

SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS
11/99

PART 1 GENERAL

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. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 449/C 449M	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
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 Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 610	(1995) Molded Expanded Perlite Block and Pipe thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 665	(1998) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 795	(1998e1) Thermal Insulation for Use in Contact With Austenitic Stainless Steel
ASTM C 916	(1985; R 1996e1) Adhesives for Duct Thermal Insulation
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 921	(1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1126	(1998) Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C 1136	(1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 1290	(1995) Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
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MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1993) National Commercial & Industrial Insulation Standards
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1.2 UNIT PRICES

1.2.1 Pipe Insulation Replacement

1.2.1.1 Measurement

Pipe insulation replacement will be measured for payment based upon linear feet of pipe insulation replacement, as directed by the Contracting Officer.

1.2.1.2 Payment

All cost associated with performing pipe insulation replacement as called for in the specifications including labor, materials, tools, equipment and incidentals, shall be paid for at the contract unit price in accordance with Item No. 0002 of the Unit Price Schedule. Payment will be made for pipe insulation replacement as directed by the Contracting Officer.

1.3 GENERAL QUALITY CONTROL

1.3.1 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.

1.3.2 Installer's Qualifications

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

1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and 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.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Thermal Insulation Materials; G|WA.

A complete list of materials, including manufacturer's

descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job.

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. Insulation

material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

PART 2 PRODUCTS

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:

2.1.1 Adhesives

2.1.1.1 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.2 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented white or red and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls.

2.1.3 Staples

Outward clinching type [monel] [ASTM A 167, Type 304 or 316 stainless steel]. Monel is a nickel rich alloy which has high strength, high ductility, and excellent resistance to corrosion.

2.1.4 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pound/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pound/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials which require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets

shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

2.1.4.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes, ducts, or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.1.4.2 Aluminum Jackets

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 retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 x 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 x 0.020 inch) thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburg or "Z" type longitudinal joint. When the "Z" 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.

2.1.4.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2.1.5 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. All other application and service properties shall be in accordance with ASTM C 647.

2.1.5.1 Vapor Retarder Required

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.5.2 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.6 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.2.1 Aboveground Hot Pipeline

Insulation for above 60 degrees F, for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturers recommended factory applied jacket.

- a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the insulation with manufacturers recommended factory applied jacket.
- b. Calcium Silicate: ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.
- c. Cellular Glass: ASTM C 552, Type II and Type III. Supply the insulation with manufacturers recommended factory applied jacket.
- d. Flexible Cellular Insulation: ASTM C 534, Type I or II to 200 degrees F service.
- e. Phenolic Insulation: ASTM C 1126 Type III to 250 F service shall comply with ASTM C 795. Supply the insulation with manufacturers recommended factory applied jacket.
- f. Perlite Insulation: ASTM C 610
- g. Polyisocyanurate Insulation: ASTM C 591, Type 1, to 300 degrees F service. Supply the insulation with manufacturer's recommended factory applied jacket.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. 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. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

3.1.2 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. When replacing a section of existing pipe insulation, new insulation shall be installed using a single, full-length unit. If replacement length exceeds standard unit length, Contractor shall arrange work to minimize the number of complete units used.

3.2.1.2 Pipes Passing Through Walls

- a. Pipe insulation shall be continuous through the sleeve.
- b. 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.

3.2.1.3 Pipes Passing Through Hangers

- a. Insulation shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.
- b. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 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. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

- c. 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. The jacket material used to cover inserts in flexible cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 6 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.

3.2.2 Aboveground Hot Pipelines

The following hot pipelines above 60 degrees F shall be insulated per Table II:

- a. Condensate return.

3.2.2.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

LEGEND:

- PF - Phenolic Foam
- CG - Cellular Glass
- CS - Calcium Silicate
- MF - Mineral Fiber
- FC - Flexible Cellular
- PL - Perlite
- PC - Polyisocyanurate Foam

Table II - Hot Piping Insulation Thickness
 Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Condensate return	CG		1.5	2.0	2.0	2.0	3.5
	PF		1.0	1.0	1.0	1.0	1.5
	MF		1.5	1.5	2.0	2.0	2.5
	CS/PL		1.5	2.0	2.5	2.5	3.5
	PC		1.0	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.

3.2.2.2 Jacket for Insulated Hot Pipe, Except Pipe Insulated with Flexible Cellular

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

3.2.2.3 Insulation for Straight Runs

- a. Insulation shall be applied to the pipe with joints tightly butted.
- b. 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.
- c. 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.
- d. 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.
- e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 4 inch centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.
- f. Flexible cellular pipe insulation shall be installed by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used.

3.2.2.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories.
- b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates, except as modified herein: 5 for anchors; 10, 11, 12, and 13 for fittings; 14, 15 and 16 for valves; 17 for flanges and unions; and 18 for couplings. Insulation shall be the same as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is

used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of adhesive 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.
- d. Insulation terminations shall be tapered to unions at a 45-degree angle.
- e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

-- End of Section --

SECTION 15100

VALVE ACTUATORS AND APPURTENANCES

PART 1 GENERAL

1.1 DESCRIPTION

1.1.1 Scope:

1.1.1.1 Contractor shall provide all labor, materials, equipment and incidentals required to furnish and install new pneumatic valve actuators on all existing Pratt butterfly valves listed on the Valve and Actuator Schedule included at the end of this Section.

1.1.1.2 The Work includes, but is not necessarily limited to, replacement of all listed actuators, required wiring, required pneumatic connections, provision of local solenoid panels as shown on Drawings and interfacing new and existing valves with the distributed process controller as indicated on Drawings.

1.1.2 Coordination:

1.1.2.1 Review installation procedures under other sections and other Contracts and coordinate with the Work which is related to this Section.

1.1.3 Related Sections:

1.1.3.1 Division 16, Electrical.

1.1.3.2 Division 13, Sections pertaining to Instrumentation and Control Systems.

1.2 QUALITY CONTROL

1.2.1 All actuators furnished as part of this Contract shall be the product of one manufacturer.

1.2.2 Shop Tests:

1.2.2.1 Hydrostatically test each actuator at 150 psig for leakage.

1.2.2.2 Each actuator shall be pneumatically tested for piston seal leakage commensurate with specified pressure requirements.

1.2.2.3 Each actuator shall be operated a minimum of five times in each direction of travel.

1.2.3 Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1.2.3.1 AWWA C540-93, Standard Specification for Power Actuating Devices.

1.2.3.2 AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

1.2.3.3 NEMA, National Electrical Manufacturer's Association.

1.3 SUBMITTALS

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

SD-01 Data

Pneumatic Actuator Cylinders and Accessories; GA|AE

Submit for approval the following: Manufacturer's literature, illustrations, specifications, detailed drawings, data and descriptive literature on all actuators; Engineering data including dimensions, materials, size and weight; Fabrication, assembly, and wiring diagrams; Installation details as described in the scope of work for this section.

Installation Conformance Certification; FIO

A signed statement from the valve actuator manufacturer certifying that the installation is in accordance with the Contract Documents and the manufacturer's prescribed instructions and recommendations, upon completion of the work and prior to final acceptance.

SD-09 Reports

Pneumatic Actuator Cylinders and Accessories; GA|AE

Submit results of operating and hydrostatic tests. Submit a written report giving the results of the field tests required.

SD-19 Operation and Maintenance Manuals

Pneumatic Actuator Cylinders and Accessories; GA|WA

Submit complete manuals including: Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, acceptable lubricants, and spare parts information.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

1.4.1 Deliver materials to the site to insure uninterrupted progress of the Work.

1.4.2 Handle all actuators very carefully. Actuators which are cracked, dented or otherwise damaged or dropped will not be accepted.

1.4.3 Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

1.4.4 Store all mechanical equipment in covered storage off the ground and prevent condensation.

PART 2 PRODUCTS

2.1 GENERAL

2.1.1 All actuators shall conform to the following:

2.1.1.1 Conform to the requirements of "Valve and Actuator Schedule" included at the end of this Specification Section. Cylinder actuators for 3" to 8" valves shall be of the scotch yoke design. Cylinder actuators for 10" to 36" valves shall of a compound link and lever design.

2.1.1.2 All actuators shall be sized based upon a plant air supply at a minimum of 80 psig and a maximum of 100 psig.

2.1.1.3 All bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.

2.1.1.4 Bolts and nuts shall have hexagon heads and nuts.

2.1.1.5 Gasket material and installation shall conform to manufacturer's recommendations.

2.1.1.6 Identification: Identify each actuator with a brass or stainless steel nameplate stamped with the approved designation. Nameplate shall be permanently fastened to actuator body at the factory. Stenciled designations are not acceptable.

2.1.1.7 All actuators shall be provided with local position indication and open and closed limit switches adjustable over the full range of travel.

2.1.1.8 Failure mode for each actuator shall be as indicated on the Valve and Actuator Schedule.

2.2 PNEUMATIC ACTUATOR CYLINDERS

2.2.1 Materials of construction for each actuator cylinder shall be as follows:

2.2.1.1 Cylinder barrel: Black amalgon tubing with a minimum of a 15 RMS finish.

2.2.1.2 Cylinder heads: Phenolic laminate, NEMA Grade C with grooves containing o-rings in the top and bottom of each head.

2.2.1.3 Piston Assembly: The piston assembly shall be of a three-piece construction consisting of a center piston and two full-face cup seal retainer plates.

a. Piston rods: Type 316 stainless steel with a minimum of 0.0005 inch thick hard chrome plating.

b. Full face piston cups: Molded Buna N

c. Piston rod bushing: Celcon

2.2.1.4 Cylinder seals: Nonadjustable, wear compensating Hycar rubber.

2.2.1.5 Piston rods shall be equipped with both internal and external dirt wipers.

2.3 PNEUMATIC CYLINDER ACCESSORIES

2.3.1 Open-Close valves

2.3.1.1 All open-close service valves shall be equipped with stainless steel 4-way solenoid valves mounted and piped with 316 stainless steel piping and fittings. Piping shall be so arranged to comply with the failure mode specified in the Valve and Actuator Schedule. Solenoid valves shall be equipped with a manual override.

2.3.1.2 Needle type speed control valves shall be furnished and sized to provide opening and closing speeds of between 30 and 60 seconds. Speed control valves shall be mounted on the cylinders.

2.3.1.3 All open-close service valves shall be supplied with rotary type, die cast aluminum, NEMA 4X enclosures. Visual indicator shall have 360 degree visibility and cover shall be free from paints or coatings and shall be sealed against the environment with an o-ring and compression lock-in-place without the use of screws or fasteners. All enclosure fasteners shall be made of 316 stainless steel and remain captive to the cover. Shaft shall be stainless steel and attached to the enclosure via a stainless steel locking ring which is internal to the shaft/bearing assembly and not exposed to the environment. The shaft shall be furnished with quick-set spline cams for easy adjustment.

2.3.1.4 All open-close service valves shall be supplied with SPDT open-closed limit switches which are fully encapsulated to prevent accidental grounding of a live circuit. Provide sufficient limit switches to provide functionality as shown on the P&IDs and as specified in Section 13660. Terminal strip shall be angle-mounted and marked for ease of identification and installation. All terminal connections shall be rated for 15 amps. Limit switches shall be ASCO Sentry model, or equal.

2.3.2 Modulating valves:

2.3.2.1 All modulating service valves shall be equipped with stainless steel 4-way dual acting solenoid valves mounted and piped with 316 stainless steel piping and fittings. Piping shall be so-arranged to comply with the failure mode specified in the Valve and Actuator Schedule. Solenoid valves shall be equipped with a manual override.

2.3.2.2 Needle type speed control valves shall be furnished and sized to provide opening and closing speeds of between 30 and 60 seconds. Speed control valves shall be mounted on the cylinders.

2.3.2.3 All modulating service valves shall be supplied with SPDT open-closed limit switches which are adjustable over the full range of travel and fully encapsulated to prevent accidental grounding of a live circuit. Provide sufficient limit switches to provide functionality as shown on the P&IDs and as specified in Section 13660. Terminal strip shall be angle-mounted and marked for ease of identification and installation. All terminal connections shall be rated for 15 amps. Limit switches shall be ASCO Sentry model, or equal.

2.3.2.4 All modulating service valves shall be provided with a positioner which shall accept a 4-20 ma signal to set position as well as provide a 4-20 ma output signal to indicate position to the distributed process controller.

- a. Pneumatic positioners shall be of the force balance type with a high gain pilot valve assembly with gold plated spool.

- b. Each positioner shall be equipped with an adjustable cam with a characterized closed position.
- c. Maximum air consumption of each positioner shall be 0.71 scfm at 80 psig.
- d. Each positioner shall be provided with visual position indication gauges, span and zero adjustment knobs and four gauges for signal, supply and pressure at both cylinder ports.
- e. Positioners shall be PMV Model EP5, or equal.

2.3.3 Local Solenoid Panels.

2.3.3.1 The actuator supplier shall furnish all solenoid valves required for each filter mounted on a local FRP mounting plate to be mounted at each filter. Each solenoid valve shall be wired to a terminal strip enclosed in a NEMA 4X junction box. All solenoid valves shall be provided with a NEMA 4X enclosure.

2.3.4 Manufacturers:

- 2.3.4.1 MDT Duracyl Series, as manufactured by the Henry Pratt Company.
- 2.3.4.2 Or equal.

2.4 SURFACE PREPARATION AND SHOP PAINTING

2.4.1 Clean and prime coat ferrous metal surfaces of equipment in the shop in accordance with manufacturers standard procedures and finish coat with manufacturers standard epoxy paint.

2.4.2 Coat machined, polished and non-ferrous surfaces including gears, bearing surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

2.5 ACTUATOR SCHEDULE

2.5.1 At the end of this Section is the "Valve and Actuator Schedule". Conform to the requirements of the schedule unless otherwise approved by Contracting Officer.

2.6 SPARE PARTS

2.6.1 Contractor shall furnish the following spare parts:

- 2.6.1.1 Two (2) sets of cylinder repair kits for each size of cylinder supplied.
- 2.6.1.2 Two (2) spare solenoids for each different size and type of solenoid supplied.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Install all actuators in accordance with manufacturer's instructions.

3.1.2 Contractor responsible for furnishing all valve pneumatic supply piping from the air header to the solenoids, and from the solenoids to the valve actuators.

3.2 FIELD TESTS AND ADJUSTMENTS

3.2.1 Adjust all parts and components as required to provide correct operation.

3.2.2 Conduct functional field test of each valve in presence of Contracting Officer to demonstrate that each part and all components together function correctly.

3.3 TRAINING

3.3.1 Provide one day of on-site training at the water treatment plant on operation and maintenance of the actuators. The training shall include, but is not limited to, actuator maintenance and calibration and communications.

-- END OF SECTION --

VALVE AND ACTUATOR SCHEDULE

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (I)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-27-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-27-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-27-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-28-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-28-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-28-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (I)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-28-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-28-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-28-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-28-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-28-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-28-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-28-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-29-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-29-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-29-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-29-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-29-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-29-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-29-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (I)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-29-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-29-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-29-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-30-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-30-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-30-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-31-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (I)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-31-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-31-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-31-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-31-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-31-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-31-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-31-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-31-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-31-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-32-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-32-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-32-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-32-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-32-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (1)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-32-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-32-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-32-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-32-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-32-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-33-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-33-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (I)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-33-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-34-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-34-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-34-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-35-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-35-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-35-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (I)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-35-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-35-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-35-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-35-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-35-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-35-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-35-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR
V-4-36-1	INFLUENT	BFV	36	NON-MOD; F.L.	25-8	2,300	1.25	EX. VALVE, NEW ACTUATOR
V-4-36-2-N	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-36-2-S	EFFLUENT ISOLATION	BFV	18	NON-MOD; F.L.	25-8	497	1.25	EX. VALVE, NEW ACTUATOR
V-4-36-3-N	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-36-3-S	BACKWASH	BFV	30	NON-MOD; F.C.	25-16	3,060	1.25	EX. VALVE, NEW ACTUATOR
V-4-36-4	FILTER DRAIN	BFV	30	NON-MOD; F.L.	25-8	1,180	1.25	EX. VALVE, NEW ACTUATOR
V-4-36-5-N	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR

VALVE TAG NUMBER	VALVE DESCRIPTION	VALVE TYPE	SIZE (IN.)	ACTUATOR TYPE	AWWA VALVE CLASS (1)	MIN. OPERATING TORQUE (FT-LBS)	SAFETY FACTOR FOR OPERATING TORQUE	COMMENTS
V-4-36-5-S	SURFACE WASH	BFV	6	NON-MOD; F.C.	25-8	147	1.25	EX. VALVE, NEW ACTUATOR
V-4-36-6	EFFL. FLOW CONTROL	BFV	18	MOD; F.L.	25-16	632	1.75	EX. VALVE, NEW ACTUATOR
V-4-36-7	FILTER TO WASTE	BFV	6	NON-MOD; F.C.	N/A	N/A	N/A	EX. VALVE, EX. ACTUATOR

NOTES

(1) Valve Class per AWWA C504-58

ABBREVIATIONS

BFV Butterfly Valve
 EFFL. Effluent
 EX. Existing
 NON-MOD; F.C. Non-Modulating Actuator; Fail to Close
 NON-MOD; F.L. Non-Modulating Actuator; Fail to Last Position
 MOD; F.L. Modulating Actuator; Fail to Last Position

SECTION 15190
GAS PIPING SYSTEMS
02/99

PART 1 GENERAL

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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.1 Cast Iron Pipe Flanges and Flange Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 774 Standard Specification for As-welded
Wrought Austenitic Stainless Steel
Fittings for General Corrosive Service at
Low and Moderate Temperatures

ASTM A 778 Welded, Unannealed Austenitic Stainless
Steel Tubular Products

ASME INTERNATIONAL (ASME)

ASME B1.20.1 (1983; R 1992) Pipe Threads, General
Purpose (Inch)

ASME B16.5 (1996; B16.5a) Pipe Flanges and Flanged
Fittings NPS 1/2 thru NPS 24

ASME B16.33 (1990) Manually Operated Metallic Gas
Valves for Use in Gas Piping Systems Up to
125 psig (Sizes 1/2 through 2)

ASME B31.1 (1998) Power Piping

ASME B31.2 (1968) Fuel Gas Piping

ASME B36.10M (1996) Welded and Seamless Wrought Steel
Pipe

ASME BPV IX (1998) Boiler and Pressure Vessel Code;
Section IX, Welding and Brazing
Qualifications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54

(1999) National Fuel Gas Code

NFPA 70

(1999) National Electrical Code

1.2 GENERAL REQUIREMENTS

1.2.1 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. 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 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. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

1.2.2 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. Manufacturer's descriptive data and installation instructions shall be submitted for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Valves, flanges and fittings shall be marked in accordance with MSS SP-25.

1.2.3 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.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System; G|WA.

Drawings showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of connectors and supports.

SD-03 Product Data

Qualifications; G|WA.

Qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

SD-6 Test Reports

Testing; FIO.
Pressure Tests; FIO.

Test reports in booklet form tabulating test and measurements performed. The reports shall be dated after award of this contract, shall state the contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

SD-13 Certificates

Material Certificates; FIO.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Stainless Steel Pipe

Stainless Steel pipe shall be as indicated in the Gas Pipe Schedule at the end of this Section. Pipe and fittings shall be seamless. All joints shall be gas tight. Pipe flanges shall be of the same material as the pipe and be in accordance with ANSI 16.1 Class 125. Unions shall be provided at all valves, instruments, equipment connections and at such joints where pipe dismantling may be required to facilitate equipment removal and maintenance. Plain ends of pipe or fittings shall be true and perpendicular to the axis with edges deburred. See Gas Pipe Schedule at the end of this Section for thickness class and joint type.

2.1.2 [Enter Appropriate Subpart Title Here] 2.1.3 Identification

Pipe flow markings and metal tags shall be provided as required.

2.1.4 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.1.5 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.

2.1.6 Insulating Pipe Joints

2.1.6.1 Insulating Joint Material

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

2.1.6.2 Threaded Pipe Joints

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

2.2 VALVES

2.2.1 Bronze Body Ball Valve

Valve shall have bronze body. Valve bottom shall have bottom loaded pressure retaining stems, PTFE seats, and reinforced PTFE stem packing seals. Valves shall be pressure rated to 600 psi WOG, 150 psi saturated steam. Valve shall conform to Federal Specification WW-V-35C, Type II, Class A, Style 3. Valve end connections shall be threaded. Valve shall be as manufactured by Watts Industries, Inc. 6400 Series, or equal.

2.3 PIPE HANGERS AND SUPPORTS

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

PART 3 EXECUTION

3.1 GAS PIPING SYSTEM

Extent of gas piping shall be as indicated on the Drawings or as specified.

3.1.1 Protection of Materials and Components

Pipe and tube openings shall be closed with caps or plugs during installation. Materials shall be protected from dirt, water, and chemical or mechanical damage. At the completion of all work, the entire system shall be thoroughly cleaned.

3.1.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Defects in piping, tubing or fittings shall not be repaired. When defective piping, tubing, or fittings are located in a system, the defective material shall be replaced.

3.2 INSTALLATION

Installation of the gas system shall be in conformance with the manufacturer's recommendations, applicable provisions of NFPA 54, and as indicated. Pipe cutting shall be done without damage to the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable.

3.2.1 Metallic Piping Installation

Changes in direction of piping shall be made with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains.

3.2.2 Metallic Tubing Installation

Metallic tubing shall be installed using gas tubing fittings approved by the tubing manufacturer. Branch connections shall be made with tees. All tubing end preparation shall be made with tools designed for the purpose.

3.2.3 Aboveground Piping

Aboveground piping shall be run as straight as practicable along the alignment indicated and with a minimum of joints. Piping shall be separately supported.

3.3 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.3.1 Threaded Metallic Joints

Threaded joints in metallic pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints may be made with either approved tetrafluoroethylene tape or with approved joint sealing compound. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.

3.3.2 Welded Metallic Joints

Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

3.4 PIPE SLEEVES

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. 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 large enough to provide a minimum clearance of 1/4 inch all around the pipe.

3.5 ESCUTCHEONS

Escutcheons shall be provided for all finished surfaces where gas piping passes through floors, walls, or ceilings

3.6 PIPING SYSTEM SUPPORTS

Gas piping systems shall be supported with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Gas piping system shall not be supported by other piping. Spacing of supports in gas piping and tubing installations shall conform to the requirements of NFPA 54. The selection and application of supports in gas piping and tubing

installations shall conform to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 1/8 inch shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.7 ELECTRICAL BONDING AND GROUNDING

The gas piping system within the building shall be electrically continuous and bonded to a grounding electrode as required by NFPA 70. Conventional flange joints allow sufficient current flow to satisfy this requirement.

3.8 SHUTOFF VALVE

Provide a valve for isolation of each connection to each piece of equipment, and as indicated on the Drawings.

3.9 TESTING

Before any section of a gas piping system is put into service, it shall be carefully tested to assure that it is gastight. 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 gas 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.

3.9.1 Pressure Tests

Before equipment is connected, piping systems shall be filled with air and shall be tested at the test pressure indicated on the Gas Piping Schedule at the end of this Section, for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gauge, 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. If leakage is recorded, the air supply shall be shut off, the leak shall be repaired, and the tests repeated until all leaks have been stopped.

3.9.2 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

3.10 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

-- End of Section --

**SECTION 15190
GAS PIPING SCHEDULE**

Service	Service Abbr.	Mtl.	Interior Lining	Exterior Coating	Thickness/ Pressure Class	Joint	Test Pres. (psi)	Remarks
Valve Pneumatic Supply (1)	CA	304L SS	-	-	Sch. 40	S	125	See Drawings for Location
Instrument Purge Air	IA	304L SS	-	-	Sch. 40	S	125	See Drawings for Location

Notes:

1. Includes supply headers and individual valve supply lines.

Material Abbreviations

Stainless Steel SS

Joint Abbreviations

Screwed S

SECTION 15200

PIPELINES, LIQUID PROCESS PIPING
08/98

PART 1 GENERAL

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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI H35.2 (1997) Dimensional Tolerances for Aluminum Mill Products

ANSI H35.2M (1997) Dimensional Tolerances for Aluminum Mill Products (Metric)

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L (1995; Errata Dec 1997) Line Pipe

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (1997a) Carbon Structural Steel

ASTM A 47 (1990; R 1995) Ferritic Malleable Iron Castings

ASTM A 47M (1990; R 1996) Ferritic Malleable Iron Castings (Metric)

ASTM A 48 (1994a) Gray Iron Castings

ASTM A 48M (1994) Gray Iron Castings (Metric)

ASTM A 53 (1998) Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded, and Seamless

ASTM A 105/A 105M (1998) Carbon Steel Forgings for Piping Applications

ASTM A 106 (1997a) Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 108 (1995) Steel Bars, Carbon, Cold-Finished, Standard Quality

ASTM A 126 (1995) Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM A 153/A 153M (1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 181/A 181M	(1995b) Carbon Steel Forgings, for General-Purpose Piping
ASTM A 182/A 182M	(1997c) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(1998) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A 216/A 216M	(1998) Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 240/A 240M	(1998) Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A 268	(1996) Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service
ASTM A 269	(1996) Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A 276	(1998) Stainless Steel Bars and Shapes
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(1995a) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 334/A 334M	(1996) Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A 351/A 351M	(1994a) Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts
ASTM A 352/A 352M	(1998) Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A 395	(1988; R 1998) Ferritic Ductile Iron

	Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 395M	(1988; R 1998) Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 403/A 403M	(1998) Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 423/A 423M	(1995) Seamless and Electric-Welded Low-Alloy Steel Tubes
ASTM A 436	(1984; R 1997) Austenitic Gray Iron Castings
ASTM A 479/A 479M	(1998) Stainless Steel Bars and Shapes for use in Boilers and Other Pressure Vessels
ASTM A 513	(1997) Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A 587	(1996) Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM A 632	(1990) Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service
ASTM A 727/A 727M	(1997) Forgings, Carbon Steel, for Piping Components with Inherent Notch Toughness
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 789/A 789M	(1995) Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM A 813/A 813M	(1995) Single- or Double-Welded Austenitic Stainless Steel Pipe
ASTM A 814/A 814M	(1996) Cold-Worked Welded Austenitic Stainless Steel Pipe
ASTM A 815/A 815M	(1998) Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings
ASTM A 858/A 858M	(1996) Heat-Treated Carbon Steel Fittings for Low-Temperature and Corrosive Service
ASTM A 865	(1997) Threaded Couplings, Steel, Black or

	Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints
ASTM B 32	(1996) Solder Metal
ASTM B 42	(1998) Seamless Copper Pipe, Standard Sizes
ASTM B 61	(1993) Steam or Valve Bronze Castings
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1997) Seamless Copper Tube
ASTM B 75M	(1997) Seamless Copper Tube (Metric)
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM B 98/B 98M	(1998) Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B 124	(1996) Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B 124M	(1996) Copper and Copper Alloy Forging Rod, Bar, and Shapes (Metric)
ASTM B 150	(1998) Aluminum Bronze Rod, Bar, and Shapes
ASTM B 150M	(1995a) Aluminum Bronze Rod, Bar, and Shapes (Metric)
ASTM B 161	(1993) Nickel Seamless Pipe and Tube
ASTM B 164	(1998) Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B 165	(1993) Nickel-Copper Alloy (N04400) Seamless Pipe and Tube
ASTM B 167	(1998) Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06690, N060625, and N06045) Seamless Pipe and Tube
ASTM B 210	(1995) Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B 210M	(1995) Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric)
ASTM B 211	(1995a) Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B 211M	(1995a) Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric)
ASTM B 241/B 241M	(1996) Aluminum and Aluminum-Alloy

Seamless Pipe and Seamless Extruded Tube

ASTM B 247 (1995a) Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings

ASTM B 247M (1995a) Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings (Metric)

ASTM B 302 (1997) Threadless Copper Pipe

ASTM B 345 (1996) Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube for Gas and Oil Transmission and Distribution Piping Systems

ASTM B 345M (1996) Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube for Gas and Oil Transmission and Distribution Piping Systems (Metric)

ASTM B 361 (1995) Factory-Made Wrought Aluminum and Aluminum-Alloy Welding Fittings

ASTM B 366 (1998) Factory-Made Wrought Nickel and Nickel Alloy Fittings

ASTM B 517 (1998) Welded Nickel-Chromium-Iron-Alloy (UNS N06600, N06025, N06045) Pipe

ASTM B 546 (1998) Electric Fusion-Welded Ni-Cr-Co-Mo Alloy (UNS N06617) and Ni-Fe-Cr-Si Alloys (UNS N08330 and UNS N08332), Ni-Cr-Fe Alloy (UNS N06025), and Ni-Cr-Fe-Si Alloy (UNS N06045) Pipe

ASTM B 564 (1998) Nickel Alloy Forgings

ASTM B 574 (1998) Low-Carbon Nickel-Molybdenum-Chromium, Low-Carbon Nickel-Chromium-Molybdenum, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Rod

ASTM B 619 (1998) Welded Nickel and Nickel-Cobalt Alloy Pipe

ASTM B 622 (1998) Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube

ASTM B 725 (1993) Welded Nickel (UNS N02200/UNS N02201) and Nickel-Copper Alloy (UNS N04400) Pipe

ASTM B 775 (1995a) General Requirements for Nickel and Nickel Alloy Welded Pipe

ASTM B 813 (1993) Liquid and Paste Fluxes for

Soldering Applications of Copper and
Copper Alloy Tube

- ASTM B 829 (1996) General Requirements for Nickel and Nickel Alloy Seamless Pipe and Tube
- ASTM C 600 (1985; R 1995el) Thermal Shock Test on Glass Pipe
- ASTM D 729 (1995) Vinylidene Chloride Molding Compounds
- ASTM D 1418 (1998) Rubber and Rubber Latices-Nomenclature
- ASTM D 1527 (1996a) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
- ASTM D 1784 (1999) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- ASTM D 1785 (1996b) Poly(Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
- ASTM D 2000 (1998a) Rubber Products in Automotive Applications
- ASTM D 2104 (1996) Polyethylene (PE) Plastic Pipe, Schedule 40
- ASTM D 2235 (1996a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
- ASTM D 2239 (1996a) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
- ASTM D 2241 (1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- ASTM D 2282 (1996a) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)
- ASTM D 2310 (1997) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
- ASTM D 2447 (1995) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
- ASTM D 2464 (1996a) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- ASTM D 2466 (1997) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

ASTM D 2467	(1996a) Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2468	(1996) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2609	(1997) Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(1996a) Polyethylene (PE) Plastic Tubing
ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2992	(1996) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D 3035	(1995) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3222	(1997) Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3307	(1998) PFA-Fluorocarbon Molding and Extrusion Materials
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM D 3350	(1996) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3754	(1996) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
ASTM D 3839	(1994a) Underground Installation of

"Fiberglass" (Glass-Fiber-Reinforced
Thermosetting-Resin) Pipe

ASTM D 3892 (1993) Packaging/Packing of Plastics

ASTM D 3965 (1994) Rigid
Acrylonitrile-Butadiene-Styrene (ABS)
Compounds for Pipe and Fittings

ASTM D 4024 (1994) Machine Made "Fiberglass"
(Glass-Fiber-Reinforced
Thermosetting-Resin) Flanges

ASTM D 4101 (1996a) Propylene Plastic Injection and
Extrusion Materials

ASTM D 4161 (1996) "Fiberglass"
(Glass-Fiber-Reinforced
Thermosetting-Resin) Pipe Joints Using
Elastomeric Seals

ASTM D 5421 (1993) Contact Molded "Fiberglass"
(Glass-Fiber-Reinforced
Thermosetting-Resin) Flanges

ASTM D 5685 (1995) "Fiberglass"
(Glass-Fiber-Reinforced
Thermosetting-Resin) Pressure Pipe Fittings

ASTM D 5686 (1995) "Fiberglass"
(Glass-Fiber-Reinforced
Thermosetting-Resin) Pipe and Pipe
Fittings, Adhesive Bonded Joint Type Epoxy
Resin, for Condensate Return Lines

ASTM E 438 (1992) Glasses in Laboratory Apparatus

ASTM E 814 (1997) Fire Tests of Through-Penetration
Fire Stops

ASTM F 336 (1993) Standard Practice for Design and
Construction of Nonmetallic Enveloped
Gaskets for Corrosive Service

ASTM F 402 (1993) Safe Handling of Solvent Cements,
Primers, and Cleaners Used for Joining
Thermoplastic Pipe and Fittings

ASTM F 423 (1995) Polytetrafluoroethylene (PTFE)
Plastic-Lined Ferrous Metal Pipe,
Fittings, and Flanges

ASTM F 437 (1996a) Threaded Chlorinated Poly(Vinyl
Chloride) (CPVC) Plastic Pipe Fittings,
Schedule 80

ASTM F 438 (1997) Socket-Type Chlorinated Poly(Vinyl
Chloride) (CPVC) Plastic Pipe Fittings,
Schedule 40

ASTM F 439	(1998) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441/F 441M	(1997) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442/F 442M	(1997) Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F 477	(1996a) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 491	(1995) Poly(Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings
ASTM F 492	(1995) Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings
ASTM F 493	(1997) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 599	(1995) Poly(Vinylidene Chloride) (PVDC) Plastic-Lined Ferrous Metal Pipe and Fittings
ASTM F 656	(1996a) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F 714	(1997) Polyethylene (PE) Plastic Pipe (SDR-PR) Based On Outside Diameter
ASTM F 781	(1995) Perfluoro (Alkoxyalkane) Copolymer (PFA) Plastic-Lined Ferrous Metal Pipe and Fittings
ASTM F 876	(1998) Crosslinked Polyethylene (PEX) Tubing
ASTM F 1055	(1998) Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
ASTM F 1056	(1997) Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
ASTM F 1199	(1988; R 1998) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F 1200	(1988; R 1998) Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F)

ASTM F 1290 (1998) Electrofusion Joining Polyolefin
Pipe and Fittings

ASME INTERNATIONAL (ASME)

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 B1.20.7 (1991; R 1998) Hose Coupling Screw Threads
(Inch)

ASME B16.1 (1989) Cast Iron Pipe Flanges and Flanged
Fittings

ASME B16.3 (1992) Malleable Iron Threaded Fittings

ASME B16.5 (1996; B16a) Pipe Flanges and Flanged
Fittings NPS 1/2 thru NPS 24

ASME B16.9 (1993) Factory-Made Wrought Steel
Buttwelding Fittings

ASME B16.11 (1996) Forged Fittings, Socket-Welding and
Threaded

ASME B16.15 (1985; R 1994) Cast Bronze Threaded
Fittings Classes 125 and 250

ASME B16.18 (1984; R 1994) Cast Copper Alloy Solder
Joint Pressure Fittings

ASME B16.20 (1993; R 1998) Metallic Gaskets for Pipe
Flanges - Ring Joint, Spiral-Wound, and
Jacketed

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 B16.26 (1988) Cast Copper Alloy Fittings for
Flared Copper Tubes

ASME B16.28 (1994) Wrought Steel Buttwelding Short
Radius Elbows and Returns

ASME B16.34 (1997) Valves - Flanged, Threaded, and
Welding End

ASME B16.42 (1987; R 1997) Ductile Iron Pipe Flanges
and Flanged Fittings, Classes 150 and 300

ASME B18.2.1 (1996) Square and Hex Bolts and Screws

(Inch Series)

ASME B18.2.2	(1987; R 1999) Square and Hex Nuts (Inch Series)
ASME B31.1	(1998) Power Piping
ASME B31.3	(1999) Process Piping
ASME B36.10M	(1996) Welded and Seamless Wrought Steel Pipe
ASME B36.19M	(19685; R 1994) Stainless Steel Pipe
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN SOCIETY OF SANITARY ENGINEERS (ASSE)

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1012	(1995) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers
ASSE 1015	(1993) Double Check Backflow Prevention Assembly
ASSE 1020	(1974; Rev thru Feb 1989) Pressure Vacuum Breaker Assembly (Recommended for Outdoor Usage)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75mm Through 1200 mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1996) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150	(1996) Thickness Design of Ductile-Iron Pipe
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C153	(1994; Errata Nov 1996) Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76

mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm) for Water Service

- AWWA C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
- AWWA C207 (1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
- AWWA C208 (1996) Dimensions for Fabricated Steel Water Pipe Fittings
- AWWA C500 (1993; C500a) Metal-Sealed Gate Valves for Water Supply Service
- AWWA C504 (1994) Rubber-Seated Butterfly Valves
- AWWA C508 (1993; C508a) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
- AWWA C509 (1994) Resilient-Seated Gate Valves for Water Supply Service
- AWWA C510 (1997) Double Check Valve Backflow-Prevention Assembly
- AWWA C511 (1997) Reduced Pressure Principle Backflow-Prevention Assembly
- AWWA C540 (1993) Power-Actuating Devices for Valves and Sluice Gates
- AWWA C550 (1990) Protective Epoxy Interior Coatings for Valves and Hydrants
- AWWA C606 (1997) Grooved and Shouldered Joints
- AWWA C651 (1992) Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

- AWS A5.3 (1991) Aluminum and Aluminum Alloy Electrodes for Shielded Metal Arc Welding
- AWS A5.8 (1992) Filler Metals for Brazing and Braze Welding
- AWS A5.10 (1992) Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods
- AWS A5.11 (1997) Filler Metal Nickel & Nickel Alloy CVD
- AWS A5.14 (1997) Filler Metal Specifications for Nickel and Nickel Alloy Bare Welding

Electrodes and Rods

- AWS D1.1 (1998) Structural Welding Code - Steel
CODE OF FEDERAL REGULATIONS (CFR)
29 CFR 1910 Occupational Safety and Health Standards
DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)
DIPRA-Restraint Design (1997) Thrust Restraint Design for Ductile
Iron Pipe
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
ISO 228-1 (1994) Pipe Threads Where Pressure-Tight
Joints are not Made on the Threads - Part
1: Dimensions, Tolerances and Designation
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)
MSS SP-25 (1998) Standard Marking System for Valves,
Fittings, Flanges and Unions
MSS SP-43 (1991; R 1996) Wrought Stainless Steel
Butt-Welding Fittings
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-89 (1998) Pipe Hangers and Supports -
Fabrication and Installation Practices
NACE INTERNATIONAL (NACE)
NACE RP0185 (1996) Extruded, Polyolefin Resin Coating
Systems With Soft Adhesives for
Underground or Submerged Pipe
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
NEMA 250 (1991) Enclosures for Electrical Equipment
(1000 Volts Maximum)
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
NFPA 49 (1994) Hazardous Chemical Data
NFPA 325-1 (1994) Fire Hazard Properties of Flammable
Liquids, Gases and Volatile Solids
NFPA 704 (1996) Identification of the Fire Hazards
of Materials for Emergency Response
RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-2

(1996) Hose Handbook

SSPC: THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE 3

(1994) Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

This specification covers the requirements for above grade liquid process pipe, pipe supports, fittings, equipment and accessories located inside the treatment plant.

1.2.1 Design Requirements

Support systems shall be selected and designed within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility.

1.2.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

1.2.2.1 Above Grade Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pipe and Equipment; G|WA

Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, the P&IDs found in the contract drawings

shall be revised to reflect the constructed process system, as directed by the Contracting Officer.

SD-03 Product Data

Welders; FIO

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc.

Waste Water Disposal; FIO

The method proposed for disposal of waste water from hydrostatic tests and disinfection, and all required permits, prior to performing hydrostatic tests.

Delivery, Storage and Handling; FIO

Material safety data sheets.

Materials and Equipment; G|WA

Manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream.

Installation; G|WA

The manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation.

SD-07 Certificates

Plastic Piping System; FIO

Documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

1.4 QUALIFICATIONS

1.4.1 Contractor

Contractor shall have successfully completed at least 3 projects of the same scope and size or larger within the last 6 years. Contractor shall demonstrate specific experience in regard to the system installation to be performed.

1.4.2 Welders

The welding of pressure piping systems shall be in accordance with qualifying procedures using performance qualified welders and operators.

Procedures and welders shall be qualified in accordance with Section 05093 WELDING PRESSURE PIPING.

1.5 GENERAL JOB REQUIREMENTS

Piping materials and appurtenances shall be as specified and as shown on the drawings, and shall be suitable for the service intended. Piping materials, appurtenances and equipment supplied as part of this contract shall be new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems are indicated by service in the Liquid Pipe Schedule.

1.5.1 Components

Piping equipment and appurtenances shall be new products of equal material and ratings as the connecting pipe.

1.5.2 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacturing of the products and shall essentially duplicate items that have been in satisfactory use for at least 5 years prior to bid opening. Nominal sizes for standardized products shall be used. Pipe, valves, fittings and appurtenances shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.5.3 Identification

Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. Valves shall bear a securely attached tag with the manufacturer's name, valve model number, and valve identification permanently displayed and be marked in accordance with MSS SP-25.

1.6 DELIVERY, STORAGE AND HANDLING

Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter. A material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F 402. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D 3892.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Existing Conditions

The Contractor shall be responsible for the verification of existing piping and penetrations. The Contractor shall verify the size, material, joint types, elevation, location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

1.7.2 Verification of Dimensions

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

1.8 MAINTENANCE

1.8.1 Extra Materials

Concurrent with delivery and installation of the specified piping systems and appurtenances, spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to 3 years of service shall be furnished. For each type and size of valve, the following extra materials shall be provided: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve. Extra materials shall include 2 of the following spare parts for each type and size of valve: gaskets; O-ring seals; all elastomer parts; stem packing; and seat rings.

PART 2 PRODUCTS

2.1 CARBON STEEL PIPING SYSTEM

2.1.1 Carbon Steel Pipe

2.1.1.1 General Service

Carbon steel pipe shall meet the requirements of ASTM A 53, Grade A or B, and shall be in accordance with Liquid Pipe Schedule. Pipe less than 4 inches diameter shall be hot-dipped galvanized.

2.1.2 Carbon Steel Joints

Carbon steel piping shall be joined by taper-threaded couplings, welding fittings, or flanges. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.1.3 Carbon Steel Fittings

Fittings less than 4 inches diameter shall be hot-dipped galvanized cast malleable iron. Fittings for pipe 4 inches and larger shall conform to AWWA 208.

2.1.3.1 Threaded Fittings

Threaded fittings shall be Class 150, malleable iron, ASTM A 47, conforming to ASME B16.3, black, banded, and threaded in accordance with ASME B1.20.1. Threaded, rigid couplings shall be Type I (hot-dipped galvanized) carbon

steel in accordance with ASTM A 865 and threaded in accordance with ASME B1.20.1. Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308 shall be used for lubricant/sealant.

2.1.3.2 Welding Fittings

Welding fittings shall be butt-welding. Welding fittings shall be forged steel, ASTM A 105/A 105M Class 150 or welded conforming to ASME B16.9 and ASME B16.28.

2.1.3.3 Flanged Fittings

For tie-in to existing flanges, the Contractor shall field check existing flanges for non-standard bolt hole configurations and shall design as required to assure new pipe and flange mate properly. Fit pipe ends with steel pipe flanges in accordance with AWWA C 207. Flanges shall be AWWA standard steel ring, Class D. Flanges shall be attached to pipe by means of two fillet welds. Gasket shall be inside bolt circle type, 1/16 inch thick, of cloth-inserted rubber. Carbon steel bolts and nuts shall be as a minimum ASTM A 307, Grade A or B.

2.2 PLASTIC PIPING SYSTEM

2.2.1 Polyvinyl Chloride (PVC)

2.2.1.1 PVC Pipe

PVC, ASTM D 1784, pipe shall be Schedule 80 conforming to ASTM D 1785.

2.2.1.2 PVC Joints

The piping system shall be joined by socket-weld connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded. A union shall be provided downstream of each valve, with screwed connections.

2.2.1.3 PVC Fittings

The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM D 1784, PVC conforming to the requirements of ASTM D 2467, socket type.

2.2.1.4 PVC Solvent Cement

Socket connections shall be joined with PVC solvent cement conforming to ASTM D 2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Joints shall be prepared with primers conforming to ASTM F 656 prior to cementing and assembly.

2.3 ISOLATION JOINTS AND COUPLINGS

2.3.1 Dielectric Fittings

Dielectric fittings shall be provided between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure, temperature and corrosive application.

2.3.2 Isolation Joints

Isolation joints shall be provided between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Isolation joints shall consist of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.3.3 Metallic Piping Couplings

Thrust ties shall be provided where shown on the contract drawings and where required to restrain the force developed by 1.5 times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, thrust ties shall be attached with fabricated lugs. For ductile iron pipe, thrust ties shall be attached with socket clamps against a grooved joint coupling or flange. For exposed installations, zinc-plated nuts and bolts shall be used. However, high-strength, low-alloy steel, in accordance with AWWA C111, may be substituted for use on cast iron and ductile iron couplings. Steel middle rings and followers shall be fusion bonded epoxy-lined and coated in accordance with Section 09900 PAINTING, GENERAL and pressure tested beyond yield point.

2.3.3.1 Sleeve-Type Couplings

Sleeve-type couplings shall be used for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe. A coupling shall consist of one steel middle ring, two steel followers, two elastomeric wedge section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. For pipe sizes between 0.5 inch through 1.5 inch, the followers shall be ductile iron, and the middle ring shall be in accordance with ASTM A 513 with AWWA C111 bolting. For pipe sizes 2 inches and larger, the followers shall be ASTM A 395, and the middle ring shall be ASTM A 513 with AWWA C111 bolting. Gaskets shall be natural rubber. Split sleeve-type couplings may be used in aboveground installations under special situations and when approved in advance by the Contracting Officer.

2.3.3.2 Transition Couplings

Transitional couplings may be used to connect two pipes of the same material that have small differences in outside diameter. A fully assembled transitional coupling shall be sized to properly fit pipe diameters. The coupling shall consist of one steel middle ring, two steel followers, two elastomeric wedge section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. The coupling shall use natural rubber, wedge gaskets. The coupling shall be sized to match the associated piping.

2.3.3.3 Flanged Coupling Adapters

Flanged coupling adapters shall be fully assembled units manufactured to meet ASTM A 126 Class B, cast iron. The flanges shall mate with AWWA C207 Class D flanges of the same nominal size. The coupling shall use natural rubber wedge gaskets. Where pipe movement out of the adaptor may occur, proper anchorage of the pipe shall be provided and couplings shall be furnished with lock pins. The coupling shall be sized to match the

associated piping.

2.4 VALVES

2.4.1 General Requirements For Valves

Valves shall include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. The valves shall be suitable for the intended service. Renewable parts are not to be of a lower quality than those specified. Valve ends shall be compatible with adjacent piping system. An operator shall be sized to operate the associated valve for the full range of pressures and velocities.

2.4.2 Valve Schedule

Requirements relative to this paragraph are shown on the Valve and Actuator Schedule located at the end of Section 15100.

2.4.3 Factory Finishing

Valves shall have an epoxy lining in accordance with AWWA C550 unless otherwise specified. The epoxy shall be either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material shall apply if a valve coating is specified as "fusion" or "fusion bonded" epoxy. The epoxy lining shall have a minimum 7.0 mils dry film thickness except where it is limited by valve operating tolerances. Exposed valves shall be finished in accordance with Section 09900 PAINTING, GENERAL.

2.4.4 Check Valves

2.4.5 Ball Valves

2.4.5.1 General Purpose Ball Valves

General purpose ball valves shall conform to the following:

- a. Ball valves, 2 inches and smaller, shall be end entry type with bronze bodies and threaded, in accordance with ASME B1.20.1, regular ports. Valves shall have polytetrafluoroethylene (PTFE) seats and packing, chrome plated brass balls and hand lever operators. Valves shall be rated for 150 psig service at 150 degrees F and shall conform to ASME B16.34. A union shall be installed adjacent to the valves to provide access to the seat.

2.4.6 Butterfly Valves

2.4.6.1 Standard Service Butterfly Valve

Butterfly valves, 2 inches and larger, shall have ASTM A 126 cast iron, ductile iron, or alloy cast iron bodies, with ASME B16.1 flanged end connections. Valves shall conform to AWWA C504 Class 150. Discs shall be contoured ASTM A 436 Type 1 Ni-resist cast iron with maximum lead content of 0.003 percent. The valve shafts shall be 316 stainless steel with self-lubricating, corrosion-resistant sleeve type bearings. Valve seats shall be attached to either the valve body or the disc and shall be constructed of Buna-N or other synthetic rubber suitable for application. Valves shall have operators as indicated on Valve and Actuator Schedule at

the end of Section 15100.

2.4.7 Valve Accessories

2.4.7.1 Tagging

Identification tags made of brass or stamped stainless steel indicating service and valve number shown on the Valve and Actuator Schedule, shall be installed on valves using stainless steel wire. Tags shall be 1.375 inch minimum diameter. Indentations shall be black for reading clarity.

2.4.8 Solenoid Valves

Solenoid valves where shown or required shall be of packless construction with screwed ends and a threaded conduit connection. Parts in contact with the fluid being handled shall be of non-corrodible construction and suitable for the service indicated. Coils shall be rated for continuous duty, and shall be completely encapsulated in epoxy resin. Install a strainer upstream of each solenoid valve. Valves shall be suitable for operation on 120 volt, 60 Hz, single phase power. Solenoid valves shall be as manufactured by Automatic Switch Company or equal.

2.5 MISCELLANEOUS PIPING COMPONENTS

2.5.1 Corporation Stops

Corporation stops shall be furnished with bronze stem, washer, nut, body and key. Corporation stops shall be as manufactured by Mueller, Crane, or approved equal.

2.5.2 Restrained Couplings

2.5.2.1 Description

A sleeve type flexible coupling that provides full restraint of pipe joints.

2.5.2.2 Pressure and Service

Same as connected piping.

2.5.2.3 Coupling Material

ASTM A 36 Carbon.

2.5.2.4 Gasket

Manufacturer's standard for service conditions indicated.

2.5.2.5 Bolts and Nuts

Alloy steel, corrosion-resistant, prime coated.

2.5.2.6 End Rings

- a. End rings shall be welded on pipe ends of both pipes to be connected.
- b. End rings shall be sized, located, and installed per manufacturer's recommendations.

2.5.2.7 Product and Manufacturer

Provide one of the following:

- a. Depend-O-Lok FxF Type 1RC, as manufactured by Brisco Industries, Inc.
- b. Or approved equal.

2.5.3 Segmented Rubberized Compression Seals

Provide link type mechanical segmented rubberized compression seals suitable for 20 psi working pressure, corrosive service and accessible from one side, with Delrin pressure plate and stainless steel bolts and nuts.

2.5.3.1 Product and Manufacturer

Provide one of the following:

- a. Link-Seal, as manufactured by Thunderline Corporation.
- b. Or approved equal.

2.5.4 Pipe Sleeves

Use standard weight 316L stainless steel pipe unless otherwise shown.

2.5.4.1 Dimensions

As required for solvent-welded joint pipe to pass through sleeve. Ends shall be flush with wall face unless otherwise shown.

2.5.5 Service Saddles

2.5.5.1 Description

Service saddles shall be of double strap construction. Coordinate threads with corporation stops, as applicable. Body shall be of ductile iron.

2.5.5.2 Manufacturer:

Provide service saddles of one of the following:

- a. Mueller.
- b. Or approved equal.

2.5.6 Strainers

Strainers shall be of the self-cleaning type, with a Y-pattern body and threaded connections. The strainers shall be rated for 150 psig working pressure at 150 degrees F and conform to ASTM F 1199. The body shall be cast bronze with a screwed bronze cap. The screen shall be heavy-gauge 316 stainless steel or Monel, with 1/16 inch perforations and a free area not less than 2-1/2 times the inlet area. Strainers shall be located upstream of all solenoid valves for liquid service.

2.5.7 Expansion Joints

The Contractor shall provide all structural work and equipment required to control expansion and contraction of piping. The Contractor shall verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems.

2.6 PIPE SUPPORTS AND PENETRATIONS

Auxiliary steel shall be provided by the Contractor where the support of piping systems and equipment is required between building structural elements. Light gauge and structural steel shapes shall conform to the requirements of ASTM A 36/A 36M. The Contractor shall have the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted. Where auxiliary steel is indicated as stainless steel, the Contractor shall provide stainless steel conforming to ASTM A 167, No. 1 Finish.

2.6.1 Pipe Supports

Pipe supports shall conform to the requirements of MSS SP-58, MSS SP-69, and MSS SP-89. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither shall have a deteriorating action on the other.

2.6.1.1 Beam Clamps

For upper attachments on structural steel, the Contractor shall provide beam clamps of ASTM A 36/A 36M carbon steel or ASTM A 181/A 181M forged steel and MSS SP-58 Types 19 through 23, 25 or 27 through 30. Holes drilled in structural steel for hanger support rods will not be permitted. Clamps shall be provided with hardened steel cup-point set screws and lock-nuts for anchoring in place. Clamp size selection shall only be based on the support of the required load.

2.6.1.2 Riser Clamps

Vertical runs of piping shall be supported at each floor, or closer where required, with ASTM A 36/A 36M carbon steel clamps bolted around pipes and attached to the building construction. Two bolt-type clamps designed for installation under insulation shall be used on insulated pipe runs.

2.6.1.3 Brackets

Where piping is run adjacent to walls or steel columns, the Contractor shall provide welded ASTM A 36/A 36M steel brackets, pre-punched with a minimum of two fastener holes.

2.6.1.4 Offset Pipe Clamp

Where pipes are indicated as offset from wall surfaces, a double-leg design two-piece pipe clamp shall be supplied by the Contractor.

2.6.1.5 Hangers

Hangers shall be fabricated of malleable iron, ASTM A 47 or ASTM A 36/A 36M carbon steel. All hangers shall be of a uniform type and material for a given pipe run and application. Coated or plated hangers shall be used to isolate steel hangers from dissimilar metal tube or pipe. Hangers for pipe

sizes 2.5 inches or larger shall incorporate a means of vertical adjustment after erection while supporting the load. For piping systems with liquid temperatures up to 122 degrees F the following shall be used: MSS SP-58 Types 1,3 through 12, Types 24 and 26 with overhead support, or Types 35 through 38 with support from below.

2.6.1.6 Hanger Rods

Hanger rods shall be carbon steel conforming to ASTM A 576. The diameter of the rods for piping system support shall conform to the following:

<u>Nominal Pipe (Inches)</u>	<u>Rod Diameter (Inches)</u>
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.1.2 System Preparation

3.1.2.1 Pipe and Fittings

Pipe and fittings shall be inspected before exposed piping is installed or buried piping is lowered into the trench. The Contractor shall clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.1.2.2 Damaged Coatings

The Contractor shall repair damaged coating areas in the field with material equal to the original coating. The Contractor shall not install damaged piping materials. Field repair of damaged and uncoated areas of galvanized piping shall conform to ASTM A 780.

3.2 EXPOSED PIPING INSTALLATION

Exposed piping shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Piping and appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Piping shall be installed without springing or forcing the pipe.

3.2.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and

fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

3.2.1.1 Drilled-In Expansion Anchors and Fasteners

Anchors shall be designed to accept both machine bolts and/or threaded rods. Such anchors shall consist of an expansion shield and expander nut contained inside the shield. The expander nut shall be fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches, and bears against the shield bottom. The shield body shall consist of four legs, the inside of each shall be tapered toward shield bottom (or nut end). The end of one leg shall be elongated and turned across shield bottom. The outer surface of shield body shall be ribbed for grip-action. The expander nut shall be of square design with sides tapered inward from bottom to top. The anchor materials of construction shall be TP304 stainless steel of 43,541 psiminimum tensile strength. Fasteners shall be machine bolts for use with above anchors; nuts and washers shall conform to ASTM A 194/A 194M. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.

3.2.1.2 Drilled-In Adhesive Anchors

Drilled-in adhesive anchors shall not be used for overhead applications. The anchors shall be composed of an anchor rod assembly and an anchor rod adhesive cartridge. The anchor rod assembly shall be a chamfered and threaded stud rod of TP304 stainless steel with a nut and washer of TP316 stainless steel. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application. The adhesive cartridge shall be a sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial within the capsule. The capsule ingredients shall be activated by the insertion procedure of the anchor rod assembly.

3.2.2 Piping Expansion Provisions

The piping shall be installed to allow for thermal expansion resulting from the difference between installation and operating temperatures. Anchors shall be installed as shown in the contract drawings to withstand expansion thrust loads and to direct and control thermal expansion. An intermediate pipe guide shall be installed for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, pipe alignment guides shall be installed adjacent to the expansion device and within four pipe diameters. Expansion devices shall be installed in accordance with the manufacturer's instructions.

3.2.3 Couplings, Adapters and Service Saddles

Pipes shall be thoroughly cleaned of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Gaskets shall be wiped clean prior to installation. Flexible couplings and flanged coupling adapter gaskets shall be lubricated with the manufacturer's standard lubricant before installation on the pipe ends. Couplings, service saddles, and anchor studs shall be installed in accordance with manufacturer's instructions. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness.

Torque-limiting wrenches shall be used to tighten bolts.

3.2.4 Pipe Flanges

Pipe flanges shall be set level, plumb, and aligned. Flanged fittings shall be installed true and perpendicular to the axis of the pipe. The bolt holes shall be concentric to the centerline of the pipe.

3.2.5 Valve Locations

Valves shall be located in accordance with the contract drawings where actuators are shown. Where actuators are not shown, valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.

3.2.6 Plastic Pipe Installation

All plastic pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Schedule 80 threaded nipples shall be used where necessary to connect to threaded valves or fittings. Strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to over tighten these fittings. The pipe ends that are to be joined shall be shielded from direct sunlight prior to and during the laying operation. Adequate ventilation shall be provided when working with pipe joint solvent cement and the handling of solvent cements, primers and cleaners shall be in accordance with ASTM F 402. The Contractor shall provide and install supports and hangers in accordance with the manufacturer's recommendations. Where plastic pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. This shall be accomplished with the use of expansion joints and offset piping arrangements. All lines shall be hydrostatically tested at the pressures listed in the Liquid Pipe Schedule.

3.2.6.1 PVC Piping

Solvent-cemented joints shall be constructed in accordance with ASTM D 2855.

3.3 CONNECTING DISSIMILAR PIPE

Flexible transition couplings, dielectric fittings and isolation joints shall be installed in accordance with the manufacturer's instructions.

3.4 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

3.4.1 Above Grade Metallic Piping

Nonferrous and stainless steel piping shall not be painted except for aluminum alloy piping. Where dissimilar metals are joined, isolation joints shall be used.

3.4.1.1 Ferrous Piping

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, mill scale or other foreign substances shall be mechanically cleaned by commercial sand blasting conforming to SSPC SP

6/NACE 3 and primed with a ferrous metal primer. Primed surfaces shall be finished in accordance with Section 09900 PAINTING, GENERAL.

3.5 CLOSURES

Closure pieces shall be installed as necessary to end pipe runs and shall conform to ASME B16.9 or ASME B16.11. Elastomer sleeves bonded to pipe ends are not acceptable. Pressure piping shall have closures of blind flanges or threaded plugs, unless otherwise shown on contract drawings or approved by the Contracting Officer. Pipes with restrained joints shall have pipe closures installed with thrust tie-rod assemblies.

3.6 PENETRATIONS

Steel pipe sleeves shall be hot-dipped galvanized after fabrication for above grade applications in nonsubmerged areas. For below grade, or in submerged and damp environments, steel pipe sleeves shall be lined and coated as specified in Section 09900 PAINTING, GENERAL. Embedded metallic piping shall be isolated from concrete reinforcement using coated pipe penetrations. Coatings shall be as specified in Section 09900 PAINTING, GENERAL.

3.7 VALVE INSTALLATION

Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.

3.7.1 Valve Orientation

The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise shown on contract drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6.75 feet above finish floor, unless otherwise shown on contract drawings. Automatic valves shall be installed in accordance with the manufacturer's instructions and approved drawings.

3.7.1.1 Butterfly Valves

Orientation of butterfly valves shall take into account changes in pipe direction. Valve shafts shall be oriented so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.

3.8 PIPING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout plant.

3.8.1 General Support Requirements

Pipe support systems shall meet the requirements of MSS SP-58. Contractor-designed and selected support systems shall be installed in

accordance with MSS SP-69, and as specified herein. Piping connections to equipment shall be supported by pipe supports and not off the equipment. Large or heavy valves, fittings, and/or equipment shall be supported independently of associated piping. Pipes shall not be supported off other pipes. Supports shall be provided at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Pipe supports and hangers shall not be installed in equipment access areas or bridge crane runs. Hanging pipes shall be braced against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, every pipe shall be provided with an intermediate pipe guide, except where pipe anchors are required. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Pedestal type pipe supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration. Piping 2.5 inches in diameter and larger shall be braced for seismic forces. Lateral supports for seismic loads shall be installed at all changes in direction.

3.8.2 Support of Insulated Piping

The Contractor shall install oversized supports to fit the insulation inserts. Supports shall be provided with galvanized or stainless steel protection shields and oversized rollers.

3.8.3 Dielectric Barriers

Dielectric barriers shall be installed between supports and copper or stainless steel piping, and between stainless steel supports and non-stainless steel ferrous piping.

3.8.4 Support Spacing

3.8.4.1 Acceptable Limits for Metallic Piping

Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

<u>Pipe Size (in.)</u>	<u>Spacing (ft)</u>
Up to 1-1/2	6
2 through 3	10
3-1/2 and greater	12

3.8.4.2 Acceptable Limits for Thermoplastic Piping

PVC, Schedule 80, up to 1-1/2 inches diameter, shall have a maximum span of 36 inches.

3.8.5 Support Methods

Piping support shall be provided as specified. Single horizontal suspended piping shall be supported by adjustable swivel-ring, split-ring, or clevis hangers. Horizontal pedestal mounted piping shall have saddle type supports. Horizontal wall mounted piping shall have wall brackets. Vertical piping shall be supported by wall brackets.

3.8.6 Supports and Hangers for Stainless Steel Piping

All hanger-pipe contact surfaces shall have a dielectric barrier consisting of chloroprene rubber wrapping or plastic coated hangers. The load rating of universal concrete inserts shall not be less than that of the hanger rods they support.

3.9 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

Color, coating, and lettering requirements for exposed piping shall be in accordance with Section 09900 PAINTING, GENERAL.

3.10 FIELD QUALITY CONTROL

3.10.1 [Enter Appropriate Subpart Title Here] 3.10.1.1 Exposed Piping

Hydrostatic testing shall be conducted in accordance with ASME B31.3. Piping systems shall be tested at the test pressure indicated in the Liquid Pipe Schedule. Water shall be used as the hydrostatic test fluid. The Contractor shall provide clean test water of such quality to prevent corrosion of the piping system materials. Contractor shall provide air release vents at all high points of the piping system in order to purge air pockets while the piping system is filling.

- a. The maximum velocity during filling shall be 0.25 fps applied over full area of pipe or in accordance with the manufacturer's instructions. The Contractor shall test all parts of the piping system. The hydrostatic test pressure shall be maintained continuously for 2 hours minimum and for such additional time as necessary to conduct examinations for leakage. All joints and connections shall be examined by the Contractor for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. The Contractor shall correct visible leakage and retest. Unless otherwise directed by the Contracting Officer, the piping system shall be left full of water after leaks are repaired.

3.10.1.2 Time for Making Test

Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.10.2 Pipe Leakage Tests

Unless approved by the Contracting Officer, leakage testing 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 piping shall be subjected to the test pressure as indicated in the Liquid Pipe Schedule. Leakage is defined as the quantity of the test liquid, that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within 5 psi of the specified leakage test pressure after the piping has been filled with the test liquid and all air is expelled. No piping installation will be accepted if leakage exceeds the allowable leakage determined by the following formula:

$$L = C_f \times N \times D \times P^{0.5}$$

C_f = conversion factor = 0.0001351

- L = allowable leakage, gallons per hour
- N = number of joints in the length of piping tested
- D = nominal pipe diameter, feet
- P = average test pressure during the test, psig.

Should any test disclose leakage greater than that allowed, the leaks shall be located and repaired until the leakage is within the specified allowance, without additional cost.

3.10.3 Testing New to Existing Connections

New piping connected to existing pipe, existing equipment, existing treatment systems, or tanks and treatment systems furnished under other Sections shall be tested. The Contractor shall isolate the new piping with pipe caps, spectacle blinds, or blind flanges. The joint between new piping and existing piping shall be tested by methods that do not place the entire existing system under the test load. The Contractor shall then proceed with the testing of new piping systems as specified herein.

3.10.4 Valve Testing

Valves may either be tested while testing pipelines, or as a separate step. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. The Contractor shall count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data.

3.11 FINAL CLEANING

3.11.1 Interim Cleaning

The Contractor shall prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.

3.11.2 Flushing

Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. The Contractor shall provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.

3.11.3 Disinfection

The Contractor shall disinfect the pipelines so noted in the Liquid Pipe Schedule. Before acceptance of piping system operation, each section of completed pipeline shall be disinfected in accordance with AWWA C651.

After pressure tests have been made, the piping section 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 liquid chlorine or sodium hypochlorite. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the piping in an approved manner. In no case shall 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. During the flushing period, each outlet on the line shall be opened and closed several times. From several points in the pipeline section, the Contracting Officer will take samples of water in sterilized containers for bacterial examination. The disinfection shall be repeated until the piping system passes the bacterial examination for 2 consecutive days. The piping system will not be accepted until satisfactory bacteriological results have been obtained.

3.12 WASTE WATER DISPOSAL

The water used for testing, cleaning, flushing and/or disinfection shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Contracting Officer prior to performing any testing, cleaning, flushing and disinfection activities.

3.13 SCHEDULES

The Contractor shall comply with the following schedules found in the contract: Liquid Pipe Schedule and Valve and Actuator Schedule documents.

-- End of Section --

**SECTION 15200
LIQUID PIPING SCHEDULE**

Service	Service Abbr.	Mtl.	Interior Lining	Exterior Coating	Thickness/ Pressure Class	Joint	Test Pres. (psi)	Remarks
Steam Condensate	SC	CS	-	Galv	Sch. 80	(1)	50	See Drawings for Location
EBS - Flushing	EBS - F	CS	-	Galv	Sch. 80	(1)	100	See Drawings for Location

Notes:

(1) All joints shall be threaded.

Material Abbreviations

Carbon Steel

CS

Lining Abbreviations

Galvanized

Galv

SECTION 15483

PURGE AIR SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

1.1.1 Provide all labor, materials, equipment and incidentals required to furnish and install a complete and workable purge air system as shown on the drawings and as specified.

1.1.2 Scope: The purge air system shall consist of the following:

1.1.2.1 Two compressors with inlet filters and silencers.

1.1.2.2 Two air receivers

1.1.2.3 Two air dryers

1.1.2.4 All interconnecting piping, wiring and accessories.

1.1.2.5 Two Local compressor control panels.

1.1.3 The compressed air system will provide clean instrument air to the following panels:

1.1.3.1 Filter Control Cabinet DM7

1.1.3.2 Filter Control Cabinet DM8

1.1.3.3 Filter Local Operating Panel 1

1.1.3.4 Filter Local Operating Panel 2

1.1.4 Related Sections:

1.1.4.1 Section 15190, Gas Piping System.

1.1.4.2 Division 16, Electrical

1.1.4.3 Section 13640, Control Panels and Enclosures.

1.2 QUALITY ASSURANCE

1.2.1 Requirements of Regulatory Agencies:

1.2.2.1 Building Codes: Comply with applicable requirements of all governing authorities and any state or local building codes having jurisdiction.

- a. NEC, National Electrical Code.
- b. UL, Underwriters Laboratory.
- c. American Society of Mechanical Engineers, ASME
- d. Compressed Air and Gas Institute, CAGI
- e. ANSI, American National Standards Institute

- f. NFPA, National Fire Protection Association.

1.3 SUBMITTALS

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

SD-01 Data

Air Compressor System; GA|WA
Refrigerated Air Dryer; GA|WA

Submit for approval the following: Manufacturer's literature, illustrations, specifications, detailed drawings, data and descriptive literature on all equipment; Engineering data including dimensions, materials, size and weight; Fabrication, assembly, and wiring diagrams; Installation details as described in the scope of work for this section.

SD-09 Reports

Air Compressor Systems; GA|WA
Refrigerated Air Dryers; GA|WA

Submit a description of proposed testing methods, procedures, and apparatus to the Contracting Officer's Representative for approval at least 48 hours in advance of testing. Submit a written report giving the results of the field tests required.

SD-19 Operation and Maintenance Manuals

Air Compressor System; GA|WA
Refrigerated Air Dryer; GA|WA

Submit complete manuals including: Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, acceptable lubricants, and spare parts information.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Air Compressor Systems:

2.1.1.1 Manufacturer: Provide products of one of the following:

- a. Model OL5D5 as manufactured by Ingersoll Rand.
- b. Or equal.

2.1.1.2 Compressors:

- a. Type: Electric motor driven, totally oil-less compressors, completely packaged simplex assemblies consisting of a 150 psig rated ASME receiver, a simplex electric control panel housed in a NEMA 12 enclosure, with all interconnecting wiring and piping.

- b. Systems shall be designed to meet the requirements of NFPA 99. Failure of a major component shall not jeopardize the supply of air. Individual compressors shall be maintained without shutting down the entire system.
- c. Capacity of each compressor shall be 16.5 ACFM at 125 psig requiring no more than 5.0 horsepower. Motor enclosures to be Totally Enclosed Fan Cooled (TEFC).
- d. Power supply shall be 460 V, 3 phase, 60 Hz.
- e. Compressors shall be furnished with aluminum heads with noncorrosive fittings, stainless steel strip valves with stainless steel strip plates, aluminum pistons with thermally insulated piston pins, separately cast cylinders with precision bore finish and cast-iron, internally primed frame with replaceable crankcase filter. No lubrication shall be required.
- f. Compressors shall be V-belt driven consisting of a single grove belt arrangement, steel sheaves with tapered bushings and a totally enclosed belt guard with provisions for belt adjustment.
- g. Each compressor shall be furnished with an inlet filter/silencer with a 10-micron replaceable element.

2.1.1.3 Air Receivers:

- a. 120 gallon, 150 psig ASME code stamped steel tank, with gauge glass and pressure gauge, mounted on vibration isolators .
- b. Provide check valve between compressors and receivers.
- c. Provide automatic drain valves.
- d. Provide 125 psig pressure relief valves, ASME rated.
- e. Provide air cooled after cooler for each compressor.

2.1.1.4 Local Compressor Control Panels:

Controls shall provide functionality as shown on the P&IDs.

- a. NEMA 12 enclosure shall house UL Listed simplex compressor electrical control system.
- b. Controls shall consist of magnetic motor starters with overload relays and reset switches, 120 volt control circuit transformers with fused secondary, and two pressure switches per compressor system. The lead compressor system shall start at 70 psig and stop at 100 psig. The lead compressor system shall be selected by a soft selector switch on the SCADA System terminal and the local control panel shall provide a permissive contact in the control circuit to be activated by this contact.
- c. Front panel shall include H-O-A selector switches, reset buttons, hour meters and overload and run indicating lights for each compressor.
- d. Auxiliary contacts rated at 5 amp and 120 volts shall be provided as follows:
 - 1) Compressor run for each compressor.

- 2) Compressor overload for each compressor.
- 3) High and low receiver air pressure.
- 4) High dryer discharge temperature (provide terminal input for this signal to be passed on to the SCADA system).
- 5) Compressor run permissive contact.

2.1.2 Refrigerated Air Dryers:

2.1.2.1 Manufacturer: Provide products of one of the following:

- a. Model PR25 as manufactured by Hankison Corporation.
- b. Or equal.

2.1.2.2 Provide refrigerated air dryer for removal of moisture content from purge air supply.

- a. Capacity of dryer shall be 25 SCFM at 100 psig at shall not require greater than 1/5 horsepower.
- b. Power supply shall be 120 V, 3 phase, 60 Hz.
- c. Dryer shall be equipped with a self-regulating hot gas by-pass valve to accurately control refrigerant temperatures and prevent freezing.
- d. Dryer shall be capable of a 37 degree F. Pressure dewpoint and shall reheat discharge gases to ambient temperature.
- e. Dryer shall be furnished with a field adjustable timed automatic dryer drain.
- f. The front panel of the dryer shall contain a Power-to-compressor indicating light, high air temperature warning light and a refrigerant suction pressure gauge.
- g. Auxiliary contacts rated at 5 amp and 120 volts shall be provided for high air temperature warning.

2.1.2.3 Provide in line pre-filter to be located upstream of the air dryer.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Installation of equipment shall be in accordance with manufacturer's instructions and recommendations.

3.1.2 Make final connections to all purge control equipment requiring compressed air.

3.2 AIR TEST

3.2.1 Provide all necessary equipment and materials, including gages and pumps, to perform the testing operations.

3.2.2 Attach air compressor testing apparatus to any suitable opening after closing all other inlets and outlets. Force dehydrated oil-less compressed air, pressure dew point -40 F, into system until there is a uniform gage pressure without the introduction of additional air. For testing the compressed air piping system, provide 150 psig for 30 minutes.

-- END OF SECTION --

SECTION 15501

CONDENSATE RECOVERY SYSTEM

PART 1 GENERAL

1.1 SCOPE

1.1.1 The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install the condensate recovery system complete with piping, valves, insulation, and accessories as shown, specified and/or required for proper operation.

1.2 REFERENCES

Equipment shall comply with the latest applicable provisions and recommendations of the following:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.3 Malleable-Iron Threaded Fittings, Class 150

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated
Welded and Seamless, Spec. for,

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS-SP-83 Steel Pipe Unions, Socket-Welding and Threaded

MSS-SP-84 Valves-Socket Welding and Threaded

1.3 SUBMITTALS

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

SD-01 Data

Condensate Recovery System; GA|WA

SD-04 Drawings

Condensate Recovery System; GA|WA

SD-06 Test Reports

Condensate Recovery System; GA|WA

Test reports showing all field test performed to adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system.

SD-13 Certificates

Factory Test Report; FIO

SD-19 Operation and Maintenance Data

Condensate Recovery System; GA|WA

Three complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment. One complete set at the time the tests procedure is submitted; remaining sets before the contract is completed. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the building, name of the Contractor, and contract number. Flysheets shall be placed before instructions covering each subject. Instruction sheets shall be approximately 8-1/2 by 11 inches, with large sheets of drawings folded in. Instructions shall include, but not be limited to, the following:

- a. System layout showing piping, valves, and controls.
- b. Approved wiring and control diagrams.
- c. A control sequence describing startup, operation, and shutdown.
- d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and troubleshooting guide.
- e. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

1.4 QUALITY CONTROL

Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.

Underwriters Laboratories, Incorporated.

National Fire Protection Association.

National Electrical Code.

Local and State Building Codes and Ordinances.

1.5 SPARE PARTS

1.5.1 The Contractor shall furnish and deliver to the Contracting Officer, at such time as the Contracting Officer may direct, spare parts.

1.5.2 The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

1.5.3 Spare parts shall be furnished in accordance with the manufacturer's recommendations.

1.5.4 Spare parts catalog data for each different item of material and equipment, shall be furnished. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 CONDENSATE RETURN/PUMPING UNIT

2.1.1 The condensate system shall consist of a low-headroom, heavy cast iron receiver with duplex condensate pumps and motors directly attached. The system shall include inlet strainer, gage glass, thermometer and combination float switch and alternator. Each pump shall have a bronze impeller, bronze casing wearing ring, cast iron base, stainless steel shaft and mechanical seal of stainless steel and Viton.

2.1.2 Design Criteria:

Pump Design Flow:	18 gpm
Pump Design Pressure:	30 psi
Receiver Tank Size:	45 gallon
Motor HP:	0.5
Motor Voltage:	208V, 3 Phase, 60 Hz
Motor Speed, rpm:	3,450
Tank Inlet Size, in.:	2.5
Pump Discharge Size, in.:	1

2.1.3 Pumps shall be connected directly to motors. Receiver shall be cast iron and shall be provided with condensate return, vent, overflow, and pump suction connections, water level indicator and automatic air vent. Strainer shall be provided in the inlet line to tank. Vent pipe shall be galvanized steel, and the fittings shall be galvanized malleable iron. Vent pipe shall be installed as indicated. Vent piping shall be flashed as specified. Pump, motor, and receiving tank may be mounted on a single base with the receiver pipe to the pump suction. A stainless steel ball valve and stainless steel check valve, designed for steam and condensate service, shall be provided in the discharge connection from each pump.

2.1.4 The unit shall be UL listed, completely prefabricated and factory tested with NEMA 4X construction Type 316 stainless steel control cabinet and accessories, with the following: one combination magnetic starter with circuit breaker and cover interlock for each motor; one AUTO-OFF-HAND switch; one numbered terminal strip and one fused control transformer. Motor shall be TEFC.

2.1.5 The condensate float switch shall be combination float switch and alternator. The function shall be to start one condensate pump at high liquid level and stop at low liquid level, alternating the pumps at each start. In addition, the switch shall start the second pump at higher than normal liquid level, both pumps then continuing to operate until the level falls to a lower level. The float switch shall be Square D mechanical alternator Class 9038, NEMA 4X, Type JW, top-of-tank mounting, or approved equal.

2.1.6 Controls: Enclosed float switches complete with float mechanisms shall be installed in the head of the receiver. The condensate pump shall be controlled automatically by means of the float switch that will automatically

start the motor when the water in the receiving tank reaches the high level and stop the motor when the water reaches the low level. Motors shall be provided with magnetic across-the-line starters equipped with general purpose enclosure and Automatic-Manual-Off selector switch in the cover. Automatic alternator shall be provided for duplex units.

2.1.7 Factory Testing: The Contractor shall submit a certificate of compliance from the pump manufacturer covering the actual test of the unit and certifying that the equipment complies with the indicated requirements.

2.1.8 Field Testing: The Contractor shall submit a Field Test Report covering the actual test of the unit and confirming that the equipment complies with the indicated requirements.

2.1.9 Packaged system shall be factory painted.

2.1.10 Condensate Recovery System shall be one of the following:

- a. Model GC3D453, as manufactured by Spirax Sarco Inc.
- b. Model XC3D453, as manufactured by Skidmore.
- c. Or equal.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1

3.2 CLEANING

3.2.1 Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. System shall be maintained in this clean condition until final acceptance. Bearings shall be 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.

3.3 TESTING

3.3.1 Equipment and Systems Testing:

Test all equipment and systems to demonstrate specified or approved performances.

3.3.2 Retesting:

Any deficiencies revealed during testing shall be corrected and tests shall be reconducted.

3.4 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members in accordance with Division 1, General Requirements of the Detailed Specifications. Training shall be provided after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals.

3.5 PAINTING

3.5.1 Surface Preparation and Shop Painting:

3.5.1.1 Clean and prime coat ferrous metal surfaces of equipment in the factory/shop in accordance with the requirements of General Specification 09900.

3.5.1.2 Coat polished and non-ferrous metal surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operations.

3.5.2 Field Painting:

3.5.2.1 Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in General Specification 09900, Painting.

3.5.2.2 Field painting of exterior surfaces of piping and equipment insulation is under General Specification 09900, Painting.

-- End of Section --

SECTION 15801

WALL PIPE JOINT REPAIR

PART 1 GENERAL

1.1 DESCRIPTION

1.1.1 Scope:

1.1.1.1 Contractor shall furnish all labor, materials, and equipment and perform all operations necessary to repair wall pipe joints on the following pipes at Filters 27-36:

- a. 36" Influent
- b. 30" Effluent/Backwash Supply (2 per Filter)
- c. 30" Filter Drain
- d. 18" Effluent

1.1.1.2 Work includes, but not necessarily limited to, the following:

- a. Removal of existing lead, oakum and jute packing material.
- b. Installation of permeable grout tubes
- c. Seal face of joint with hydraulic cement.
- d. Injection of void with hydrophobic urethane grout through grout tubes.

1.2 QUALITY CONTROL

1.2.1 Installation

1.2.1.1 Components shall be installed in accordance with manufacturers' specifications and as specified herein.

1.2.1.2 Installer's qualifications shall be as required by the hydrophobic urethane grout manufacturer.

1.2.2 References

ANSI/NSF Standard 61 Drinking Water System Components - Health Effects

1.3 SUBMITTALS

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

SD-01 Data

Hydrophobic urethane grout; GA|WA

SD-08 Statements

Warranty; FIO

Hydrophobic Urethane Grout Installation Certification; FIO

SD-13 Certificates

Hydrophobic urethane grout; FIO

Written certification that product is listed as certified drinking water system components in accordance with ANSI/NSF 61.

1.4 WARRANTY

1.4.1 The Contractor shall obtain from the Manufacturer a warranty for all material and labor associated with the hydrophobic urethane grout, for a period of 7 years from the date of Substantial Completion.

1.4.2 During the warranty period, the Manufacturer shall provide the services of a trained manufacturer's representative to make all repairs and replacements of defective materials at no cost to the Government.

1.4.3 All costs incurred by the manufacturer, including travel and expenses, shall be included under the terms of the warranty.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Materials shall be delivered in unopened, original packaging bearing manufacturer's original labels.

1.5.2 Materials shall be stored and protected in accordance with manufacturer's recommendations.

PART 2 PRODUCTS

2.1 PERMEABLE GROUT TUBES

2.1.1 Permeable grout tubes shall be completely permeable for the injected hydrophobic urethane grout materials and impermeable for the hydraulic cement particles.

2.1.2 Tubes shall be one of the following:

2.1.2.1 INJECTO, as distributed by De Neef Construction Chemicals, Inc.

2.1.2.2 Or equal.

2.2 HYDROPHOBIC URETHANE GROUT

2.2.1 The hydrophobic urethane grout shall be a polyurethane grout with accelerator system, as described below:

2.2.1.1 The polyurethane grout shall be a hydrophobic compound, and shall have the ability to react with water and expand up to three times in volume.

2.2.1.2 The accelerator shall be able to control the reaction time from one minute to one hour.

2.1.1.3 After reaction, the polyurethane grout shall form a flexible, dense closed cell polyurethane foam.

2.1.1.4 Hydrophobic urethane grout materials shall be non-toxic, and shall be listed as certified drinking water system components in accordance with ANSI/NSF Standard 61.

2.1.1.5 The hydrophobic urethane grout shall be one of the following:

a. Hydro-Active Flex LV, as supplied by De Neef Construction Chemicals, Inc.

b. Or equal.

2.2.2 Mixing and Handling:

2.2.2.1 Mixing and handling of the hydrophobic urethane grout in accordance with manufacturer's recommendations, all applicable safety codes, and shall be executed in such a manner as to minimize hazard to personnel. It is the responsibility of the Contractor to provide appropriate protective measures to insure that chemicals or foam produced are under the control of the Contractor at all times.

2.2.2.2 Plastic or metal mixing tanks shall be used. Tanks or concrete or wood shall not be used.

2.2.2.3 Review MSDS prior to opening sealed pails or cans.

2.3 HYDRAULIC CEMENT

2.3.1 The hydraulic cement must be of the fast setting type and has to bond to the piping surfaces to hold a hydrostatic pressure of 75 psi when dry.

2.3.2 The material used as a surface seal shall have adequate strength and adhesion to confine the hydrophobic urethane grout in the void until the injected material has cured.

2.3.3 Hydraulic cement shall be as recommended by the hydrophobic urethane grout manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Remove existing lead, jute and oakum joint packing materials from annular space between pipe spigot and bell, around entire circumference of joint at wall pipe.

3.1.2 Clean surfaces within joint of all dirt, laitance, corrosion or other contamination prior to installation grout tubes and hydraulic cement.

3.2 INSTALLATION OF PERMEABLE GROUT TUBE

3.2.1 Install grout tubes in accordance with manufacturer's recommendations.

3.2.2 Seal face of joint with hydraulic cement in accordance with manufacturer's recommendations. The joint shall be totally sealed such that no sealant will run out of joint when the hydrophobic urethane grout is injected into the tube.

3.3 INJECTION OF HYDROPHOBIC URETHANE GROUT

3.3.1 After hydraulic cement has fully cured and can withhold a hydrostatic pressure of 75 psi, the hydrophobic urethane grout is injected into the joint void through the grout tube.

3.3.2 Install hydrophobic urethane grout in accordance with manufacturer's instructions and recommendations.

3.3.3 All grout shall be injected under such a pressure so as not to damage the existing piping or structure.

3.3.4 Following hydrophobic urethane grout injection, patch the injection ports with cement.

3.4 HYDROPHOBIC URETHANE GROUT INSTALLATION CERTIFICATION

3.4.1 Manufacturer shall provide a letter certifying that the hydrophobic urethane grout system has been installed in accordance with manufacturer's instructions and recommendations. Manufacturer shall provide supervision and inspection services, as deemed necessary by the manufacturer, to certify work at the completion of installation.

-- End of Section --

SECTION 16415

ELECTRICAL WORK, INTERIOR
11/01

PART 1 GENERAL

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 NATIONAL STANDARDS INSTITUTE (ANSI)

- | | |
|----------------|---|
| ANSI C57.12.50 | (1981; R 1989) Ventilated Dry-Type Distribution Transformers 1 to 500 kVA, Single-Phase; and 15 to 500 kVA, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 120 to 600 Volts |
| ANSI C78.1 | (1991; C78.1a; R 1996) Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics |
| ANSI C78.1355 | (1989) Electric Lamps - 150-Watt, 55-Volt S55 High-Pressure Sodium Lamps |
| ANSI C78.20 | (1995) Electric Lamps - Characteristics of Incandescent Lamps A, G, PS, and Similar Shapes with E26 Medium Screw Bases |
| ANSI C78.21 | (1995) Physical and Electrical Characteristics - Incandescent Lamps - PAR and R Shapes |
| ANSI C82.1 | (1997) Specifications for Fluorescent Lamp Ballasts |
| ANSI C82.4 | (1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type) |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|------------|--|
| ASTM B 1 | (1995) Hard-Drawn Copper Wire |
| ASTM B 8 | (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D 709 | (2000) Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- | | |
|----------------|--|
| IEEE C2 | (1997) National Electrical Safety Code |
| IEEE C57.12.80 | (1996) Terminology for Power and |

Distribution Transformers \Savail only as
part of Distribution, Power, and
Regulating Transformer Stds Collection

- IEEE C62.41 (1991; R 1995) Surge Voltages in
Low-Voltage AC Power Circuits
- IEEE Std 242 (1986; R 1991) Recommended Practice for
Protection and Coordination of Industrial
and Commercial Power Systems
- IEEE Std 399 (1997) Recommended Practice for Industrial
and Commercial Power Systems Analysis

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- NEMA 250 (1997) Enclosures for Electrical Equipment
(1000 Volts Maximum)
- NEMA AB 1 (1993) Molded Case Circuit Breakers and
Molded Case Switches
- NEMA FU 1 (1986) Low Voltage Cartridge Fuses
- NEMA ICS 1 (1993) Industrial Control and Systems
- NEMA ICS 2 (1993) Industrial Controls and Systems
Controllers, Contactors, and Overload
Relays Rated Not More Than 2,000 Volts AC
or 750 Volts DC
- NEMA ICS 3 (1993) Industrial Control and Systems
Factory Built Assemblies
- NEMA ICS 6 (1993) Industrial Control and Systems,
Enclosures
- NEMA MG 1 (1998) Motors and Generators
- NEMA MG 10 (1994) Energy Management Guide for
Selection and Use of Polyphase Motors
- NEMA OS 2 (1998) Nonmetallic Outlet Boxes, Device
Boxes, Covers and Box Supports
- NEMA PB 1 (1995) Panelboards
- NEMA ST 20 (1992) Dry-Type Transformers for General
Applications
- NEMA TC 2 (1998) Electrical Polyvinyl Chloride (PVC)
Tubing (EPT) and Conduit (EPC-40 and
EPC-80)
- NEMA WD 1 (1999) General Requirements for Wiring
Devices
- NEMA WD 6 (1997) Wiring Devices - Dimensional
Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2000) Life Safety Code

NFPA 70 (1999) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 18 Industrial, Scientific, and Medical
Equipment

UNDERWRITERS LABORATORIES (UL)

UL 1004 (1994; Rev thru Nov 1999) Electric Motors

UL 1029 (1994; Rev thru Dec 1997)
High-Intensity-Discharge Lamp Ballasts

UL 1059 (Third Ed; Rev Jan 2001) Terminal Blocks

UL 1449 (1996; Rev thru Dec 1999) Transient
Voltage Surge Suppressors

UL 1570 (1995; Rev thru Nov 1999) Fluorescent
Lighting Fixtures

UL 1571 (1995; Rev thru Nov 1999) Incandescent
Lighting Fixtures

UL 1572 (1995; Rev thru Nov 1999) High Intensity
Discharge Lighting Fixtures

UL 1660 (2000) Liquid-Tight Flexible Nonmetallic
Conduit

UL 198B (1995) Class H Fuses

UL 198C (1986; Rev thru Feb 1998)
High-Interrupting-Capacity Fuses,
Current-Limiting Types

UL 198D (1995) Class K Fuses

UL 198E (1988; Rev Jul 1988) Class R Fuses

UL 20 (1995; Rev thru Oct 1998) General-Use Snap
Switches

UL 44 (1999) Thermoset-Insulated Wires and Cables

UL 467 (1993; Rev thru Apr 1999) Grounding and
Bonding Equipment

UL 486A (1997; Rev thru Dec 1998) Wire Connectors
and Soldering Lugs for Use with Copper
Conductors

UL 486E (1994; Rev thru Feb 1997) Equipment Wiring

Terminals for Use with Aluminum and/or
Copper Conductors

- UL 489 (1996; Rev thru Dec 1998) Molded-Case
Circuit Breakers, Molded-Case Switches,
and Circuit-Breaker Enclosures
- UL 498 (1996; Rev thru Jan 1999) Attachment Plugs
and Receptacles
- UL 50 (1995; Rev thru Nov 1999) Enclosures for
Electrical Equipment
- UL 506 (1994; R Oct 1997) Specialty Transformers
- UL 508 (1999) Industrial Control Equipment
- UL 510 (1994; Rev thru Apr 1998) Polyvinyl
Chloride, Polyethylene, and Rubber
Insulating Tape
- UL 512 (1993; Rev thru Mar 1999) Fuseholders
- UL 514B (1997; Rev Oct 1998) Fittings for Cable
and Conduit
- UL 514C (1996; Rev thru Dec 1999) Nonmetallic
Outlet Boxes, Flush-Device Boxes, and
Covers
- UL 542 (1999) Lampholders, Starters, and Starter
Holders for Fluorescent Lamps
- UL 651 (1995; Rev thru Oct 1998) Schedule 40 and
80 Rigid PVC Conduit
- UL 651A (1995; Rev thru Apr 1998) Type EB and A
Rigid PVC Conduit and HDPE Conduit
- UL 67 (1993; Rev thru Oct 1999) Panelboards
- UL 817 (1994; Rev thru May 1999) Cord Sets and
Power-
- UL 83 (1998; Rev thru Sep 1999)
Thermoplastic-Insulated Wires and Cables
- UL 924 (1995; Rev thru Oct 97) Emergency Lighting
and Power Equipment
- UL 935 (1995; Rev thru Oct 1998) Fluorescent-Lamp
Ballasts
- UL 943 (1993; Rev thru May 1998) Ground-Fault
Circuit-Interrupters
- UL 98 (1994; Rev thru Jun 1998) Enclosed and
Dead-Front Switches

UL Elec Const Dir (1999) Electrical Construction Equipment
Directory

1.2 GENERAL

1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation. Lighting fixtures shall be located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from structural members of the building or from framing channels that are supported from structural members of the building. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware and structural support, even if not shown on the drawings.

1.2.3 Special Environments

1.2.3.1 Damp or Wet Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations. Enclosures shall be NEMA 4X (non-metallic).

1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.2.5 Nameplates

1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the

supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Panelboards	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Transformers	
Equipment Enclosures	
Switchgear	
Switchboards	
Motors	

Each panel, section, or unit in panelboards or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Interior Electrical Equipment; G/WA.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission.

Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication,

provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Panelboards.
- b. Cable Terminal Boxes.
- c. Sway bracing for suspended luminaires.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

SD-03 Product Data

Manufacturer's Catalog; G/WA.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; G/WA.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

As-Built Drawings; FIO.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for

accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction.

The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

Field Test Plan; G/WA.

A detailed description of the Contractor's proposed procedures for onsite test submitted 10 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; G/WA.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The product and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.

SD-07 Certificates

Materials and Equipment; FIO.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the

manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 CABLES AND WIRES

Conductors No. 14 AWG and larger diameter shall be stranded. Conductors No. 16 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.1.1 Equipment Manufacturer Requirements

Equipment manufacturer requirements shall not conflict with requirements specified herein and shown on the drawings.

2.1.2 Aluminum Conductors

Aluminum conductors shall not be used.

2.1.3 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, [Type THWN, THHN, or THW conforming to UL 83] [or] [RHW conforming to UL 44], except that grounding equipment wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.1.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.1.5 Data Communication

Provide data communication protocol RS 485 cable as manufactured by Beldon or equal.

2.1.6 Tray Cable or Power Limited Tray Cable

UL listed; Type TC or PLTC.

2.1.7 Cord Sets and Power-Supply Cords

UL 817.

2.2 CABLE TRAYS

2.2.1 Solid Bottom

Solid bottom-type cable trays shall be of a nominal 6, 12, 18, or 24 inch width. Solid covers shall be provided.

2.3 TRANSIENT VOLTAGE SURGE PROTECTION

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of IEEE C62.41 and be UL listed and labeled as having been tested in accordance with UL 1449. Surge suppressor ratings shall be as indicated 120/128 volts rms, operating voltage; 60 Hz; 3-phase; 4 wire with ground; transient suppression voltage (peak let-through voltage) of 400 volts. Fuses shall not be used as surge suppression.

A previous production unit shall have been life-cycle tested to protect against and survive at least 2,500 ANSI/IEEE C62.41-1991 Category C surges without failing or degrading the UL 1449 Surge Suppression Rating by more than 10%. The unit shall incorporate an integral test point allowing easy off-line diagnostic testing, using test equipment available from the TVSS device manufacturer, which verifies the operational integrity of the unit's suppression/filter system. The unit shall include high-frequency extended range tracking filter and shall be UL 1283 Listed as an Electromagnetic Interference Filter. The filter shall provide minimum noise attenuation as follows:

Attenuation Frequency	Single Unit Insertion Loss
100 kHz	34 dB
1 MHz	51 dB
10 MHz	54 dB
100 MHz	48 dB

2.4 CIRCUIT BREAKERS

2.4.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

2.4.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Terminal lugs shall be listed for copper conductors only in

accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break over center toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.4.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be 14,000 amps or higher to correspond with the UL listed integrated short-circuit current rating specified for the panelboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1.

2.4.1.3 Cascade System Ratings

Circuit breakers used in series combinations shall be in accordance with UL 489. Equipment, such as switchboards and panelboards, which house series-connected circuit breakers shall be clearly marked accordingly. Series combinations shall be listed in the UL Recognized Component Directory under "Circuit Breakers-Series Connected."

2.4.1.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection.

2.5 CONDUIT AND TUBING

2.5.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

EMT is not allowed to be installed.

2.5.2 Electrical Nonmetallic Tubing (ENT)

ENT is not allowed to be installed.

2.5.3 Electrical Plastic Tubing and Conduit

NEMA TC 2; NEMA TC 14A and NEMA TC 14B.

2.5.4 Flexible Conduit, Plastic

General-purpose type, UL 1; liquid tight, UL 1660.

2.5.5 Rigid Plastic Conduit

NEMA TC 2, NEMA TC 14A and NEMA TC 14B, UL 651 and UL 651A.

2.6 CONDUIT AND DEVICE BOXES AND FITTINGS

2.6.1 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

2.6.2 Fittings for Conduit and Outlet Boxes

UL 514B.

2.6.3 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

2.7 CONNECTORS, WIRE PRESSURE

2.7.1 For Use With Copper Conductors

UL 486A.

2.8 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.8.1 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

2.9 ENCLOSURES

NEMA ICS 6 or NEMA 250 unless otherwise specified. The EBS control enclosure shall have space heaters in order to keep temperatures above 40 degrees F when ambient temperature around enclosure is 0 degrees F.

2.9.1 Cabinets and Boxes

NEMA 4X non-metallic.

2.10 LIGHTING FIXTURES, LAMPS, BALLASTS, EMERGENCY EQUIPMENT, CONTROLS AND ACCESSORIES

The following specifications are supported and supplemented by information and details on the drawings. Additional fixtures, if shown, shall conform to this specification. Lamps, lampholders, ballasts, transformers, electronic circuitry and other lighting system components shall be constructed according to industry standards. Equipment shall be tested and listed by a recognized independent testing laboratory for the expected installation conditions. Equipment shall conform to the standards listed below.

2.10.1 Lamps

Lamps shall be constructed to operate in the specified fixture, and shall function without derating life or output as listed in published data. Lamps shall meet the requirements of the Energy Policy Act of 1992.

- a. Incandescent and tungsten halogen lamps shall be designed for 125

volt operation (except for low voltage lamps), shall be rated for minimum life of 2,000 hours, and shall have color temperature between 2,800 and 3,200 degrees Kelvin. Tungsten halogen lamps shall incorporate quartz capsule construction. Lamps shall comply with ANSI C78.20 and sections 238 and 270 of ANSI C78.21.

- b. Fluorescent lamps be green-tipped and shall have color temperature of 3,500 degrees Kelvin. They shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used. Fluorescent lamps, including spares, shall be manufactured by one manufacturer to provide for color and performance consistency. Fluorescent lamps shall comply with ANSI C78.1. Fluorescent tube lamp efficiencies shall meet or exceed the following requirements.

T8, 32 watts	(4' lamp)	2800 lumens
T12, 34 watts	(4' lamp)	2800 lumens
T8, 59 watts	(8' lamp)	5700 lumens
T12, 60 watts	(8' lamp)	5600 lumens
T8/U, 31-32 watts	(U-tube)	2600 lumens
T12/U, 34 watts	(U-tube)	2700 lumens

Linear fluorescent lamps, unless otherwise indicated, shall be 4 feet long 32 watt T8, 265 mA, with minimum CRI of 75. Lamps of other lengths or types shall be used only where specified or shown. Lamps shall deliver rated life when operated on rapid start ballasts.

- c. High intensity discharge lamps, including spares, shall be manufactured by one manufacturer in order to provide color and performance consistency. High intensity discharge lamps shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used and shall have wattage, shape and base as shown. High intensity discharge lamps, unless otherwise shown, shall have medium or mogul screw base and minimum starting temperature of -20 degrees F. Metal halide lamps, unless otherwise shown, shall have minimum CRI of 65; color temperature of 4,300 degrees Kelvin; shall be -BU configuration if used in base-up position; and shall be -H or high output configuration if used in horizontal position. Lamps shall comply with all applicable ANSI C78.1350, ANSI C78.1351, ANSI C78.1352, ANSI C78.1355, ANSI C78.1375, and ANSI C78.1376.

2.10.2 Ballasts and Transformers

Ballasts or transformers shall be designed to operate the designated lamps within their optimum specifications, without derating the lamps. Lamp and ballast combinations shall be certified as acceptable by the lamp manufacturer.

- a. Fluorescent ballasts shall comply with ANSI C82.1 and shall be mounted integrally within fluorescent fixture housing unless otherwise shown. Ballasts shall have maximum current crest factor of 1.7; high power factor; Class A sound rating; maximum operating case temperature of 77 degrees F above ambient; and shall be rated Class P. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture. A single

ballast may be used to serve multiple fixtures if they are continuously mounted, identically controlled and factory manufactured for that installation with an integral wireway.

Electronic fluorescent ballasts shall comply with 47 CFR 18 for electromagnetic interference. Ballasts shall withstand line transients per IEEE C62.41, Category A. Ballasts shall have total harmonic distortion between 10 and 20%; minimum frequency of 20,000Hz; filament voltage between 2.5 and 4.5 volts; maximum starting inrush current of 20 amperes; and shall comply with the minimum Ballast Efficacy Factors shown in the table below. Minimum starting temperature shall be 50 degrees F. Ballasts shall carry a manufacturer's full warranty of three years, including a minimum \$10 labor allowance per ballast.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL VOLTAGE	NUMBER OF LAMPS	MINIMUM BALLAST EFFICACY FACTOR
32W T8	rapid start	120 or 277 V	1	2.54
	linear & U-tubes		2	1.44
			3	0.93
			4	0.73
34W T12	rapid start	120 or 277 V	1	2.64
	linear & U-tubes		2	1.41
			3	0.93
59W T8	rapid start linear	120 or 277 V	2	0.80
60W T12	rapid start linear	120 or 277 V	2	0.80

Magnetic fluorescent ballasts shall be energy-saving, automatic resetting type, approved for the application by the Certified Ballast Manufacturers and complying with ANSI C82.1 and UL 935. Minimum ballast starting temperature shall be 40 degrees F for normal service and 0 degrees F where cold temperature service is required. Magnetic fluorescent ballasts shall have a ballast factor not less than shown in the following table:

MAGNETIC FLUORESCENT BALLAST FACTORS*

Design starting temperature above 40 degrees F with 60 Hz input frequency

LAMP TYPE	NUMBER OF LAMPS	NOMINAL OPERATIONAL INPUT VOLTAGE	TYPE OF STARTER & LAMP	MIN. BALLAST FACTOR
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MAGNETIC FLUORESCENT BALLAST FACTORS*

25W F25T8	1	120v	rapid start	.96
	1	277v		.96
	2	120v		.95
	2	277v		.94
32W F32T8	1	120v	rapid start	.96
	1	277v		.95
	2	120v		.85
	2	277v		.96
96W F96T8	1	120 or 277v	instant start	1.10
	2			.85

* For ballasts not specifically designed for use with dimming controls.

b. High intensity discharge ballasts shall comply with UL 1029 and, if multiple supply types, with ANSI C82.4. Ballasts shall have minimum ballast factor of 0.9; high power factor; Class A sound rating; and maximum operating case temperature of 77 degrees F above ambient.

(1) Electronic high intensity discharge ballasts shall be constant wattage autotransformer type; shall have less than 10% ballast loss; shall have total harmonic distortion between 10 and 20%; and shall have a minimum starting temperature of 0 degrees F.

(2) Magnetic high intensity discharge ballasts shall have a minimum starting temperature of -20 degrees F.

2.10.3 Fixtures

Fixtures shall be in accordance with the size, shape, appearance, finish, and performance shown. Unless otherwise indicated, lighting fixtures shall be provided with housings, junction boxes, wiring, lampholders, mounting supports, trim, hardware and accessories for a complete and operable installation. Recessed housings shall be minimum 20 gauge cold rolled or galvanized steel as shown. Extruded aluminum fixtures shall have minimum wall thickness of 0.125 inches. Plastic lenses shall be 100% virgin acrylic or as shown. Glass lenses shall be tempered. Heat resistant glass shall be borosilicate type. Conoid recessed reflector cones shall be Alzak with clear specular low iridescent finish.

a. Incandescent fixtures shall comply with UL 1571. Incandescent fixture specular reflector cone trims shall be integral to the cone and shall be finished to match. Painted trim finishes shall be white with minimum reflectance of 88%. Low voltage incandescent fixtures shall have integral step-down transformers.

b. Fluorescent fixtures shall comply with UL 1570. Recessed ceiling fixtures shall comply with NEMA LE 4. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles. Fluorescent fixture lens frames on recessed and surface mounted troffers shall be one assembly with mitered corners. Parabolic louvers shall have a low iridescent finish and 45 degree cut-off. Louver intersection joints shall be hairline type and shall conceal mounting tabs or other assembly methods. Louvers shall be

free from blemishes, lines or defects which distort the visual surface. Integral ballast and wireway compartments shall be easily accessible without the use of special tools. Housings shall be constructed to include grounding necessary to start the lamps. Open fixtures shall be equipped with a sleeve, wire guard, or other positive means to prevent lamps from falling. Medium bi-pin lampholders shall be twist-in type with positive locking position. Long compact fluorescent fixtures and fixtures utilizing U-bend lamps shall have clamps or secondary lampholders to support the free ends of the lamps.

- c. High intensity discharge fixture shall comply with UL 1572. Recessed ceiling fixtures shall comply with NEMA LE 4. Reflectors shall be anodized aluminum. Fixtures for horizontal lamps shall have position oriented lampholders. Lampholders shall be pulse-rated to 5,000 volts. Fixtures indicated as classified or rated for hazardous locations or special service shall be designed and independently tested for the environment in which they are installed. Recessed lens fixtures shall have extruded aluminum lens frames. Ballasts shall be integral to fixtures and shall be accessible without the use of special tools. Remote ballasts shall be encased and potted. Lamps shall be shielded from direct view with a UV absorbing material such as tempered glass, and shall be circuited through a cut-off switch which will shut off the lamp circuit if the lens is not in place.
- d. Emergency lighting fixtures and accessories shall be constructed and independently tested to meet the requirements of applicable codes. Batteries shall be Nicad or equal with no required maintenance, and shall have a minimum life expectancy of five years and warranty period of three years.
- e. Exit Signs

Exit signs shall be ENERGY STAR compliant, thereby meeting the following requirements. Input power shall be less than 5 watts per face. Letter size and spacing shall adhere to NFPA 101. Luminance contrast shall be greater than 0.8. Average luminance shall be greater than 15 cd/m² measured at normal (0 degree) and 45 degree viewing angles. Minimum luminance shall be greater than 8.6 cd/m² measured at normal and 45 degree viewing angles. Maximum to minimum luminance shall be less than 20:1 measured at normal and 45 degree viewing angles. The manufacturer warranty for defective parts shall be at least 5 years.

2.10.4 Lampholders, Starters, and Starter Holders

UL 542

2.11 LOW-VOLTAGE FUSES AND FUSEHOLDERS

2.11.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

2.11.2 Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with UL 198C.

2.11.3 Fuses, Class K, High-Interrupting-Capacity Type

UL 198D.

2.11.4 Fuses, Class H

UL 198B.

2.11.5 Fuses, Class R

UL 198E.

2.11.6 Fuses, Class T

UL 198H.

2.11.7 Fuses for Supplementary Overcurrent Protection

UL 198G.

2.11.8 Fuses, D-C for Industrial Use

UL 198L.

2.11.9 Fuseholders

UL 512.

2.12 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.13 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below.

2.13.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2.13.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of

motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

MINIMUM NOMINAL MOTOR EFFICIENCIES
 OPEN DRIP PROOF MOTORS

<u>kW</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
0.746	82.5	85.5	80.0
1.12	86.5	86.5	85.5
1.49	87.5	86.5	86.5
2.24	89.5	89.5	86.5
3.73	89.5	89.5	89.5
5.60	91.7	91.0	89.5
7.46	91.7	91.7	90.2
11.2	92.4	93.0	91.0
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	93.6
44.8	95.0	95.0	94.1
56.9	95.0	95.0	94.5
74.6	95.0	95.4	94.5
93.3	95.4	95.4	95.0
112.0	95.8	95.8	95.4
149.0	95.4	95.8	95.4
187.0	95.4	96.2	95.8
224.0	95.4	95.0	95.4
261.0	94.5	95.4	95.0
298.0	94.1	95.8	95.0
336.0	94.5	95.4	95.4
373.0	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>kW</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
0.746	82.5	85.5	78.5
1.12	87.5	86.5	85.5
1.49	88.5	86.5	86.5
2.24	89.5	89.5	88.5
3.73	89.5	89.5	89.5
5.60	91.7	91.7	91.0
7.46	91.7	91.7	91.7
11.2	92.4	92.4	91.7
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	94.1
44.8	94.5	95.0	94.1
56.9	95.0	95.4	94.5
74.6	95.4	95.4	95.0
93.3	95.4	95.4	95.4
112.0	95.8	95.8	95.4
149.0	95.8	96.2	95.8
187.0	95.6	96.2	95.9

TOTALLY ENCLOSED FAN-COOLED MOTORS

224.0	95.4	96.1	95.8
261.0	94.5	96.2	94.8
298.0	94.5	95.8	94.5
336.0	94.5	94.5	94.5
373.0	94.5	94.5	94.5

MINIMUM NOMINAL MOTOR EFFICIENCIES
 OPEN DRIP PROOF MOTORS

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1	82.5	85.5	80.0
1.5	86.5	86.5	85.5
2	87.5	86.5	86.5
3	89.5	89.5	86.5
5	89.5	89.5	89.5
7.5	91.7	91.0	89.5
10	91.7	91.7	90.2
15	92.4	93.0	91.0
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	93.6
60	95.0	95.0	94.1
75	95.0	95.0	94.5
100	95.0	95.4	94.5
125	95.4	95.4	95.0
150	95.8	95.8	95.4
200	95.4	95.8	95.4
250	95.4	96.2	95.8
300	95.4	95.0	95.4
350	94.5	95.4	95.0
400	94.1	95.8	95.0
450	94.5	95.4	95.4
500	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1	82.5	85.5	78.5
1.5	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5
100	95.4	95.4	95.0
125	95.4	95.4	95.4

TOTALLY ENCLOSED FAN-COOLED MOTORS			
150	95.8	95.8	95.4
200	95.8	96.2	95.8
250	95.6	96.2	95.9
300	95.4	96.1	95.8
350	94.5	96.2	94.8
400	94.5	95.8	94.5
450	94.5	94.5	94.5
500	94.5	94.5	94.5

2.14 MOTOR CONTROLS

2.14.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Panelboards supplying non-linear loads shall have neutrals sized for 200 percent of rated current.

2.14.2 Motor Starters

Combination starters are included in other sections of the contract documents and shall be provided with circuit breakers.

2.14.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.14.4 Low-Voltage Motor Overload Relays

2.14.4.1 General

Thermalmagnetic current overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds.

2.14.4.2 Construction

Manual reset type thermal relay shall be melting alloy or bimetallic construction.

2.14.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature,

and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2.14.5 Automatic Control Devices

2.14.5.1 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.14.5.2 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.
- b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2.15 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67; incorporated into NEMA 4X (non-metallic) enclosures; rated for 14,000 amps interrupting capacity, or more.

2.16 RECEPTACLES

2.16.1 Ground Fault Interrupters

UL 943, Class A or B.

2.16.2 NEMA Standard Receptacle Configurations

NEMA WD 6.

- a. Duplex, 20-Ampere, 125 Volt

20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

2.17 CONNECTION, CONDUCTOR

UL 486E; UL 1059; Splicing of wire and cable is not allowed. All wire and cable shall be installed without splices for their entire length from terminal to terminal. All wire and cable shall be landed on terminal posts equipped with screw-down pressure plates. Where lengths of wire or cable are such that they cannot be installed from equipment terminal to equipment terminal, NEMA 4X, non-metallic boxes equipped with in and out terminal blocks shall be provided.

Wire and cable taps shall consist of suitable through-wire type power distribution blocks equipped with "Allen-Wrench-type screw-down pressure plates and securely mounted in NEMA 4X, non-metallic boxes. Each wire or cable whether it's incoming or outgoing, phase, neutral or ground conductor shall have its own separate screw-down pressure plate.

2.18 SNAP SWITCHES

UL 20.

2.19 TAPES

2.19.1 Plastic Tape

UL 510.

2.19.2 Rubber Tape

UL 510.

2.20 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

PART 3 EXECUTION

3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

3.1.1 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor of each panelboard shall have less than 0.01 ohm continuity back to the separately derived grounding connection. All equipment grounding conductors, shall be bonded or joined together in each wiring box or equipment enclosure. Grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. When switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following

specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid plastic conduit or rigid fiberglass reinforced epoxy conduit. Where cables and wires are installed in cable trays, they shall be of the type permitted by NFPA 70 for use in such applications. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified.

3.2.1 Conduit Systems

Conduit systems shall be installed as noted and called out. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit shall be used in damp, wet or corrosive locations as permitted by NFPA 70 and the conduit is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. All wiring installed shall be suitable for installation in wet locations.

3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of plastic having not less than 200 pounds per square inch tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below floor slab to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3.2.1.3 Changes in Direction of Runs

Changes in direction of runs shall be made with factory-made elbows. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced. Installed raceways that get crushed or deformed shall be replaced.

3.2.1.4 Supports

Conduits and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze, all of which including hardware shall be of non-metallic or Type 316 stainless steel materials. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts to hollow masonry units; by expansion bolts to concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work, all of which including hardware shall be of non-metallic or Type 316 stainless steel materials. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws, all of which including hardware shall be of non-metallic or Type 316 stainless steel materials. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used, all of which including hardware shall be of non-metallic or Type 316 stainless steel materials. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems.

3.2.1.5 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

3.2.2 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3.2.2.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3.2.2.2 Use of Aluminum Conductors in Lieu of Copper

Aluminum conductors shall not be used.

3.2.2.3 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).
120/240-volt, 1-phase: Black and red.

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

NEMA 4X, non-metallic boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with non-metallic or Type 316 stainless steel screw-fastened covers. Indicated elevations are approximate. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box or number and size of conduits entering the box whichever is the largest. Boxes for raceways shall be listed for the

intended use when located in wet damp corrosivelocations. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. . All boxes shall meet NEMA 4X requirements and use non-metallic materials.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with concrete with non-metallic or Type 316 stainless steel bolts and non-metallic expansion. Threaded Type 316 stainless steel studs driven in by powder charge and provided with Type 316 stainless steel lockwashers and Type 316 stainless steel nuts, or nail-type nylon anchors may be used in lieu of expansion anchors. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted.

3.4 WIRING DEVICE COVERS

One-piece type wiring device covers shall be provided for all outlets and fittings. Covers shall b installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Covers installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified. Hardware and hinges shall be non-metallic or Type 316 stainless steel.

3.5 RECEPTACLES

3.5.1 Duplex, 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall match color of switch handles in the same room or harmonize with the color of the respective wall. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per pole. The third grounding pole shall be connected to the metal mounting yoke. Receptacles with ground fault circuit interrupters shall have the 20-amp current rating as indicated, and shall be UL Class A type. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

3.5.2 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Wet Locations When In Use", "Damp locations", "Wet Locations", "Wet Location Only When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

3.5.2.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, non-metallic cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

3.5.2.2 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use. [Assemblies which utilize a self-sealing boot or gasket to maintain wet location rating shall be furnished with a compatible plug at each receptacle location and a sign notifying the user that only plugs intended for use with the sealing boot shall be connected during wet conditions].

3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere/120-volt for use on alternating current only.

3.7 PANELBOARDS AND LOADCENTERS

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be tin-plated.

3.7.1 Panelboards

Panelboards shall be circuit breaker equipped as indicated on the drawings. Each branch circuit shall be listed as to its fed load on an individual identification card in a cardholder with a clear plastic covering. Switches serving as motor disconnect means shall be horsepower rated in conformance with UL 98.]

3.8 FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as required.

3.8.1 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class G J K L RK1 RK5 T CC shall have tested interrupting capacity not less than 100,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

3.8.2 Continuous Current Ratings (600 Amperes and Smaller)

Feeder circuit fuses (600 amperes and smaller) shall be Class RK1 RK5 and J, current-limiting, with 200,000 amperes interrupting capacity.

3.9 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3.10 MOTOR CONTROL

Each motor or group of motors requiring a single control shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.10.1 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.11 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.12 LIGHTING FIXTURES, LAMPS AND BALLASTS

This paragraph shall cover the installation of lamps, lighting fixtures and ballasts in interior or building mounted applications.

3.12.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15% of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. 10% spare lamps of each type, from the original manufacturer, shall be provided.

3.12.2 Lighting Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on the drawings. Schedules shown on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved.

3.12.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

3.12.2.2 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on or from the ceiling as shown. Installation and support of fixtures shall be in accordance with NFPA 70 and manufacturer's recommendations. Where seismic requirements are specified herein, fixtures shall be supported as shown or specified. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling, in conformance with UL Elec Const Dir. Surface-mounted fixtures shall be suitable for fastening to the ceiling panel structural supports.

3.12.2.3 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers or hand-straightens so that they hang plumb. Pendants, rods, or chains 4 feet or longer excluding fixture shall be braced to prevent swaying using three cables at 120 degrees of separation. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 10 feet or as recommended by the manufacturer, whichever is less.

3.12.3 Ballasts

Ballasts shall be integral with each respective fixture.

3.12.4 Emergency Light Sets

Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

3.13 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3.13.1 Motors and Motor Control

Motors and motor controls shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and panelboards and terminated.

3.13.2 Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

3.13.3 Food Service Equipment Provided Under Other Sections

Wiring shall be extended to the equipment and terminated.

3.14 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3.15 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section

09900 PAINTING, GENERAL.

3.16 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.17 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer [_____] days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.17.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.17.2 AC System Neutral Continuity and Isolation Tests

Verify that each AC System Neutral conductor has continuity from its respective separately derived distribution center to each of the neutral busses in the panelboards fed by that distribution center.

Verify that each AC System Neutral conductor is connected to the grounding electrode conductor in its respective separately derived distribution center and only at that one point. Perform an insulation resistance test on the conductor after disconnecting the single point connection to ground while leaving the distributed neutral connected to the deenergized source neutral.

3.17.3 Equipment Grounding Conductor Continuity Tests

Verify that each equipment grounding conductor has continuity from its respective separately derived distribution center to the ground bus in each of the panelboards fed by that distribution center.

3.17.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all wires and cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be

500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

R in megohms = (rated voltage in kV + 1kV x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired or replaced cable system shall then be retested until failures have been eliminated.

3.17.4.1 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

3.17.5 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.
- f. Dielectric absorption test on motor [and starter].

3.17.6 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.17.6.1 Circuit Breakers, Molded Case, 150-Amps or Less

- a. Insulation resistance test phase-to-phase, all combinations, contacts closed and open.
- b. Insulation resistance test phase-to-ground, each phase, contacts closed and open.
- c. Closed breaker contact resistance test.
- d. Manual operation of the breaker, prove open and closed contacts in respective toggle positions.

3.18 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3.19 FIELD SERVICE

3.19.1 Onsite Training

Not needed for any equipment to be installed under this section.

3.19.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, check for loose connections, linkages, and mountings, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.20 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --