance manuals shall include spare parts data and recommended maintenance tool kits for all control devices. Maintenance instructions shall include recommended repair methods, either field repair, factory repair, or whole-item replacement. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated and separately indexed. The Contractor shall provide six copies of the Building HVAC Control Systems Operation & Maintenance manual. A copy of all final approved submittals shall be included in the Building HVAC Control Systems Operation & Maintenance manual.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design, and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty

period of the contract.

2.1.2 Power-Line Surge Protection

All equipment connected to ac circuits shall be protected from power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

2.1.3 Nameplates, Lens Caps, and Tags

Nameplates and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. Nameplates shall be mechanically attached to HVAC control panel interior doors. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire.

2.1.4 Verification of Dimension

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

2.1.5 Delivery and Storage

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

2.2 MATERIALS AND EQUIPMENT

2.2.1 General Equipment Requirements

All electrical, electronic, and electro-pneumatic devices not located within an HVAC control panel shall have an enclosure NEMA 1 in accordance with NEMA 250 unless otherwise shown. Any control panel located outside of the building shall have a NEMA 4X enclosure. Any electrical requirements not specifically specified or shown shall conform to SECTION: LOCK ELECTRICAL WORK.

2.2.1.1 Standard Signals

The analog input and output of all single-loop controllers and function modules shall be 4-to-20 mAdc signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

2.2.1.2 Ambient Temperature Limits

Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of plus 35 to 150 degrees F. All panel-mounted instruments shall operate within limit ratings of 35 to 120 degrees F and 10 percent to 95 percent relative humidity, non-condensing. All devices installed outdoors shall operate within limit ratings of minus 35 to 150 degrees F.

2.2.2 Wiring

2.2.2.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.2.2.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum and shall be rated for 300-volt service.

2.2.2.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 14 AWG minimum and shall be rated for 600-volt service.

2.2.2.4 Analog Signal Wiring Circuits

Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-volt service.

2.2.2.5 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single or multiple-twisted, minimum 2-inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20-AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20-AWG tinned-copper cable drain wire, and overall cable insulation.

2.2.2.6 Nonconducting Wiring Duct

Nonconducting wiring duct in control panels shall have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

2.2.3 Actuators and Automatic Control Valves

Actuators shall fail to their spring-return positions as shown on signal or power failure and shall have a visible position indicator. Actuators shall open or close the devices to which they are applied within 60 seconds after a full scale input signal change. Electric or electronic actuators operating in parallel or in sequence shall have an auxiliary actuator driver. Actuators shall be electric or electronic. Electric actuators shall have oil-immersed gear train.

2.2.3.1 Valve Assembly

Valves shall have stainless steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be .01 percent of rated Cv.

2.2.3.2 [Enter Appropriate Subpart Title Here]
2.2.3.2 Two-Way Valves

Two-way modulating valves shall have equal percentage characteristics.

2.2.3.3 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

2.2.3.4 Valves for Hot-Water Service

Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for 2-inch valves shall have threaded ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for valves 4 inches and larger shall be iron. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal trim (including seats, seat rings, modulating plugs, and springs) shall be Type 316 stainless steel. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher. Valves 4 inches and larger shall be butterfly valves.

2.2.3.5 Damper Actuators

Actuators shall smoothly operate the devices to which they are applied. Actuators shall fully open and close the devices to which they are applied and shall have a full stroke response time of 60 seconds or less. The actuator stroke shall be limited by an adjustable stop in the direction of power stroke. Actuators shall be provided with 120 volt internal transformer, where required. The actuators shall be provided with mounting and connecting hardware.

2.2.3.6 Valve Actuators

Valve actuators shall be selected to provide a minimum of 125 percent of the motive power necessary to operate the valve over its full range of operation.

2.2.3.7 Positive Positioners

Each positive positioned shall be a pneumatic relay with a mechanical feedback mechanism and an adjustable operating range and starting point.

2.2.4 Dampers

2.2.4.1 Damper Assembly

A single damper section shall have blades no longer than 48 inches and shall be no higher than 60 inches. Maximum damper blade width shall be 6 inches. Larger sizes shall be made from a combination of sections. Dampers shall be galvanized steel, or other materials where shown. Flat blades shall be made rigid by folding the edges, and shall be minimum 16 gauge galvanized steel. All blade-operating linkages shall be within the frame unless otherwise noted. Damper axles shall be 0.5-inch (minimum) plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 fpm in the wide-open position. Frames shall not be less than 5 inches in width, and shall be constructed from minimum 16 gauge galvanized steel. Dampers shall be tested in accordance with AMCA 500.

2.2.4.2 Operating Links

Operating links external to dampers (such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers) shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

2.2.4.3 Damper Types

Dampers shall be parallel blade type.

2.2.4.4 Outside-Air, Return-Air, and Exhaust-Air Dampers

The dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with field replaceable compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 20 cfm per square foot at 4 inches water gauge static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 degrees F to 200 degrees F.

2.2.5 Smoke Detectors

Smoke detectors shall be designed for duct mounting and shall include sampling tubes which extends across the duct, self-contained power supply for stand alone operation, and electrical contacts, as required, by sequence of operation. Detectors shall be ionization type. Smoke detectors in the supply air and return air ductwork shall stop the HVAC equipment (including burners and supply fan) and energize the building smoke detection system.

2.2.6 Instrumentation

2.2.6.1 Measurements

Transmitters shall be calibrated to provide the following measurements, over the indicated ranges, for an output of 4 to 20 mA dc:

a. Conditioned space temperature, from 50 to 85 degrees F.
b. Duct temperature, from 40 to 160 degrees F
c. Outside-air temperature, from minus 30 to 130 degrees F.

2.2.6.2 Temperature Instruments

Resistance Temperature Detectors (RTD). Each RTD shall be platinum with a tolerance of plus or minus 0.1 percent at 32 degrees F, and shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter as specified, integrally-mounted unless otherwise shown.

RTD Transmitter. The RTD transmitter shall be selected to match the resistance range of the RTD. The transmitter shall be a 2-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required temperature measurement. The output

error shall not exceed 0.1 percent of the calibrated measurement. The transmitter shall include offset and span adjustments.

2.2.7 Thermostats

Thermostat ranges shall be selected so that the setpoint is adjustable without tools between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electric, electronic, or low-voltage electric.

2.2.7.1 Nonmodulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Electrical contacts shall be rated for minimum 10 amp at 120 volts. Maximum differential shall be 2 degrees F. Thermostat covers shall be made of locking metal or heavy-duty plastic, and shall be capable of being locked by an allen-head wrench or a special tool. Thermostats shall have manual switches as required by the application.

2.2.7.2 Room Thermostats

Thermostats provided for control of furnaces F-101 and F-102 and condensers ACC-101 and ACC-102 shall have settings for cooling, heating, and fan only (economizer cycle). The thermostats shall be a residential type, including a mercury switch and adjustable heat anticipator, similar to a Honeywell T-87.

2.2.7.3 Modulating Room Thermostats

These thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Each thermostat shall have an adjustable throttling range of 4 to 8 degrees F for each output.

2.2.7.4 Low Temperature Protection Thermostats (Freezestats)

Low-temperature-protection thermostats shall be manual reset, low-temperature safety thermostats, with NO and NC contacts and a 20-foot sensing element which shall respond to the coldest 18-inch segment.

2.2.7.5 Modulating Capillary Thermostats

Each thermostat shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Thermostats shall have adjustable throttling ranges of 4 to 8 degrees F for each output.

2.2.8 Pressure Switches

Each switch shall have an adjustable setpoint with visible setpoint scale. Range shall be as shown. Differential adjustment shall span 20 to 40 percent of the range of the device.

2.2.8.1 Differential-Pressure Switches

Each switch shall be an adjustable diaphragm-operated device with 2 SPDT contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. These fittings shall be of the angled-tip type with tips pointing into the air stream. Range shall be 0.5 to 6.0 inches water gauge. Differential shall be a maximum of 0.15 inch

water gauge at the low end of the range and 0.35 inch water gauge at the high end of the range.

2.2.9 Indicating Devices

2.2.9.1 Thermometers

Thermometers for insertion in ductwork systems shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9-inch scale.

a. Thermometer Stems. All thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

2.2.9.2 Air-Duct Thermometers

Air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

a. Duct-Mounted Outside Air Temperature Sensor. Sensor shall be Honeywell Controller, Model L6007A or approved equal. Totally enclosed Micro Switch snap-acting switches operate on temperature use to setpoint. Sensor shall have visible control point scale and external adjustment screw to permit easy setting.

2.2.9.3 Accuracy

Thermometers shall have an accuracy of plus or minus 1 percent of scale range. Thermometers shall have the following ranges:

a. Mixed-air temperature: 0 to 100 degrees F in 1-degree F graduations.
b. Return-air temperature: 0 to 100 degrees F in 1-degree F graduations.
c. Cooling-coil-discharge temperature: 0 to 100 degrees F in 1-degree F graduations.
d. Heating-coil-discharge temperature: 30 to 180 degrees F in 2-degree F graduations.

2.2.9.4 Pressure Gauges

Gauges shall be 2 inch (nominal) size, back-connected, suitable for field or panel mounting as required, shall have black legend on white, background, and shall have a pointer traveling through a 270-degree arc. Accuracy shall be plus or minus 3 percent of scale range. Gauges shall meet requirements of ASME B40.1.

2.2.9.5 Low Differential Pressure Gauges

Gauges for low differential pressure measurements shall be 4-1/2 inch (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauges shall have ranges and graduations as shown. Accuracy shall be plus or minus 2 percent of scale range.

2.2.10 Control Devices and Accessories

Control device and accessory input impedance shall not exceed 250 ohms.

2.2.10.1 Time Clocks

Each time clock shall be a 365-day programmable timing device with 4 independently timed circuits. Each clock shall have a manual scheduling keypad and an alphanumeric display of all timing parameters. Timing parameters shall include: date in Gregorian calendar for month, day and day-of-month indication; and 24-hour time-of-day display, with one-minute resolution for programming the ON and OFF times for each circuit. Each clock shall allow programming of each circuit for 12 holiday periods for either ON or OFF events for any selected duration of the 365-day program. Each clock shall have capacity for programming 4 ON events and 4 OFF events for each circuit. The programmed events shall be assignable to a 365-day schedule. Each clock shall have automatic Standard Time and Daylight Saving Time adjustment, by input of the appropriate dates. Each time clock shall have automatic leap year correction. Each clock shall be provided with 4-day battery backup. Power consumption shall not be greater than 10 watts.

2.2.10.2 Regulated Power Supplies

Each power supply shall provide a 24 Vdc linear supply at not less than 2 amperes, with regulation to 0.05 percent of output voltage. Each power supply shall have a fused input, and shall be protected from voltage surges and power-line transients. The power supply output shall be protected against overvoltage and shortcircuits. Power supply loading shall not be greater than 1.2 amperes.

2.2.10.3 Power Line Conditioner (PLC)

PLCs shall be furnished for each controller panel. The PLCs shall provide both voltage regulation and noise rejection. The PLCs shall be of the ferroresonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The PLCs shall be sized for 125 percent of the actual connected kva load. Characteristics of the PLC shall be as follows:

(a) At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal voltage when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal voltage.
(b) During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal voltage. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.
(c) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

2.2.11 Pilot Lights and Manual Switches

Pilot lights and switches shall be oil-tight rectangular devices arranged in a horizontal matrix. Momentary switches shall be non-illuminated. Interlocking switches shall have separately illuminated sections. Device illumination shall be by light-emitting diode or neon lamp.

2.2.12 HVAC System Control Panels

2.2.12.1 Panel Assembly

Each panel shall be fabricated as a bottom-entry connection point for control-system electric power, control-system wiring, interconnection of control systems, interconnection of starters, and external shutdown devices. Each panel shall have an operating temperature rise of not greater than 20 degrees F above an ambient temperature of 100 degrees F.

2.2.12.2 Panel Electrical Requirements

Each control panel shall be powered by nominal 120 volts ac terminating at the panel on terminal blocks. Instrument cases shall be grounded. Interior panel, interior door, and exterior panel enclosure shall be grounded.

2.2.12.3 Enclosure

The enclosure for each panel shall be a NEMA 12 single-door wall-mounted box conforming to NEMA 250, with continuous hinged and gasketed exterior door with print pocket and key lock, continuous hinged interior door, interior back panel, and ventilation louvers in back. Inside finish shall be white enamel, and outside finish shall be gray primer over phosphatized surfaces.

2.2.12.4 Mounting and Labeling

Controllers, pilot lights, switches, and pressure gauge shall be mounted on the interior door. Power conditioner, fuses and duplex outlet shall be mounted on the interior of the cabinet. All other components housed in the panel shall be mounted on the interior back panel surface of the enclosure, behind the door on rails. Controllers and gauges shall be identified by a plastic or metal nameplate that is mechanically attached to the panel. The nameplate shall have the inscription describing function. Lettering shall be cut or stamped into the nameplate to a depth of not less than 1/64 inch, and shall show a contrasting color, produced by filling with enamel or lacquer or by the use of a laminated material. Painting of lettering directly on the surface of the interior door or panel is not permitted.

2.2.12.5 Wiring

a. Wiring Interconnections. Wiring shall be installed in wiring ducts in such a way that devices can be added or replaced without disturbing wiring that is not affected by the change. Wiring to all devices shall have a 4-inch wiring loop in the horizontal wiring duct at each wiring connection. There shall be no wiring splices within the control panel. All interconnections required for power or signals shall be made on device terminals or panel terminal blocks, with not more than 2 wires connected to a terminal.

b. Terminal Blocks. Terminal blocks shall be arranged in groups as shown. Instrument signal grounds at the same ground reference level shall end at a grounding terminal for connection to a common ground point. Wiring-shield grounds at the same reference level shall end at a grounding terminal for connection to a common ground point. Grounding terminal blocks shall be identified by reference level.

c. Wiring Identification. All wiring connected to controllers, time clocks and function modules shall be identified by function and polarity

with full word identifiers, i.e., process variable, input, remote setpoint input and control output.

PART 3 EXECUTION

3.1 COORDINATION OF SYSTEMS

One contractor shall be responsible for coordinating and installing both the heating and air conditioning systems, ducting, and controls.

3.2 INSTALLATION

3.2.1 General

Control systems shall be installed in accordance with the manufacturers instructions. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control-system installation shall provide clearance for control-system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control-system devices. The control-system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.2 Device-Mounting Criteria

Devices mounted on ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed on ductwork shall be provided with all required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

3.2.3 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways or conduit. Wiring shall be installed without splices between control devices and HVAC control panels. Instrumentation grounding shall be installed as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Cables and conductors wires shall be tagged at both ends, with the identifier shown on the shop drawings.

3.2.4 Controller Output Loop Impedance Limitation

Controller output loops shall be constructed so that total circuit impedance connected to the analog output of a single-loop controller shall not exceed 600 ohms.

3.2.5 Thermostats

Furnace, cooling coil, and condenser thermostats shall be located where shown on the drawings.

3.2.6 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators

operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

3.2.7 Room-Instrument Mounting

Room instruments shall be mounted so that their sensing elements are 5 feet above the finished floor unless otherwise shown. Temperature setpoint device shall be recess mounted.

3.2.8 Surge Protection for Transmitter and Control Wiring

All HVAC system control-panel equipment shall be protected against surges induced on control and transmitter wiring installed outside and as shown. The equipment protection shall be tested in the normal mode and in the common mode, using the following two waveforms:

(a) A 10-microsecond by 1000-microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
(b) An 8-microsecond by 20-microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

3.3 SEQUENCE OF OPERATION

3.3.1 General Requirements

These requirements shall apply to all primary HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur when the direction of change is reversed.

3.3.1.1 HVAC System Supply Fan Operating

When air handling system is operating outside-air and supply-air dampers shall be open.

3.3.1.2 HVAC System Supply Fan Not Operating

When an HVAC system is stopped, the outside-air and supply-air dampers shall close, all stages of direct-expansion cooling shall stop.

3.3.2 HVAC System - Furnaces and Direct-Expansion Cooling Coils

The space-temperature sensors and transmitters operating through the thermostat shall maintain the space setpoint. Sequence of control shall be as follows:

(a) Direct Expansion Cooling Coil. Conversion to cooling mode and start-up of the cooling system shall be done manually through the thermostat and controller. Heating system shall be off. Outside air and return air dampers (economizer box) shall automatically adjust to the summer (cooling) setting. Controller shall not permit cooling below an outdoor air temperature of 55 degrees fahrenheit. Cooling system shall be shut down during unoccupied building hours by setting of the time clock. Contractor shall coordinate with building foreman to establish building occupancy times.

(b) Low-Temperature-Protection Thermostat (Freezestat). A thermostat in the entering-air side of the cooling coil shall stop the supply fan and shall turn on the low-temperature pilot light if the temperature drops below 55 F. Restarting the fan and turning off the pilot light shall require manual reset at the thermostat and at the HVAC control panel. The low temperature thermostat shall be hard wired to the fan motor starter.

(c) Heating System. Conversion to heating mode and start-up of the heating system shall be done manually through the thermostat and controller. Cooling system shall be off. Outside air and return air dampers shall automatically adjust to the winter (heating) setting. Heating system shall not shut down during unoccupied hours of the building.

(d) Economizer Cycle for F-101 and F-102. Between the outdoor temperatures of 40 to 80 degrees fahrenheit, blower fans in the furnaces shall run continuously during building occupied hours. Provision for setting of economizer mode shall also be provided at the thermostat for F-101 and F-102. Blower RPM at nominal 70% of maximum. Cooling and heating systems off. Contractor shall coordinate with building foreman to set the time clock for building occupancy periods. Outdoor air damper shall be at maximum open setting. Engagement of cooling or heating system shall override economizer cycle.

(e) Smoke Control. Smoke Detectors in the supply-air and return-air ductwork shall stop the supply fan, shut down the heating or cooling system in use, close the supply air damper, and turn on the smoke pilot light if smoke is detected at either location. Restarting the supply fan and turning off the pilot light shall require manual reset at the smoke detector and at the HVAC control panel. The smoke detector shall be hard wired to the fan motor starter, burner and the building smoke detection system.

3.3.3 Perimeter Baseboard Heat - FT-101, FT-102

Space temperature controls modulate hot water valves to maintain space setpoint. All Modes - A room thermo-stat, located as shown, shall operate to maintain the room setpoint. Thermostat shall be line voltage, wall mounted. An "AUTO-OFF" switch shall cycle the fan to maintain its setpoint as shown when the switch is in the "AUTO" position. When the switch is in the "OFF" position, the fan and unit shall be stopped.

3.3.4 Unit Heaters - Hot Water (Typical)

Space thermostat cycles unit heater fan to maintain setpoint. Thermostat with Heat-Off switch on subbase. Thermostat for paint room shall be explosion proof temperature switch.

3.3.5 Unit Heaters - Electric (Typical)

Space thermostat controls unit heater(s) to maintain space temperature. Thermostat with HEAT-OFF switch on subbase.

3.3.6 Bathroom and Kitchen Exhaust - Typical

Bathroom and Shower exhaust fans shall be interlocked with the light switches. Kitchen exhaust fans shall be started and stopped manually.

3.3.7 Ventilation Fan: EF-101 (Electrical Room)

EF-101 to operate as intake/exhaust fan.

EF-101 energized with electrical vault light. Fan will operate as an intake. MOD-101A, 102 also energized. MOD-101B closed.

Fan controlled by space thermostat in exhaust mode. When space temperature is above thermostat setpoint, energize fan, and MOD-101A, 101B, 102.

Fan with H-O-A switch next to thermostat. In HAND position fan runs bypassing thermostat (exhaust).

3.3.8 Ventilation Fan: EF-102 (General Storage)

MOD-103,102A energized with EF-102

Fan controlled by space thermostat. When space temperature above thermostat setpoint fan is energized.

Fan with H-O-A switch next to thermostat. In HAND position fan runs bypassing thermostat.

3.3.9 Ventilation Fan: EF-103 (Generator Room)

MOD-104 energized with EF-103

MOD-101D energized with EF-103 (also energized with engine generator)

Fan controlled by space thermostat. When space temperature above thermostat setpoint fan is energized.

Fan with H-O-A switch next to thermostat. In HAND position fan runs bypassing thermostat.

3.3.10 Ventilation Fan: EF-104 (Paint Room, RM 115)

MOD-106,104A energized with EF-104

Fan controlled by space thermostat and by exterior mounted wall switch. When space temperature above thermostat setpoint fan is energized also when light switch is turned on fan will run. Indicating light located at room entrance will energize when exhaust fan is operating. Thermostat shall be explosion proof temperature switch as specified in SECTION: LOCK ELECTRICAL WORK.

MOD-106 shall be explosion proof.

3.3.11 Ventilation Fans: EF-106 and EF-105 (GARAGE)

MOD-107, 108, 106A energized with EF-106
MOD-107, 108, 105A energized with EF-105

EF-106 controlled by space thermostat. When space temperature above thermostat setpoint fan is energized.

EF-105 controlled by on-off switch.

EF-106 with H-O-A switch located at thermostat. In HAND position dampers open and fan runs bypassing thermostat.

3.3.12 Ventilation Fan: EF-107 (SHOP - RM 117)

MOD-107A,109,110 energized with EF-107

Fan controlled by space thermostat. When space temperature above thermostat setpoint fan is energized.

Fan with H-O-A switch located at thermostat. In HAND position dampers open and fan runs bypassing thermostat.

3.3.13 Shop Air Conditioning: RTU-103 (Shop AC Unit, Rm 117)

RTU with ON-OFF switch located in electrical box beside space thermo-stat. When ON the supply fan runs continuously and the condenser cycles as required to maintain space temperature via space thermostat.

When RTU-103 is on EF-107 shall be manually turned off.

3.3.14 Make-Up Air Unit and Welding Exhaust: MAU-101, EF-108 (Garage)

MOD-128 and MAU-101 energized with EF-108

WELDING EXHAUST Activated with manual on-off switch located next to the welding bench.

Freezestat will de-energize MAU-101 if freezing supply air temperature is detected (below 40 deg F). Freezestat located in supply air duct.

SD-103 will de-energize MAU-101 if smoke is detected in the supply air.

MAU-101 shall have remote panel, next to welding exhaust switch, which shall include "WINTER-OFF-SUMMER" switch, and a HAND/AUTO switch, freeze stat alarm light, smoke alarm light, flame failure alarm light, "fan operating" indicating light, "burner" light indicating that burner is energized. With switch in "WINTER" position, burner control will energize and unit will provide heating. In "SUMMER" position, fan only shall operate. Burner controls and burner control sequence shall be bypassed. Hand position shall allow MAU-101 to operate independently of EF-108. "SUMMER" position; fan only shall operate with no return air. "WINTER" position; 75% return air and 25% outside air. In auto position, make-up-air unit to provide 100 percent outside air in both summer and winter.

3.3.15 Hot Water Boiler and Distribution Pumps (B-101, P-101, P-102)

a. All Modes - The hot water boiler controls shall be furnished with the boiler. The boiler shall maintain 180 F water when operating. The boiler should be manually controlled by "AUTO-OFF" switch located at the boiler.

b. Hot water distribution pumps shall be manually started and stopped from a pump selector switch at the motor starter. The starter shall be located in NEMA 12 cabinet on mechanical room wall adjacent to the pumps. Indicating lights shall be provided on panel face showing switch position.

3.3.16 Emergency Generator Damper Sequences

When the emergency generator is started, intake motor operated dampers MOD-101c and 101d and exhaust dampers MOD-105 shall open. Damper motors shall be connected to emergency power. The dampers shall open when their power source is cut off. Each motor operated damper shall have a test button for testing the operation of the dampers. When the button is pushed, the damper shall open; when the button is released, the damper shall close. The test button shall be located in an oil tight enclosure next to associated operator.

3.4 COMMISSIONING PROCEDURES

3.4.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, tune the controllers, set the clock schedule, and make any necessary control-system corrections to ensure that the systems function as described in the sequence of operation. The Contractor shall permanently record, on system equipment schedule, the final setting of controller proportional, integral and derivative constant settings, setpoint, manual reset setting, maximum and minimum controller output, and ratio and bias settings, in units and terminology specific to the controller.

3.4.2 Item Check

An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shut down; Step 4 shall be performed after the HVAC systems have been started. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the time clock. External input signals to the HVAC control panel (such as EMCS, starter auxiliary contacts, and external systems) may be simulated in Steps 1, 2, and 3. With each operational-mode change signal, Pilot lights and HVAC-panel output-relay contacts shall be observed to ensure that they function. All terminals assigned to EMCS shall be checked and observed to ensure that the proper signals are available.

3.4.3 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the Contractor shall verify the actual results in the appropriate season.

3.4.4 Configuration

The Contractor shall configure each controller for its specified service.

3.4.4.1 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC-control-system sensing element and transmitter shall be performed by comparing the HVAC-control-panel readout to the actual value of the variable measured at the sensing element and transmitter or air-flow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified

sensing element-to-controller readout accuracy. The calibration of the test instruments shall be traceable to NBS standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-controller readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrates or replaced and the calibration check repeated.

3.4.4.2 Insertion, Immersion Temperature

Insertion-temperature and immersion-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

3.4.4.3 Averaging Temperature

Averaging-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked every 2 feet along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

3.4.5 Space-Temperature-Controlled Baseboard Heating

The heating medium shall be turned on, and the thermostat temperature setpoint shall be raised. The valve shall open. The thermostat temperature shall be lowered and the valve shall close. The thermostat shall be set at the setpoint shown.

3.4.6 Single-Zone Heating, Direct-Expansion Cooling

Steps for installation shall be as follows:

(a) Step 1 - System Inspection: The HVAC system shall be verified in its shutdown condition. The system shall be checked to see that power is available at the HVAC system control panel, the outside-air damper and supply-air damper are closed, all stages of cooling are off, and that the return-air damper is open.

(b) Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be checked.

(c) Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be visually verified. The signal shall be varied from live zero of 4 ma to 20 ma, and verify that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

(d) Step 4 - Control-System Commissioning:

(1) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be set in the remote-setpoint mode. Setpoint shall be set for 70 degrees F at midpoint, 55 degrees F at the low end, and 85 degrees F at the high end. Proper operation of the temperature setpoint device at the space-temperature sensing element location shall be verified. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure shall be performed. The temperature setpoint device shall be set to the space temperature setpoint as shown.

(2) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated, at the device. It shall be verified that the filter pilot light turns on, and contact output at EMCS terminals shall be verified. The differential-pressure switch shall be set at the setpoint as shown.

(3) With the HVAC system running, a low-temperature-protection thermostat trip input signal shall be simulated, at the device. HVAC system shutdown shall be verified, the low-temperature pilot light turns on. The thermostat shall be set at the setpoint as shown. The HVAC system shall be started by manual reset, and it shall be verified that the pilot light turns off.

(4) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions as described in the Sequence of Operation shall be verified. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and it shall be verified that the pilot light turns off.

3.4.7 Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned down so that it makes contact. The unit heater fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. It shall be ensured that the unit heater fans start. Each space-thermostat temperature setting shall be turned up, and the unit heater fans stop. The thermostats shall be set at their temperature set points. The results of testing of one of each type of unit shall be logged.

3.4.8 Make-up Air Unit

Steps for installation are as follows:

a. Control-System Commissioning:

(1) With the HVAC system running, a low-temperature-protection thermostat trip input signal shall be simulated, at the device. HVAC system shutdown shall be observed. It shall be verified that low-temperature pilot light turns on and contact output at EMCS terminals shall be verified. The thermostat shall be set at the setpoint as shown. The HVAC shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(2) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and verification of control-device actions and interlock functions as described in the Sequence of Operation shall be made. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and it shall be verified that the pilot light turns off.

3.4.9 Exhaust Fans

The "HAND-OFF-AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact. The exhaust fan shall not start. The "HAND-OFF-AUTO" switch shall be placed in the "AUTO" position. It shall be ensured that the exhaust fan starts and the motor operated dampers open. Each space-thermostat temperature setting shall be turned down, and the exhaust fan stops and dampers close. The thermostats shall be set at their temperature set points. The results of testing of one of each type of unit shall be logged. Place switch in "HAND" position fan should run and dampers open. Exhaust fans for building exhaust shall be verified to operate as shown in the sequence of operation.

3.5 TESTING, COMMISSIONING AND BALANCING

3.5.1 Site Testing

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing, calibration, adjusting and commissioning. The tests shall not be conducted during scheduled seasonal off-periods of base heating and cooling systems. Wiring shall be tested for continuity and for ground, open, and short circuits. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment, and commissioning of the operational HVAC control system. The Contractor shall obtain written Government approval of the specific site-testing procedures prior to any test. Written notification of any planned site-testing, commissioning or tuning shall be given to the Government at least 14 calendar days prior to any test.

3.5.2 Control System Calibration, Adjustments, and Commissioning

All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. Control system commissioning shall be performed for each HVAC system.

3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test procedures shall explain, step-by-step, the actions and expected results that will demonstrate that the control systems perform in accordance with the sequences of operation. The performance verification

test shall not be started until after receipt by the Contractor of written permission by the Government, based on the Contractor's written certification of successful completion of Contractor site testing as specified.

3.5.4 Coordination with HVAC System Balancing

The Contractor shall tune the HVAC control system after all the system balancing has been completed, minimum damper positions set, and the report has been issued.

3.5.5 Posted Instructions

Instructions on 8-1/2 by 11-inch sheets and half-size plastic laminated drawings for each system, showing the final installed conditions, shall be placed in each HVAC control panel. The posted instructions shall include the control sequence, control schematic, ladder diagram, wiring diagram, damper schedules, panel arrangement drawings, commissioning procedures, controller configuration check sheet with final configuration record, preventive maintenance instructions and single-loop controller operators manual.

3.6 TRAINING

3.6.1 Training-Course Requirements

A training course shall be conducted for a minimum of four operating staff members designated by the Contracting Officer. The training period, for a total of 3 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. The Contractor shall be responsible for furnishing all audiovisual equipment and 10 sets of all other training materials and supplies. The Contractor shall submit an outline for the course, with a proposed time schedule.

3.6.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to the panels, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15955

COMMISSIONING HVAC AND PLUMBING SYSTEMS

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SECTION 15955

COMMISSIONING HVAC AND PLUMBING SYSTEMS

PART 1 GENERAL

This section provides requirements for commissioning HVAC and plumbing systems. This includes HVAC control systems, ductwork, all mechanical equipment, plumbing system, and the fuel oil system.

1.1 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Commissioning Documentation; FIO.

The Contractor shall maintain commissioning documentation in ring binders. The documentation shall be maintained by system and subsystem. All pages shall be numbered and a table of contents page shall be provided. Commissioning documentation shall include the following:

a. Approved test and balance report.

b. Approved field test reports on plumbing system. Tests as specified in SECTION: PLUMBING.

c. All approved field tests on the HVAC systems.

d. All approved shop drawings of the HVAC system, control system, plumbing system, plumbing fixtures, and fuel oil system.

e. All pre-commissioning checklists initialed by Contractor representatives as approved. Checklists shall be organized by system and subsystem.

f. All functional performance test checklists signed by Contractor representatives as approved. Checklists shall by organized by system and subsystem.

g. A copy of the mechanical Operation and Maintenance manuals that are specified in other sections of these specifications.

The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. All checklists included in this section of the specifications shall become part of the commissioning documentation. Commissioning documentation shall be kept current and kept available for Government inspection. The Contractor shall furnish 3 copies of commissioning documentation upon completion of the project.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Tools and Equipment

The Contractor shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted for approval. The Government will furnish all the required utilities.

3.1.2 Shop Drawing & Operation Manual Revision

HVAC and plumbing shop drawings shall be changed as required after the commissioning process is complete. Operation and Maintenance manuals shall be changed as required after the commissioning process is complete.

3.1.3 System Performance Criteria

All HVAC related equipment and plumbing systems commissioned in this section of the specifications will be evaluated based on the performance parameters given in these specifications and on the drawings.

3.1.4 Technical Requirements

Commissioning of systems shall not commence until the technical requirements are completed for all HVAC equipment and plumbing equipment. This includes the installation and testing requirements as indicated in the specifications for each item of equipment.

3.2 COMMISSIONING SCHEDULE

3.2.1 Phase 1 - Pre-Commissioning

All mechanical shop drawings shall be submitted and approved. All Operation and Maintenance manuals shall be submitted and approved. All pre-commissioning checklists shall be completed. Pre-commissioning checklists are attached at the end of this specification.

3.2.2 Phase 2 - Functional Performance Testing

Checklists for functional performance testing are attached at the end of this specification. This phase shall not begin until Phase 1 commissioning is complete.

3.2.3 Phase 3 - HVAC Training

Training shall be conducted for the mechanical equipment as indicated in the specifications for each item of equipment.

3.3 PRE-COMMISSIONING CHECKLISTS

3.3.1 General

Pre-commissioning checklists shall be filled out by the Contractor.

Initials, as indicated below, shall be put in the designated locations, except where an 'X' is shown indicating no initials are required. Pre-commissioning checklists will not be accepted as complete until all the required initials are on the checklists. The Government Contracting Officer's representative shall be the last person to initial the checklists. Contractor shall submit a list of all subcontractors responsible for initialing these lists.

3.3.1.1 Initials legend shall be as shown below

A - General Contractor Representative
B - Mechanical Contractor Representative
C - Electrical Contractor Representative
D - Government Representative
E - Balancing Contractor Representative
F - Controls Contractor Representative

3.4 FUNCTIONAL PERFORMANCE TEST CHECKLIST.

3.4.1 Testing

Functional performance testing shall be performed by a commissioning team. One team shall be formed for the plumbing system and one for the HVAC and control system. Contractor shall submit a list of all proposed representatives for these commissioning teams. All representatives shall remain on the team until completion of commissioning. Functional performance checklists shall be completed in the presence of all team personnel.

Upon failure of completion of a functional performance test, the Contractor shall provide a written report to the Government listing the deficiencies and the plan for corrective action. After corrective action, the entire functional test shall be repeated. No system will be accepted until all equipment in the system has passed the functional performance test.

Failure to complete 3 functional performance tests within a system shall constitute failure of the commissioning process for that system. The Contractor shall provide a written report to the Government listing the deficiencies and the plan for corrective action. After corrective action has been taken, Phase 2 of the commissioning shall be repeated in its entirety.

PRE-COMMISSIONING CHECKLISTS

LEGEND

A = GENERAL CONTRACTOR REPRESENTATIVE

B = MECHANICAL CONTRACTOR REPRESENTATIVE

C = ELECTRICAL CONTRACTOR REPRESENTATIVE

D = GOVERNMENT REPRESENTATIVE

E = BALANCING CONTRACTOR REPRESENTATIVE

F = CONTROLS CONTRACTOR REPRESENTATIVE

1. PRE-COMMISSIONING CHECKLIST - DUCTWORK

For Air Handler/Furnace: _____ (fill in air handler symbol used on drawings)

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Ductwork complete			X		X	X
b. As-built shop drawings submitted			X		X	X
c. Duct pressure and leakage test complete			X			X
d. Fire dampers installed as required			X		X	X
e. Smoke alarms/dampers installed			X		X	X
f. Access doors and panels installed			X		X	X
g. Verify open/closed status of dampers			X			X
h. Verify smoke alarms/dampers operation			X		X	
Test and Balance						
a. Test and Balance operation complete			X			

2. PRE-COMMISSIONING CHECKLIST - FURNACE/AIR HANDLING UNIT

For Furnace/Air Handling Unit:_____ (fill in symbol)

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. O.A Dampers/actuators installed			X		X	X
b. O.A Dampers/actuators operable			X		X	
c. Smoke Dampers/Detectors installed			X		X	X
d. Smoke Dampers/Detectors operable			X		X	
e. Return Dampers/actuators installed			X		X	X
f. Return Dampers/actuators operable			X		X	
g. Heating/Cooling controls installed					X	
h. Heating/Cooling Controls operational					X	
Test and Balance						
a. Filters installed			X			X
b. T & B Results +/- 10% specified cfm			X			X
c. Test and Balance Report submitted			X			X
Installation						
a. Furnace installed/service clearance			X		X	X
b. Flue installed			X		X	X
c. Fuel oil pipe/controls installed			X		X	
d. Fuel oil pipe/controls tested			X		X	
e. Fuel oil day tank installed			X		X	X
f. Fuel oil day tank tested			X		X	
g. All ducting connected			X		X	X
h. Electrical connections installed					X	X
i. Electrical systems operational					X	

PRE-COMMISSIONING CHECKLIST - FURNACE/AIR HANDLER (CONTINUED)

CHECKLIST ITEM	A	B	C	D	E	F
Start-UP						
a. Furnace/Ductwork Cleaned			X		X	X
b. Safety/Protection Devices Tested			X		X	X
c. Start-up and checkout complete			X		X	X

3. PRE-COMMISSIONING CHECKLIST - COOLING COIL/CONDENSING UNIT

For Cooling Coil/Condensing Unit:_____ (fill in symbol)

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. Condenser wired and operational					X	X
b. Cooling Coil wired and operational					X	X
c. Cooling controls/interlocks installed			X		X	
d. Cooling Controls operational			X		X	
Test and Balance						
a. Filters installed			X		X	X
b. T & B Results +/- 10% specified cfm			X			X
c. Test and Balance Report submitted			X			X
Installation						
a. Coil installed/service clearance			X		X	X
b. Condenser installed/service clearance			X		X	X
c. Refrigerant pipe/controls installed			X		X	X
d. Refrigerant pipe/controls tested			X		X	X
e. All ducting connected			X		X	X
f. Electrical connections installed					X	X
g. Electrical systems operational					X	X
h. Condensate Drainage installed			X		X	X
i. Installation checkout complete					X	X
Start-UP						
a. Ductwork Cleaned			X		X	X
b. Safety/Protection Devices Tested			X		X	X
c. Factory Start-up/checkout complete			X		X	X

4. PRE-COMMISSIONING CHECKLIST - EXHAUST FANS

For Exhaust Fan:_____ (fill in symbol)

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. Control Interlocks installed			X		X	
b. Control Interlocks operable			X		X	
Test and Balance						
a. T & B Results +/- 10% specified cfm			X			X
b. Test and Balance Report submitted			X			X
Installation						
a. Fan installed/service clearance			X		X	X
b. All adjustments made			X		X	X
c. Ductwork connected			X		X	X
d. Electrical connections installed					X	X
e. Electrical systems operational					X	X
f. Roof Curbs Installed/Functional			X		X	X
Start-UP						
a. Ductwork Cleaned			X		X	X
b. Safety/Protection Devices Tested			X		X	X
c. Start-up and checkout complete			X		X	X

5. PRE-COMMISSIONING CHECKLIST - ELECTRIC UNIT HEATERS

For Electric Unit Heater:_____ (fill in symbol)

CHECKLIST ITEM	A	B	C	D	E	F
Controls						
a. Controls/interlocks installed					X	
b. Controls operational			X		X	
Test and Balance						
a. T & B Results +/- 10% specified cfm			X			X
b. Test and Balance Report submitted			X			X
Installation						
a. Unit installed/service clearance			X		X	X
b. Electrical connections installed					X	X
c. Electrical systems operational					X	X
d. Installation checkout complete			X		X	X
Start-UP						
a. Safety/Protection Devices Tested			X		X	X
b. Factory Start-up/checkout complete			X		X	X

6. PRE-COMMISSIONING CHECKLIST - HVAC SYSTEM CONTROLS

For HVAC System: _____(fill in system description)

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Installation Complete			X		X	
b. Layout of control panel matches drawings			X		X	
c. Components properly labeled (on inside and outside of panel)			X		X	
d. Control components piped and/or wired to labeled terminal strip(s)			X		X	
e. EMCS connection made to labeled terminal strip(s) as shown on drawings			X		X	
f. Control wiring and tubing labeled at all terminations, splices and junctions			X		X	
g. Shielded wiring used on electronic sensors			X		X	
Main Power						
a. 110 volt AC power available to panel					X	

7. PRE-COMMISSIONING CHECKLIST - PLUMBING

For Plumbing System:_____(fill in symbol)

CHECKLIST ITEM	A	B	C	D	E	F
Installation						
a. Fixtures installed			X		X	X
b. Rough-in Complete			X		X	X
c. Vent Piping installed			X		X	X
d. Insulation installed			X		X	X
e. Water supply piping installed			X		X	X
f. Sewer piping installed			X		X	X
g. Water Pipe Tested			X		X	X
h. Sewer Pipe Tested			X		X	X
i. Hot water system installed			X		X	X
j. Hot water system operational			X		X	X
k. Sewage lift station operational			X		X	X
l. Test Report submitted			X		X	X
Start-UP						
a. Fixtures Cleaned			X		X	X
b. Safety/Protection Devices Tested			X		X	X
c. Start-up and checkout complete			X		X	X

COMMISSIONING

FUNCTIONAL PERFORMANCE TEST CHECKLISTS

1. FUNCTIONAL PERFORMANCE TEST CHECKLIST - FURNACE/AIR HANDLING UNIT

For Furnace/Air Handling Unit:_____ (fill in symbol)

1. Functional Performance Test: Contractor shall verify operation of furnace as per the specifications and drawings including the following:

a. Verify activation of furnace using control system command.

ON _____ AUTO _____ OFF _____

b. Verify sequence of control during start-up

c. Verify sequence of control during operation. Outside air and return air dampers shall automatically adjust to the winter (heating) setting. Verify outdoor air and return air quantities.

d. Verify operation of economizer cycle. Between the outdoor temperatures of 40 to 80 degrees Fahrenheit, blower fans in the furnaces shall run continuously. Blower RPM at 70% of maximum. Verify all air quantities. Cooling and heating systems off. Outdoor air damper shall be at maximum open setting. Engagement of cooling or heating system shall override economizer cycle.

e. Verify operation of differential-pressure switch across the filter.

f. Verify operation of smoke control system. Smoke Detectors in the supply-air and return-air ductwork shall stop the supply fan, close the supply air damper, and turn on the smoke pilot light if smoke is detected at either location.

g. Verify operation of fuel oil delivery system. Verify float control operation on fuel oil day tank.

h. Air delivery, Air return, and outdoor air temperatures shall be recorded during all testing. Blower RPM and cfm shall be recorded during all testing.

SIGN-OFF

DATE: _____

GENERAL CONTRACTOR REPRESENTATIVE _____

MECHANICAL CONTRACTOR REPRESENTATIVE _____

ELECTRICAL CONTRACTOR REPRESENTATIVE _____

GOVERNMENT REPRESENTATIVE _____

BALANCING CONTRACTOR REPRESENTATIVE _____

CONTROLS CONTRACTOR REPRESENTATIVE _____

2. FUNCTIONAL PERFORMANCE TEST CHECKLIST - COOLING COIL

For Cooling Coil or Cooling Unit:_____ (fill in symbol)

1. Functional Performance Test: Contractor shall verify operation of the cooling coil or cooling unit as per the specifications and drawings including the following:

a. Verify sequence of control upon start-up

b. Verify sequence of control during operation. Heating system shall be off. Outside air and return air dampers shall automatically adjust to the summer (cooling) setting. Return air and outdoor air quantities shall be measured. Controller shall not permit cooling below an outdoor air temperature of 55 degrees Fahrenheit times. This shall be simulated and verified.

c. Air delivery, Air return, and outdoor air temperatures shall be recorded during all testing. Blower RPM and cfm shall be recorded for all testing.

d. Verify cooling operation by varying thermostat setpoint to from space setpoint to space setpoint plus 10 degrees, space setpoint minus 10 degrees, and returning to space setpoint.

SIGN-OFF

DATE: _____

GENERAL CONTRACTOR REPRESENTATIVE _____

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ELECTRICAL CONTRACTOR REPRESENTATIVE _____

GOVERNMENT REPRESENTATIVE _____

BALANCING CONTRACTOR REPRESENTATIVE _____

CONTROLS CONTRACTOR REPRESENTATIVE _____

3. FUNCTIONAL PERFORMANCE TEST CHECKLIST - AIR COOLED CONDENSING UNIT

For Condensing Unit: _____(fill in condensing unit symbol)

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

a. Start Air Handling Unit. Verify control system energizes condensing unit start sequence. _____
b. Shut off air handling equipment to verify condensing unit de-energizes.
c. Re-start air handling equipment 1 minute after condensing unit shut down. Verify condensing unit restart sequence. _____

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

	Phase 1	Phase 2	Phase 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to Ground	_____	_____	_____

3. Record the ambient temperature in degrees F. _____

4. Check and report unusual vibration, noise, etc.

5. Results:
   a. Contractor shall record and submit results obtained in items 1, 2, 3 and 4 above to the Contracting Officer.
   b. If specified equipment performance is not verified, Contractor shall report remedial action required and re-schedule Functional Performance Test.

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

DATE: _____

GENERAL CONTRACTOR REPRESENTATIVE _____

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GOVERNMENT REPRESENTATIVE _____

BALANCING CONTRACTOR REPRESENTATIVE _____

CONTROLS CONTRACTOR REPRESENTATIVE _____

4. FUNCTIONAL PERFORMANCE TEST CHECKLIST - EXHAUST FAN

For Exhaust Fan: _____ (fill in symbol)

1. Functional Performance Test: Contractor shall verify operation of exhaust fan as per the specifications and drawings including the following:

a. Verify sequence of control upon start-up.

b. Verify sequence of control during operation.

c. Note general operation and operating characteristics

SIGN-OFF

DATE:_____

GENERAL CONTRACTOR REPRESENTATIVE _____

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ELECTRICAL CONTRACTOR REPRESENTATIVE _____

GOVERNMENT REPRESENTATIVE _____

BALANCING CONTRACTOR REPRESENTATIVE _____

CONTROLS CONTRACTOR REPRESENTATIVE _____

5. FUNCTIONAL PERFORMANCE TEST CHECKLIST - ELECTRIC HEATERS

For Electric Heater: _____ (fill in symbol)

1. Functional Performance Test: Contractor shall verify operation of electric heater as per the specifications and drawings including the following:

a. Verify sequence of control upon start-up.

b. Verify sequence of control during operation. "AUTO-OFF" switch shall cycle the fan to maintain its setpoint as shown when the switch is in the "AUTO" position. When the switch is in the "OFF" position, the fan shall be stopped.

c. Verify heating operation by varying thermostat setpoint to from space setpoint to space setpoint plus 10 degrees, space setpoint minus 10 degrees, and returning to space setpoint.

SIGN-OFF

DATE:_____

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GOVERNMENT REPRESENTATIVE _____

BALANCING CONTRACTOR REPRESENTATIVE _____

CONTROLS CONTRACTOR REPRESENTATIVE _____

6. FUNCTIONAL PERFORMANCE TEST CHECKLIST - HVAC CONTROLS

For HVAC System: _____ (fill in symbol)

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that the controller is maintaining the setpoint by manually measuring the controlled variable with a thermometer, psychrometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare with readings taken manually. Record all readings.

c. Verify system stability by changing the controller setpoint as follows:

Air temperature -10 degrees F

d. Verify proper interlocking of all controls. Proper tuning of the controller shall be verified including setting the initial proportional, integral, and derivative (PID) mode constants, controller setpoints, and logging the settings. The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be set in the remote-setpoint mode. Setpoint shall be set for 70 degrees F at midpoint, 55 degrees F at the low end, and 85 degrees F at the high end. Proper operation of the temperature setpoint device at the space-temperature sensing element location shall be verified.

e. With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions as described in the Sequence of Operation shall be verified. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and it shall be verified that the pilot light turns off.

SIGN-OFF

DATE: _____

GENERAL CONTRACTOR REPRESENTATIVE _____

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ELECTRICAL CONTRACTOR REPRESENTATIVE _____

GOVERNMENT REPRESENTATIVE _____

BALANCING CONTRACTOR REPRESENTATIVE _____

CONTROLS CONTRACTOR REPRESENTATIVE _____

7. FUNCTIONAL PERFORMANCE TEST CHECKLIST - PLUMBING

For Plumbing System: _____ (fill in symbol)

1. Functional Performance Test: Contractor shall verify operation of the plumbing system as per the specifications and drawings including the following:

a. Verify operation of all fixtures

b. Verify operation of water heater

c. Verify operation of sanitary sewer lift station

d. Measure and record water pressure reading into the building

SIGN-OFF

DATE:_____

GENERAL CONTRACTOR REPRESENTATIVE _____

MECHANICAL CONTRACTOR REPRESENTATIVE _____

GOVERNMENT REPRESENTATIVE _____

-- End of Section --