UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2026
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SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

11/25

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USACE / NAVFAC / AFCEC **UFGS-23 64 26 (November 2025)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 64 26 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2026
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SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS
11/25

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NOTE: This guide specification covers requirements for chilled water, chilled-hot (dual service) water and condenser water piping systems associated with HVAC systems, and located within, on, or under buildings, or connected to equipment adjacent to buildings.
Remove non-applicable section for each project to meet project-specific and locality requirements and restrictions. Do not remove section to provide lesser quality than the minimum level published in this standard.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: Project design may require supplemental information to be added to paragraphs of this section.
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NOTE: Show the following information on project

drawings:

1. Only drawings (not specifications) must indicate capacity, efficiency, dimensions, details, plan views, sections, elevations and location of equipment; and space required for equipment maintenance.

2. Show configuration, slope and location of each piping system such as: above or below floors, above or below ceilings, above or below roofs, above or below ground.

3. Location, sizes, and type of each valve.

4. Details of expansion joints for aboveground piping.

5. Locations and installation details of aboveground pipe hangers and supports.

6. Scale ranges for pressure gages and thermometers.

7. Whether piping is run aboveground on pedestals or poles, or run buried underground.

8. Design working pressures and temperatures for each system.

9. Cathodic protection for buried metal piping.

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NOTE: System requirements must conform to UFC 3-410-01, "Heating, Ventilating, and Air Conditioning Systems".

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project

specification when you choose to reconcile references in the publish print process.

****

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

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015; R 2020; Errata 2026) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014; R 2020) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2025) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2021) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2024) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2025) Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.9	(2025) Building Services Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section

IX-Welding, Brazing and Fusing Qualifications

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003 (2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)

ASSE 1017 (2023) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606 (2022) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2019) Specification for Filler Metals for Brazing and Braze Welding

AWS BRH (2007; 5th Ed) Brazing Handbook

AWS D1.1/D1.1M (2025) Structural Welding Code - Steel

AWS Z49.1 (2021) Safety in Welding, Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M (1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings

ASTM A53/A53M (2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A106/A106M (2026) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A183 (2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts

ASTM A536 (2024) Standard Specification for Ductile Iron Castings

ASTM A653/A653M (2025a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A733 (2025) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B42	(2025) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2017; R 2025) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2026) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2025) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D520	(2025) Standard Specification for Zinc Dust Pigment
ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2022) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2026) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F1007	(2018; R 2022) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2024) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1199	(2021) Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

ASTM F1545	(2015a; R 2021) Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings and Flanges
ASTM F2389	(2024a) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions

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

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2025) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle, and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 00001	(2024) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for

	Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2026; TIA 26-1; ERTA 26-1; TIA 26-2; TIA 26-3; TIA 26-4; TIA 26-5; TIA 26-6; TIA 26-7; ERTA 26-2; ERTA 26-3) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2024) Plastics Piping System Components and Related Materials

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Grooved Mechanical Connections For Steel; G, [_____]

Grooved Mechanical Connections For Copper; G, [_____]

Calibrated Balancing Valves; G, [_____]

Water Temperature Mixing Valve; G, [_____]

Water Temperature Regulating Valves; G, [_____]

Water Pressure Reducing Valve

Pressure Relief Valve

Combination Pressure and Temperature Relief Valves

Expansion Joints; G, [_____]

Pumps; G, [_____]

Combination Strainer and Pump Suction Diffuser

Expansion Tanks

Air Separator Tanks

Water Treatment Systems; G, [_____]

SD-06 Test Reports

Pressure Tests Reports; G, [_____]

Condenser Water Quality Test Reports; G, [_____]

[One-Year Inspection Report For Cooling Water; G, [_____]

] SD-07 Certificates

Employer's Record Documents (For Welding)

Welding Procedures and Qualifications

Manufacturer's Certification Of Bearing Life

SD-08 Manufacturer's Instructions

Lesson Plan for the Instruction Course; G, [_____]

SD-10 Operation and Maintenance Data

Water Treatment Systems; G, [_____]

Calibrated Balancing Valves, Data Package 3; G, [_____]

Water Temperature Mixing Valve, Data Package 3; G, [_____]

Water Temperature Regulating Valves, Data Package 3; G, [_____]

Water Pressure Reducing Valve, Data Package 3; G, [_____]

Pressure Relief Valve, Data Package 2; G, [_____]

Combination Pressure and Temperature Relief Valves, Data Package 2; G, [_____]

Expansion Joints, Data Package 2; G, [_____]

Pumps, Data Package 3; G, [_____]

Combination Strainer and Pump Suction Diffuser, Data Package 2; G, [_____]

Expansion Tanks, Data Package 2; G, [_____]

Air Separator Tanks, Data Package 2; G, [_____]

Spare Parts Data; G, [_____]

Qualified Service Organizations; G, [_____]

1.3 ADMINISTRATIVE REQUIREMENTS

a. In each of the publications referred to herein, consider the advisory provisions to be mandatory. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

b. For the International Code Council (ICC) Codes referenced in the contract documents, consider advisory provisions as mandatory, and the word "should" is to be interpreted as "must." Interpret references to the "code official" to mean the "Contracting Officer." For Navy owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, interpret references to the "owner" to mean the "lessor." Interpret references to the "permit holder" to mean the "Contractor."

c. For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by this administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation must be the Contractor's responsibility. Replace, at the Contractor's expense, any materials found to be damaged. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.5 QUALITY CONTROL

1.5.1 Employer's Record Documents (For Welding)

Submit for review and approval the following documentation. This documentation and the subject qualifications must be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

1.5.2 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification must state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.5.3 Examination of Piping Welds

a. [The Contractor must][The Government will]perform visual examinations to detect surface and internal discontinuities in completed welds. NDE on piping welds covered by ASME B31.9 is visual inspection only. Verify piping welds meet the acceptance criteria. Submit a NDE report meeting the requirements specified in ASME B31.9. Visually examine all welds. When examination indicates defects in a weld joint, the weld must be repaired by a qualified welder. Remove and replace defects as specified in ASME B31.1, unless otherwise specified. Repair defects discovered between weld passes before additional weld material is deposited. Whenever a defect is removed, and repair by welding is not required, blend the affected area into the surrounding surface, eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, examine the area by the same methods which first revealed the defect to ensure that the defect has been eliminated. After rewelding, reexamine the repaired area by the same test methods originally used for that area. Any indication of a defect must be regarded as a defect unless reevaluation by surface conditioning and reexamination shows that no unacceptable defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects

will not be permitted.

b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder and welding operator qualifications. The certification must state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.5.4 Standard Commercial Products

a. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

b. The 2 year use must include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

c. Products having less than a 2 year field service record may be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components must be environmentally suitable for the indicated locations.

d. Support the equipment items by service organizations, located reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Safety Requirements

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

1.6.2 Verification of Dimensions

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

1.6.3 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor must carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required

offsets, fittings, and accessories to meet such conditions.

1.6.4 Accessibility

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NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations.

However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult.

Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

1.7 OPERATION AND MAINTENANCE DATA

Requirements for data packages are specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

1.7.1 Spare Parts Data

Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for one year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

1.7.2 Qualified Service Organizations

Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located

within, on, and adjacent to building(s) within the building(s) 1.66 meter 5 foot line and for connections aboveground to cooling towers or air-cooled chillers.

2.2 STEEL PIPING

Provide steel piping with a minimum ANSI/ASME Class 125 service rating, which for 66 degrees C the pressure rating is 1207 kPa 150 degrees F, the pressure rating is 175 psig.

2.2.1 Pipe

****
NOTE: Corrosion and pipe wall thinning concerns may warrant schedule 80 piping to mitigate piping connection degradation.
****

Steel pipe, conform to ASTM A53/A53M, Schedule [40][80], Type E or S, Grades A or B. Do not use Type F pipe.

2.2.2 Fittings and End Connections (Joints)

****
NOTE: Do not use press fittings on NAVFAC projects. Do not use grooved connections on NAVFAC projects.
****

****
NOTE: For Navy projects in Sigonella and Aviano, consider multilayered piping (HDPE/AL/PEXb) for chilled water systems because of the hard water. Requirements for this piping should be included in the specification. Additionally, in Djibouti, the temperatures are hot and corrosive and the water is corrosive (RO system) so PVC and Schedule 40 steel are not appropriate. Special consideration should be given to these systems.
****

Piping and fittings 25 mm 1 inch and smaller must have threaded connections. Piping and fittings larger than 25 mm 1 inch and smaller than 80 mm 3 inches may have either threaded[, grooved,] or welded connections. Piping and fittings 80 mm 3 inches and larger may have[grooved,] welded, or flanged connections. The manufacturer of each fitting must be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Use threaded fittings conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2.2.2.2 Flanged Connections

Flanges must conform to ASME B16.1, Class 125. Gaskets must be

nonasbestos compressed material in accordance with ASME B16.21, 1.59 mm 1/16 inch thickness, full face or self-centering flat ring type. These gaskets must contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns must conform to ASME B16.1.

2.2.2.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) must conform to ASME B31.9. Butt-welded fittings must conform to ASME B16.9. Socket-welded fittings must conform to ASME B16.11. Identify welded fittings with the appropriate grade and marking symbol.

2.2.2.4 Grooved Mechanical Connections For Steel

****
NOTE: This subpart is tailored for AIR FORCE and ARMY. Do not use on NAVFAC projects.
****

Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C 230 degrees F. Use flexible grooved connections only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components must meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. Each grooved mechanical joint must be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Joint installation must be in compliance with joint manufacturer's written instructions.

Use fitting and coupling houses of malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12; or steel conforming ASTM A106/A106M, Grade B or ASTM A53/A53M. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and conforming to ASTM D2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 93 degrees C 200 degrees F. Grooved mechanical connections must conform to AWWA C606. Coupling nuts and bolts must be steel and must conform to ASTM A183. Pipe connections and fittings must be the product of the same manufacturer. Provide joint installation be in compliance with joint manufacturer's written instructions.

2.2.2.5 Dielectric Waterways and Flanges

Provide ASTM F1545 compliant dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier must be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Provide dielectric waterways suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe [and][or] equipment as described herein for dielectric waterways.

2.3 STAINLESS STEEL PIPING

Requirements for stainless steel piping are listed in Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING.

2.4 POLYPROPYLENE PIPING (CHILLED WATER APPLICATIONS ONLY)

2.4.1 Pipe

****
NOTE: Copolymer is not quite as strong as homopolymer, but it is more durable because it is less brittle, meaning that it has higher impact strength, higher stress crack resistance, and better toughness at low temperatures.
****

Polypropylene pipe must be Schedule 40, copolymer, and must meet ASTM F2389 and NSF/ANSI 14.

2.4.2 Fittings

****
NOTE: This specification is intended for hydronic systems, and therefore it is not intended that this specification would apply to drinking water. Many persons are not aware of the NSF-PW designation for potable water systems, and as a safety precaution, require that all of the polypropylene materials have the NSF-PW rating to prevent job materials on the construction site from being installed in the wrong application, or the pipe being converted later for reuse. Furthermore, systems can become interconnected if solar water heating is used without a heat exchanger.
****

Fittings must meet ASTM F2389 and NSF/ANSI 14 and must be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement must bear the NSF seal "NSF-PW."

Polypropylene fittings must conform to dimensional requirements of Schedule 40. Provide a factory applied UV resistant coating to polypropylene piping that will be exposed to UV light.

2.5 COPPER TUBING

Provide copper tubing and fittings with a minimum ANSI/ASME Class 125 service rating, which for 66 degrees C, the pressure rating is 1207 kPa 150 degrees F, the pressure rating is 175 psig.

2.5.1 Tube

Use copper tube conforming to ASTM B88M ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

2.5.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions

and flanges, must conform to ASME B16.22 and ASTM B75/B75M. Provide adapters as required. Cast copper alloy solder-joint pressure fittings, including unions and flanges, must conform to ASME B16.18. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. ASTM B42 copper pipe nipples with threaded end connections must conform to ASTM B42.

Copper tubing of sizes larger than 100 mm 4 inches must have brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

2.5.3 Grooved Mechanical Connections For Copper

****
NOTE: This subpart is tailored for AIR FORCE and ARMY. Do not use on NAVFAC projects.
****

Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C 230 degrees F. Use flexible grooved connections only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components must meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein.

Each grooved mechanical joint must be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Install joints in compliance with joint manufacturer's written instructions. Provide ductile iron grooved fitting and mechanical coupling housing conforming to ASTM A536. Provide gaskets for use in grooved joints constructed of molded synthetic polymer of pressure responsive design and conforming to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Provide grooved joints in conformance with AWWA C606.

2.5.4 Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Provide solder flux in non-corrosive liquid or paste form, conforming to ASTM B813.

2.5.5 Brazing Filler Metal

Filler metal must conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.6 VALVES

****
NOTE: Indicate on the design drawings valves that are located more than 3 m 10 feet or higher above the floor. Indicate the valves that are to be provided with chain operators.

Indicate on the design drawings valves that are located in insulated lines that require extended necks to accommodate insulation thickness. Indicate which valves require weatherproof operators with mechanical position indicators.

****

Provide valves with a minimum ANSI/ASME Class 125 service rating, which for 66 degrees C, the pressure rating is 1207 kPa 150 degrees F, the pressure rating is 175 psig.

Valves in sizes larger than 25 mm 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves are subject to the same requirements as rigid grooved mechanical joints and fittings and must be furnished by the same manufacturer as the grooved pipe joint and fitting system.

2.6.1 Gate Valve

****

NOTE: For Army projects, ball valves are recommended for equipment or component isolation in lieu of gate valves

****

Gate valves 65 mm 2-1/2 inches and smaller must conform to MSS SP-80 Class 125 and must be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves 80 mm 3 inches and larger must conform to MSS SP-70, Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.6.2 Globe and Angle Valve

Globe and angle valves 65 mm 2-1/2 inches and smaller must conform to MSS SP-80, Class 125. Globe and angle valves 80 mm 3 inches and larger must conform to MSS SP-85, Class 125.

2.6.3 Check Valve

Check valves 65 mm 2-1/2 inches and smaller must conform to MSS SP-80. Check valves 80 mm 3 inches and larger must conform to MSS SP-71, Class 125.

2.6.4 Butterfly Valve

Provide butterfly valves conforming to MSS SP-67, Type 1 and either the wafer or lug type. Valves smaller than 200 mm 8 inches with throttling handles with a minimum of[two][seven] locking positions. Provide valves 200 mm 8 inches and larger with totally enclosed manual gear operators with adjustable balance return stops and position indicators.

2.6.5 Plug Valve

Plug valves 50 mm 2 inches and larger must conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Provide bronze construction for valves 50 mm 2 inches and smaller with NPT connections for black steel pipe and brazed connections for copper tubing. Valve may be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Provide valves with resilient, double seated, trunnion

mounted with tapered lift plug capable of 2-way shutoff. Provide valve operation from fully open to fully closed by rotation of the handwheel to lift and turn the plug.[Provide weatherproof operators with mechanical position indicators.] Provide valves 200 mm 8 inches or larger with manual gear operators with position indicators.

2.6.6 Ball Valve

Full port design. Ball valves 15 mm 1/2 inch and larger must conform to MSS SP-72 or MSS SP-110 and be cast iron or bronze construction with threaded, soldered, or flanged ends. Provide valves 200 mm 8 inches or larger with manual gear operators with position indicators. Ball valves may be provided in lieu of gate valves.

2.6.7 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

2.6.8 Calibrated Balancing Valves

****

NOTE: Plug and ball valves uses include being used as manual balancing valves and will be indicated on the drawings. A supplemental flow measuring scheme or device must be used to measure flow with a manual balancing valve. A calibrated balancing valve incorporates a flow measuring element and can be used in place of a manual balancing valve and a flow measuring device. Delete the last sentence of this subpart if inapplicable.

****

Valves bodies must be composed of copper alloy or cast iron, and valve internal working parts must be composed of copper alloy or stainless steel. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Provide an integral pointer which registers the degree of valve opening. Valve must function as a service valve when in fully closed position. Construct valves with internal seals to prevent leakage and with removable and reusable insulated cover.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. Provide with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the liters per second gallons per minute flow for each differential pressure reading.[In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.]

2.6.9 Automatic Flow Control Valves

****

NOTE: An automatic flow control valve offers complete flow control in many applications; however, the flow control range is dependent on inlet pressure being within a given range, the flow

selection is limited, and, in some cases it may require pump power slightly more than alternative balancing means.

In any facility where typical load imbalances cannot be tolerated and where automatic control is needed to ensure constant hydronic flow, the design must incorporate automatic flow control valves. Show the location, capacity and pressure range of the automatic flow control valves on the drawings. Provide a cyclonic separator in the water system where automatic flow control valves are used for removing particles.

Do not use automatic flow control valves where there is a high risk of dirty sediment-laden water in the system.

Automatic flow control valves must not be used in conjunction with 2-way modulating control valves.

Indicate sub-micron filtration system on drawings.
****

Valve must automatically maintain the constant flow indicated on the design drawings. Valve must modulate by sensing the pressure differential across the valve body with a separate flow measuring device (such as orifice, venturi, or calibrated balancing valve). Valve must be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Provide valve that controls the flow within 5 percent of the tag rating. Valve materials must be the same as specified for the ball or plug valves. Provide a flushing bypass upstream of the valves.

Provide valve that are [electric][or][pneumatic] type as indicated. Valve must be capable of positive shutoff against the system pump head, valve bodies must be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions must be provided with quick connecting hose fittings and differential meter, suitable for the operating pressure specified. Provide the meter complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

2.6.10 Water Temperature Mixing Valve

Valve, ASSE 1017 for water service.

2.6.11 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

2.6.12 Water Pressure Reducing Valve

Valve, ASSE 1003 for water service, copper alloy body.

2.6.13 Pressure Relief Valve

Valve must prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Provide ANSI Z21.22/CSA 4.4 valves with cast iron bodies and corrosion resistant internal working parts. The discharge pipe from the relief valve must be the size of the valve outlet unless otherwise indicated.

2.6.14 Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

2.6.15 Float Valve

[Angle pattern][and][or][Globe pattern]. Construct valve bodies 80 mm 3 inches nominal pipe size and smaller of bronze. Construct valve bodies larger than 80 mm 3 inches of cast iron or bronze. Steel parts must be corrosion resistant. Where float rods are extended for tank applications,provide properly supported and guided extension to avoid bending of float rod or stressing of valve pilot linkage.

2.6.16 Drain Valves

****

NOTE: Indicate the location of each drain valve on the design drawings. Indicate if a drain valve is freeze-proof. Indicate whether a manual or automatic air venting valve. Delete freeze-proof drain valve specification if not required.

****

Valves, MSS SP-80 gate valves. Provide manually-operated valve, 20 mm 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter.[Freeze-proof type valves must be provided in installations exposed to freezing temperatures.]

2.6.17 Air Venting Valves

****

NOTE: Indicate the location of each air venting valve on the drawings. Indicate whether a manual or automatic air venting valve.

****

[Manually-operated general service type air venting valves, brass or bronze valves that are furnished with threaded plugs or caps.][Provide ball-float type automatic air venting valves with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat.]Provide air venting valves on water coils with not less than 3 mm 1/8 inch threaded end connections. Provide air venting valves on water mains with not less than 20 mm 3/4 inch threaded end connections. Provide air venting valves on all other applications with not less than 15 mm 1/2 inch threaded end connections.

2.6.18 Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

2.7 PIPING ACCESSORIES

2.7.1 Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer may be either the cleanable, basket or "Y" type, the same size as the pipeline. Fabricate strainer bodies of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. Provide strainer bodies with arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. Provide screen with minimum 0.8 mm 22 gauge[brass sheet,][monel,][corrosion-resistant steel,] with small perforations numbering not less than 60 per square centimeter 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Provide flow into the screen and out through the perforations.

2.7.2 Cyclonic Separator

Metal-bodied, with removal capability of removing solids 45 microns/325 mesh in size and heavier than 1.20 specific gravity, maximum pressure drop of 35 kPad 5 psid, with cleanout connection.

2.7.3 Combination Strainer and Pump Suction Diffuser

Angle type body with removable strainer basket and internal straightening vanes, a suction pipe support, and a blowdown outlet and plug. Strainer must be in accordance with ASTM F1199, except as modified and supplemented by this specification. Provide unit body with arrows clearly cast on the sides indicating the direction of flow. Provide strainer screen made of minimum 0.8 mm 22 gauge[brass sheet,][monel,][corrosion-resistant steel,] with small perforations numbering not less than 60 per square centimeter 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Direct flow into the screen and out through the perforations. Provide an auxiliary disposable fine mesh strainer which must be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal.

Provide casing with connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Provide unit casing with blowdown port and plug. Provide a magnetic insert to remove debris from system.

2.7.4 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, provide flexible connectors as recommended by the manufacturer for the service intended. Provide internal sleeves or liners, compatible with circulating medium, when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.7.5 Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 115 mm 4.5 inch dial,

brass or aluminum case, bronze tube, and siphon. Provide gauge with a range from 0 kPa 0 psig to approximately 1.5 times the maximum system working pressure. Select each gauge range so that at normal operating pressure, the needle is within the middle-third of the range.

2.7.6 Temperature Gauges

****

NOTE: If known, indicate on the design drawings the locations where all universal adjustable angle type or remote element type temperature gauges must be provided in accordance with requirements specified below.

****

Provide industrial-duty temperature gauges for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2 percent of scale range. Provide Celsius scale in 1 degree Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face, with an adjustable pointer. Provide rigid stem type temperature gauges in thermal wells located within 1.5 m 5 feet of the finished floor. Provide universal adjustable angle type or remote element type temperature gauges in thermal wells located 1.5 to 2.1 m 5 to 7 feet above the finished floor or in locations indicated. Provide remote element type temperature gauges in thermal wells located 2.1 m 7 feet above the finished floor or in locations indicated.

2.7.6.1 Stem Cased-Glass

Provide stem cased-glass with polished stainless steel or cast aluminum, 229 mm 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.7.6.2 Bimetallic Dial

Provide bimetallic dial type case with not less than 89 mm 3-1/2 inches, stainless steel, and hermetically sealed with clear acrylic lens. Provide silicone-dampened, bimetallic element fitted with external calibrator adjustment.

2.7.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Provide liquid-, solid-, and vapor-filled dial type cases with not less than 89 mm, 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill must be nonmercury, suitable for encountered cross-ambients. Provide connecting capillary tubing constructed of double-braided bronze.

2.7.6.4 Thermal Well

Provide thermal well of identical size, 15 or 20 mm 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 15 mm 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Do not use mercury thermometers. Extended neck thermal wells must be of sufficient length to clear insulation thickness by 25 mm 1 inch.

2.7.7 Pipe Hangers, Inserts, and Supports

****
NOTE: In project locations with Environmental Severity Classification (ESC) of C4 or C5 or high humidity areas as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C, include bracketed sentence below to require hot-dipped galvanized hangers if ferrous materials are used. See UFC 1-200-01 for determination of ESC for project locations.
****

Design and fabrication of pipe hangers, inserts, supports, and welding attachments must conform to MSS SP-58 and ASME B31.9. Hanger types and supports for bare and covered pipe must conform to MSS SP-58 for the temperature range. Type 5, 12, and 26 are prohibited.[If ferrous materials are used, provide hot-dipped galvanized hangers, inserts and supports.]

2.7.8 Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.7.9 Expansion Joints

****
NOTE: Expansion loops, offsets, and bends will be used where possible instead of expansion joints. Indicate all expansion provisions, including necessary details, on the drawings. Locate expansion joints in serviceable areas.
****

2.7.9.1 Slip-Tube Type

Slip-tube expansion joints, ASTM F1007, Class I or II. Provide joints with internally-externally alignment guides, injected semi-plastic packing, and service outlets. Provide flanged or beveled-end connections for welding as indicated. Make initial settings in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer.

2.7.9.2 Flexible Ball Type

****
NOTE: The ball joint only moves in an angular offset or rotation mode. The configuration of the ball joint link will require a 2 or 3 ball joint offset to absorb axial and/or lateral movement.
****

Provide flexible ball expansion joints capable of 360 degrees rotation plus 15 degrees angular flex movement. Construct joints of carbon steel

with the exterior spherical surface of carbon steel balls plated with a minimum 0.12 mm 5 mils of hard chrome in accordance with EJMA Stds. Thread joint end connections for piping 50 mm 2 inches or smaller. For joint end connections larger than 50 mm 2 inches provide grooved, flanged, or beveled for welding. Provide joint with pressure-molded composition gaskets suitable for continuous operation at twice design temperature.

2.7.9.3 Bellows Type

Bellows expansion type joints, ASTM F1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections may be either grooved, flanged, or beveled for welding. Provide pipe guides on both sides of expansion joint in accordance with the published recommendations of the manufacturer of the expansion joint.

2.8 PUMPS

****
NOTE: Indicate pump capacity, efficiencies, motor sizes, and impeller types on the drawings. Typical impeller types include the double-suction horizontal split-case type, end-suction vertical split-case type, close-coupled end-suction type, and close-coupled in-line type.
****

Provide electrically driven, non-overloading, centrifugal type pumps which conform to HI 1.1-1.2. Select pumps at or within 5 percent of peak efficiency. Pump curve must rise continuously from maximum capacity to shutoff. Pump motor must conform to NEMA MG 00001, be[open][splash-proof][totally enclosed], and have sufficient wattage horsepower for the service required. Pump motor must have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed must not exceed 3,600 rpm, except where the pump head is less than 180 kPa 60 feet of water, the pump speed must not exceed 1,750 rpm. Provide pump motor with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

2.8.1 Construction

****
NOTE: In most cases, mechanical shaft seals will be the preferred type of shaft seal rather than the stuffing-box type. Although less costly in many cases, the stuffing-box type seals require periodic maintenance which means that the seals are typically only economically justifiable for very large pumps where the first cost difference is great. The shaft seal selection should be based upon a life cycle cost comparison.
****

a. Specify the pump casing to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 862 kPa 125 psig. Provide pump casing and bearing housing constructed of close grained cast iron. Provide manual air vents at the high points in the casing and drain plugs at the low points. Provide threaded suction and discharge pressure gage tapping with

square-head plugs.

b. Impeller must be statically and dynamically balanced. Fabricate the impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve of bronze. Shaft may be carbon or alloy steel, turned and ground. Bearings may be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.

c. [Mount pump and motor on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings. Provide pump with a steel shaft-coupling guard. Bolt the base-mounted pump, coupling guard, and motor to a fabricated steel base fabricated with bolt holes for securing base to supporting surface.][Provide close-coupled integrally cast or fabricated steel feet with bolt holes for securing feet to supporting surface. Provide close-coupled pumps with drip pockets and tapped openings.]Install pump to be accessible for servicing without disturbing piping connections. Shaft seals may be mechanical-seals or stuffing-box type.

2.8.2 Mechanical Shaft Seals

Provide single, inside mounted, end-face-elastomer bellows type shaft seals with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Fabricate glands of bronze and of the water-flush design to provide lubrication flush across the face of the seal. Provide a bypass line from pump the discharge to the flush connection in the gland, with filter or cyclone particle separator in line.

2.8.3 Stuffing-Box Type Seals

Include minimum four rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring in the stuffing box. Provide bronze interlocking split-type.

2.8.4 Bearings

Provide antifriction ball- or roller-bearings with full provision for the mechanical and hydraulic radial and thrust loads imposed. Bearings must have a L-10 rating of at least [60,000][_____] hours in accordance with ABMA 9 and ABMA 11 and verified with manufacturer's certification of bearing life.

2.9 EXPANSION TANKS

****
NOTE: Indicate the requirements for these tanks on the drawings including operating pressure.
****

Construct tank of welded steel, constructed for, and tested to pressure-temperature rating of 862 kPa at 66 degrees C 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Provide a captive air type tank with a polypropylene or butyl lined[diaphragm][replaceable bladder] which keeps the air charge separated from the water.

Tanks must accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Fit each tank air chamber with a drain, fill, an air charging valve, and system connections. Support tank by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system must be the permanent sealed-in air cushion contained within the expansion tank.

2.10 AIR SEPARATOR TANKS

****
NOTE: Indicate the requirements for these tanks on the drawings including operating pressure.
****

****
NOTE: Indicate the routing of all vent and blow-down piping.
****

[Provide external air separation tank with an internal design constructed of stainless steel and suitable for creating the required vortex and subsequent air separation. Construct tank of be steel, constructed for, and tested to pressure-temperature rating of 862 ka at 66 degrees C 125 psi at 150 degrees F. Tank must have tangential inlets and outlets connections, threaded for 50 mm 2 inches and smaller and flanged for sizes 65 mm 2-1/2 inches and larger. Release air captured in a tank[to the atmosphere][vented as indicated]. Provide tank with a blow-down connection.

][Design to separate air from water and to direct released air to automatic air vent. Fabricate unit of one piece cast-iron construction with internal baffles and two air chambers at top of unit; provide one air chamber with an outlet to the expansion tank and the other air chamber with an automatic air release device. Fabricate tank of steel, constructed for, and tested to an ANSI Class 125 pressure-temperature rating.

]2.11 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing hexavalent chromium (CPR) is prohibited.

Provide a water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph WATER ANALYSIS, a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

2.11.1 Water Analysis

****
NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.
****

Conditions of make-up water to be supplied to the condenser and chilled water systems are reported in accordance with ASTM D596 and are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees C
Silica (SiO 2)	[_____] ppm (mg/L)
Insoluble	[_____] ppm (mg/L)
Iron, total (Fe)	[_____] ppm (mg/L)
Aluminum (Al)	[_____] ppm (mg/L)
Calcium (Ca)	[_____] ppm (mg/L)
Magnesium (Mg)	[_____] ppm (mg/L)
Carbonate (HCO 3)	[_____] ppm (mg/L)
Sulfate (SO 4)	[_____] ppm (mg/L)
Chloride (Cl)	[_____] ppm (mg/L)
Nitrate (NO 3)	[_____] ppm (mg/L)
Turbidity	[_____] NTU
pH	[_____]
Residual Chlorine	[_____] ppm (mg/L)
Total Alkalinity	[_____] ppm (mg/L)
Non-Carbonate Hardness	[_____] ppm (mg/L)
Total Hardness	[_____] ppm (mg/L)
Dissolved Solids	[_____] ppm (mg/L)
Conductivity	[_____] microhm/cm

2.11.2 Chilled and Condenser Water

Treat water to be used in the chilled and condenser water systems to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals must meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

[2.11.3 Glycol Solution

****

NOTE: If freeze protection for chilled water is not required, this paragraph should be deleted.

When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC Systems and Equipment Handbook" should be consulted for the appropriate calculation procedures.

Use only propylene glycol at calculated concentration based upon the anticipated ambient or operating temperature. Do not use ethylene glycol.

****

Provide a [_____] percent concentration by volume of industrial grade

propylene glycol in the chilled water. Test the glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. The glycol must contain corrosion inhibitors. Do not use silicate based inhibitors. The solution must be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

][2.11.4 Water Treatment Services

****
NOTE: The services of a water treatment company to treat a chilled water system should only be required if the makeup water available is of very poor quality.
****

Provide the services of a company regularly engaged in the treatment of[condenser][condenser and chilled] water systems to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company must maintain the chemical treatment and provide all chemicals required for the[condenser][condenser and chilled] water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period must meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Do not use acid treatment or proprietary chemicals.

]2.11.5 Chilled Water System

****
NOTE: For dual temperature systems (chilled and heated water), coordinate the compatibility of the separate water treatment systems.
****

Provide a shot feeder on the chilled water piping as indicated. Base the size and capacity of the feeder on local requirements and water analysis. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

[2.11.6 Condenser Water

****
NOTE: Cooling towers with a capacity of greater than 176 kW 50 tons will be provided with automatic chemical feed and blow down systems. Smaller towers will be provided with continuously activated systems. Indicate the location of the entire water treatment system. Specify only non-toxic chemicals for use in cooling towers with automatic blowdown systems. Delete all the information under this paragraph if a cooling tower is not used in the system.
****

The water treatment system must be capable of[automatically][continuously] feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations.[Automatic chemical feed systems must automatically feed chemicals into the condenser water based

on varying system conditions.][Continuous chemical feed systems must continuously feed chemicals into the condenser water at a constant rate. Initially set the system manually based on the water analysis of the make-up water.]

2.11.6.1 Chemical Feed Pump

Provide one pump of the positive displacement diaphragm type for each chemical feed tank. The flow rate of the pumps must be adjustable from 0 to 100 percent while in operation. The discharge pressure of pumps must not be less than 1.5 times the line pressure at the point of connection. Provide each pump with a pressure relief valve and a check valve mounted in the pump discharge.

2.11.6.2 Tanks

Provide two chemical tanks constructed of[high density polyethylene][stainless steel] with a hinged cover. Provide the tanks with sufficient capacity to require recharging only once per 7 days during normal operation. Include a level indicating device and an electric agitator with each tank.

2.11.6.3 Injection Assembly

Provide an injection assembly at each chemical injection point along the condenser water piping as indicated. Construct the injection assemblies of stainless steel and extend the discharge assemblies to the centerline of the condenser water piping. Include a shutoff valve and check valve at the point of entrance into the condenser water line for each assembly.

2.11.6.4 Water Meter

Provide water meters with an electric contacting register and remote accumulative counter. Install the water meter within the make-up water line, as indicated.

2.11.6.5 Timers

Provide timers of the automatic reset, adjustable type, and electrically operated, suitable for a 120 volt current. Locate the timers within the water treatment control panel.

2.11.6.6 Water Treatment Control Panel

****

NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems. In areas where a panel could come in contact with the water treatment chemical, choose the stainless steel construction.

****

Provide a NEMA 12 control enclosure panel suitable for surface mounting. Construct panel of[stainless steel][steel] with a hinged door and lock. Provide a laminated plastic nameplate on the panel identifying each of the following functions:

(1) Main power switch and indicating light

(2) MAN-OFF-AUTO selector switch

(3) Indicating lamp for bleed-off valve

(4) Indicating lamp for each chemical feed pump

(5) Set point reading for each timer

2.11.6.7 Chemical Piping

Construct piping and fittings of[schedule 80 PVC][stainless steel] suitable for the water treatment chemicals.

2.11.6.8 Sequence of Operation

****
NOTE: Choose the first set of brackets for automatic chemical feed systems. Choose the second set of brackets for continuous chemical feed systems.
****

[Add the chemicals based upon sensing the make-up water flow rate and activating appropriate timers. Provide a separate timer for each chemical. Control the blow down based upon the make-up water flow rate and a separate timer.][The system must contain an adjustable valve for continuous blow down. Manually set the flow rate from the appropriate chemical tanks at the metering pump for continuous chemical feed.]Control the injection of the chemical required for biological control by a timer which can be manually set for proper chemical feed. Determine the set timer set points, blow down rates, and chemical pump flow rates by the water treatment company.

2.11.6.9 Test Kits

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals.

[2.11.6.10 Bleed Line

****
NOTE: Delete the following paragraph on bleed lines if an automatic chemical system is chosen.
****

Provide a bleed line with a flow valve of the needle-valve type sized for the flow requirement or fixed orifice in the pump return to the tower. Extend the bleed line to the nearest drain for continuous discharge.

]]2.12 ELECTRICAL COMPONENTS

****
NOTE:
1. Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

2. Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION

SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (SD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 "Interior Electrical Systems".

****

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

b. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

c. Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 00001. Provide motors in accordance with NEMA MG 00001 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

d. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Provide motor bearings with grease supply fittings and grease relief to outside of the enclosure.

e. [Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW 10 hp or less and adjustable frequency drives for larger motors.][Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.]

2.13 PAINTING OF NEW EQUIPMENT

New equipment painting may be factory applied or shop applied, as specified herein, and provided under each individual section.

2.13.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The

factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test.

Conduct salt-spray fog test in accordance with ASTM B117, and as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of 3 mm 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service

2.13.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil, and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing must be coated with a zinc-rich coating conforming to ASTM D520, Type I. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be either aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm 1 mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm 1 mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F must receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F must receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

2.14 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 25 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84.

Test insulation 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 must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.15 NAMEPLATES

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

****

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks must have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates must remain durable and legible throughout equipment life and made of[anodized aluminum][stainless steel] [_____]. Plates must remain fixed in prominent locations with nonferrous screws or bolts.

PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified in this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 Welding Safety

Welding and cutting safety requirements must be in accordance with AWS Z49.1.

3.1.2 Directional Changes

Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller is permitted, provided a pipe bender is used and the centerline radius of pipe bends are not less than 6 pipe diameters. Piping bends showing kinks, wrinkles, flattening, or other malformations are not acceptable. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted.

3.1.3 Functional Requirements

a. Pitch horizontal supply mains down in the direction of flow as indicated. The grade must not be less than 2 mm in 1 m 1 inch in 40 feet. Do not use reducing fittings for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

b. Unless otherwise specified provide uncoated pipe. Provide connections to appliances with malleable iron unions for steel pipe 65 mm 2-1/2 inches or less in diameter, and with flanges for pipe 80 mm 3 inches and above in diameter. Provide connections between ferrous and copper piping with electrically isolated from each other with dielectric waterways or flanges.

c. Piping located in air plenums must conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs must be welded. Fit equipment and piping arrangements into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Provide electric isolation fittings between dissimilar metals.

3.1.4 Fittings and End Connections

3.1.4.1 Threaded Connections

Make threaded connections with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Allow not more than three threads to show after the joint is made.

3.1.4.2 Brazed Connections

Brazing, AWS BRH, except as modified herein. During brazing, fill the pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, clean both the outside of the tube and the inside of the fitting with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Remove surplus brazing material at all joints. Make steel tubing joints in accordance with the manufacturer's recommendations. Prior to brazing, support piping so as not to force or cause to be sprung.

3.1.4.3 Welded Connections

****

NOTE: Do not use nitrogen (N2) as a shielding gas or purge gas if the gas will be directly exposed to

a welding arc. N2 dissociates to single atom nitrogen (N) when directly exposed to welding-arc temperatures. Single atom nitrogen is reactive and can reduce weld integrity by increasing weld porosity and weld embrittlement.

****

Make branch connections with manufactured pipe fittings that match piping material and schedule. Field-fabricated direction changes and branch connections formed by mitering or notching pipe or other similar construction to form elbows and tees is not permitted. Thoroughly clean pipe of all scale and foreign matter before the piping is assembled. During welding, fill the pipe and fittings with an inert gas, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld must conform to ASME B31.9. Remove weld defects and rewelded at no additional cost to the Government. Electrodes must be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating.

3.1.4.4 Grooved Mechanical Connections

****

NOTE: This subpart is tailored for AIR FORCE and ARMY. Do not use on NAVFAC projects.

****

Prepare grooves in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. For each change in grooving tool setup, measure and record the width and dimension of the groove from end of pipe to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.1.4.5 Flared Connections

When flared connections are used, use a suitable lubricant between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4.6 Flanges and Unions

Except where copper tubing is used, provide union or flanged joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Assemble flanged joints square and tight with matched flanges, gaskets, and bolts. Gaskets must be suitable for the intended application.

3.1.5 Valves

****

NOTE: Do not use wafer-type butterfly valves if system maintenance requires the valve to function as

a piping dead-end, e.g., piping is disconnected on one side of the valve and the valve is required to maintain isolation.

****

Install isolation gate, ball, or butterfly valves on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Identify each valve except check valves. Install valves in horizontal lines with stems at or above the horizontal plane.

Install calibrated balancing valves with a minimum unrestricted straight pipe length equivalent to 3-pipe diameters upstream and 1-pipe diameter downstream immediately adjacent the valve, or the manufacturer's recommended amounts, if greater. Calibrated balancing valves are not permitted to serve as isolation valves.

3.1.6 Air Vents

Provide air vents at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7 Drains

Provide drains at all low points and where indicated to ensure complete drainage of the piping. Drains must be accessible, and consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Flexible Pipe Connectors

****

NOTE: Flexible pipe connectors will be provided where required to absorb expansion and contraction, isolate vibration, absorb noise, compensate offset motion, absorb continuous flexing, and relieve equipment from piping stresses. Where flexible pipe connectors are needed to correct lateral, parallel, and angular misalignment, their use will be limited to maximum offset as recommended, in writing, by the manufacturer. Flexible pipe connectors will only be used on water piping.

****

Attach connectors to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the connectors, of the type recommended by the flexible pipe connector manufacturer and at the intervals recommended.

3.1.9 Temperature Gauges

Locate temperature gauges on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats must extend beyond thermal insulation surface not less than 25 mm 1 inch.

3.1.10 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58, except as supplemented and modified in this specification section. Do not use pipe hanger types 5, 12, and 26. Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Support piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers.

3.1.10.1 Hangers

Do not use Type 3 hangers on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.10.2 Inserts

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

3.1.10.3 C-Clamps

Type 19 and 23 C-clamps must be torqued per MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.10.4 Angle Attachments

Furnish Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.1.10.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, must be used on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Type 40 shields must be used on all piping less than 100 mm 4 inches and all piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F. A high density insulation insert of cellular glass must be used under the Type 40 shield for piping 50 mm 2 inches and larger.

3.1.10.6 Horizontal Pipe Supports

Horizontal pipe supports must be spaced as specified in MSS SP-58 and a support installed not over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe supports not over 1.5 m 5 feet apart at valves.[Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg 50 pounds must have the excess hanger loads suspended from panel points.]

3.1.10.7 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet, not more than 2.4 m 8 feet from end of risers, and at vent terminations, or with manufacturer's recommendation and requirements, whichever is less.

3.1.10.8 Pipe Guides

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

3.1.10.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle must be used. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.10.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.10.11 Seismic Requirements

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NOTE: Use this subparagraph for Army projects only.
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NOTE: Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if no seismic details are provided. Sections 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, properly edited, must be included in the contract documents.
****

Support and brace piping and attached valves to resist seismic loads as specified under Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS[as shown on the drawings]. Provide under this section structural steel required for reinforcement to properly support piping, headers, and equipment but not shown. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.10.12 Structural Attachments

Attachment to building structure concrete and masonry may be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Apply inserts and anchors with a safety factor not less than 5. Supports must not be attached to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Construct masonry anchors for overhead applications of ferrous materials only. Provide under this section structural steel brackets required, but not shown, to support piping, headers, and equipment. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.11 Pipe Alignment Guides

Provide pipe alignment guides where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m 5 feet on each side of each expansion joint, and in lines 100 mm 4 inches or smaller not more than 600 mm 2 feet on each side of the joint.

3.1.12 Pipe Anchors

****
NOTE: Designer must indicate locations and details of pipe anchors on the design drawings.
****

Provide anchors where indicated. Unless indicated otherwise, anchors must comply with the requirements specified. Anchors must consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results using turnbuckles where required.

Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, anchor these items immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

3.1.13 Building Surface Penetrations

Do not install sleeves in structural members except where indicated or approved. Except as indicated otherwise, piping sleeves must comply with requirements specified. Sleeves in nonload bearing surfaces must be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 1.0 mm 20 gauge. Sleeves in load bearing surfaces must be uncoated carbon steel pipe, conforming to ASTM A53/A53M,[Schedule 30][Schedule 20][Standard weight]. Apply sealants to moisture and oil-free surfaces and elastomers to not less than 13 mm 1/2 inch depth. Do not install sleeves in structural members.

3.1.13.1 Refrigerated Space

a. Fit refrigerated space building surface penetrations with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Construct sleeves with integral collar or cold side fitted with a bonded slip-on flange or extended collar.

b. In the case of masonry penetrations where sleeve is not cast-in, fill voids with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors.

c. Flash integral cast-in collar type sleeve[as indicated.][with not less than 100 mm 4 inches of cold side vapor barrier overlap of sleeve

surface.] Seal normally non-insulated penetrating round surfaces to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth insulated with not less than [100][_____] mm [4][_____] inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer.

d. Apply vapor barrier sealant to finish warm side insulation surface. Insulate warm side of penetrating surface beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Seal wires in refrigerated space surface penetrating conduit with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.1.13.2 General Service Areas

Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Provide pipes passing through concrete or masonry wall or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Sleeves must be of such size as to provide a minimum of 6.35 mm 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve must be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.13.3 Waterproof Penetrations

Install pipes passing through roof or floor waterproofing membrane through a 5.17 kg/sq. m .17 ounce copper sleeve, or a 0.81 mm 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve must be suitably formed, and skirt or flange must extend not less than 200 mm 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing sleeve up the pipe a minimum of 50 mm 2 inches above the roof or floor penetration. Seal the annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation as indicated. Seal penetrations by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Provide seals of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Loosely assemble links with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

c. After the seal assembly is properly positioned in the sleeve, tightening of the bolt must cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the

sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.1.13.4 Fire-Rated Penetrations

Seal penetration of fire-rated walls, partitions, and floors as specified in Section 07 84 00 FIRESTOPPING.

3.1.13.5 Escutcheons

Provide escutcheons for finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep-type escutcheons. Secure escutcheons to pipe or pipe covering.

3.1.14 Drain and Make-Up Water Piping

****
NOTE: Indicate all drain and makeup water piping on the drawings.
****

Requirements for drain and make-up water piping and backflow preventer is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.1.15 Cathodic Protection

Requirements for cathodic protection systems are specified in[Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][and][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

3.1.16 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

3.1.17 Field Painting

Requirements for painting of surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00 PAINTS AND COATINGS.

[3.1.17.1 Color Coding

****
NOTE: Color coding for piping identification required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09 90 00 PAINTS AND COATINGS.
****

Requirements for color coding for piping identification are specified in Section 09 90 00 PAINTS AND COATINGS.

]3.1.17.2 Color Coding For Hidden Piping

****
NOTE: Use this paragraph for Army projects only.
****

****
NOTE: Color Coding Scheme may be deleted in accordance with Notes in Section 22 00 00 PLUMBING, GENERAL PURPOSE.
****

Provide a color coding scheme for locating hidden piping in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][Section 22 00 70 PLUMBING FOR HEALTHCARE FACILITIES].

3.1.18 Access Panels

****
NOTE: To the extent possible, designer must indicate locations of access panels on the design drawings.
****

Provide access panels where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Provide access panels of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Provide access panels as specified in[Section 08 31 00 ACCESS DOORS AND PANELS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.1.19 Heat Trace

****
NOTE: Show heat trace on drawings.
****

Install heat trace as indicated and in accordance with 23 05 15 COMMON PIPING FOR HVAC.

3.2 INSTALLATION FOR POLYPROPYLENE PIPING (CHILLED WATER APPLICATIONS ONLY)

3.2.1 Locations

****
NOTE: Fire retardant grades of polypropylene may be worthwhile to specify, but it has been reported that the physical properties of the pipe are lowered after the addition of flame retardant filler material. Fusion equipment and tools used for joining the pipe are unlike PVC piping connecting methods and associated PVC cement. It should be noted that the fusion tools can be challenging using in overhead or confined spaces. The designer should consider the recommended working clearances by the manufacturer. Maintenance staff must be made aware when polypropylene piping exists in their area of responsibility. Proper equipment and tools for

polypropylene piping used to address maintenance problems such as changing valves should be kept available to maintenance personnel. The applicable training for this equipment and tools should occur shortly after a facility with polypropylene piping is turned over to the customer.

****

Plastic pipe to include polypropylene must not be installed in air plenums. Plastic pipe to include polypropylene must not be installed in a pressure piping system in buildings greater than three stories, including any basement levels.

3.2.2 Pipe Joints

Make joints for polypropylene pipe and fittings by heat fusion welding socket-type or butt-fusion type fittings complying with ASTM F2389. Keep joint surfaces clean and free from moisture, and undisturbed until cool.

3.2.3 Overheating Precautions

Make provisions to prevent the pipe from exceeding operating temperatures recommended by the manufacturer. This includes a safeguard provision from preventing a pump from running with zero flow, if such operation could overheat the pipe beyond pipe manufacturer's recommendations. If heat tracing is permitted elsewhere in the specifications, ensure that the heat tracing is installed per piping manufacturer's recommendations to prevent overheating of the pipe.

3.2.4 Testing and Flushing

Conduct pressure test for 15 minutes at 1.5 times the operating pressure or 1034 kPa 150 psi, whichever is greater, with no observable loss in pressure. Water, rather than air, must be used for pressure testing plastic pipe. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 1.2 m/s 4 fps through all portions of the piping system. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials. Upon completion of flushing, drain all water from system at low points, and remove/clean/replace strainers.

3.3 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturers instructions.

3.4 CLEANING AND ADJUSTING

Clean pipes free of scale and thoroughly flush of all foreign matter. Provide a temporary bypass for all water coils to prevent flushing water from passing through coils. Thoroughly clean strainers and valves. Prior to testing and balancing, remove air from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel must be taken to avoid water damage during the venting process. Plug or cap air vents after the system has been vented. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed.

3.5 PAINTING OF NEW EQUIPMENT

New equipment painting may be factory applied or shop applied, as specified herein, and provided under each individual section.

3.5.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Conduct salt-spray fog test in accordance with ASTM B117, and for that test, apply the acceptance criteria as follows: Immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of 3 mm 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

3.5.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal. Where hot-dip galvanized steel has been cut, coat resulting surfaces with no galvanizing with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat may be either aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm 1 mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm 1 mil per coat.

b. Temperatures Between 50 and 205 degrees C 120 and 400 degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F must receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F must receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

3.6 FIELD TESTS

Conduct field tests in the presence of the QC Manager[and Contractor Officer's Representative (COR)] or designated representative(s) to verify systems comply with specifications. Any material, equipment, instruments, and personnel required for the test must be provided by the Contractor.

3.6.1 Equipment and Component Isolation

Prior to testing, isolate equipment and components that cannot withstand the tests.

3.6.2 Pressure Tests

Hydrostatically test each piping system, except for polypropylene piping, at a pressure 1.5 times the maximum operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Monitor the test pressure by a currently calibrated test pressure gauge. Repair leaks and retest piping until test requirements are met. No leakage or reduction in gage pressure is allowed for the duration of the test. Repair leaks by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Test concealed and insulated piping in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping. Provide report in bound 216 by 279 mm 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs and adjustments made, and the final test results.

3.6.3 Condenser Water Quality Test Reports

Analyze the condenser water system by the water treatment company a minimum of once a month for a period of one year after system acceptance. Submit for approval the specified condenser water quality test reports. The analysis and resulting reports must include the following information recorded in accordance with ASTM D596.

Date of Sample	[_____]
Temperature	[_____] degrees C
Silica (SiO 2)	[_____] ppm (mg/L)
Insoluble	[_____] ppm (mg/L)
Iron, total (Fe)	[_____] ppm (mg/L)
Aluminum (Al)	[_____] ppm (mg/L)
Calcium (Ca)	[_____] ppm (mg/L)
Magnesium (Mg)	[_____] ppm (mg/L)
Carbonate (HCO 3)	[_____] ppm (mg/L)
Sulfate (SO 4)	[_____] ppm (mg/L)
Chloride (Cl)	[_____] ppm (mg/L)
Nitrate (NO 3)	[_____] ppm (mg/L)
Turbidity	[_____] NTU
pH	[_____]
Residual Chlorine	[_____] ppm (mg/L)

Total Alkalinity	[_____] ppm (mg/L)
Non-Carbonate Hardness	[_____] ppm (mg/L)
Total Hardness	[_____] ppm (mg/L)
Dissolved Solids	[_____] ppm (mg/L)
Conductivity	[_____] microhm/cm

3.6.4 Related Field Inspections and Testing

3.6.4.1 Piping Welds

Examination of Piping Welds is specified in the paragraph EXAMINATION OF PIPING WELDS (above).

3.6.4.2 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.7 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements and Legionella minimization of the[chilled water,][chilled-hot water,][and][condenser water piping system[s]] in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Instructors must be thoroughly familiar with all parts of the installation and must be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course must be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. Furnish[one man-day][[_____][_____] continuous man-days]. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

[3.8 ONE-YEAR INSPECTION REPORT FOR COOLING WATER

****
NOTE: Include this paragraph and the corresponding submittal requirements if the piping specified by this specification is to be used in conjunction with either a cooling tower [and][or] water-cooled refrigeration/air-conditioning equipment.
****

At the conclusion of the one year period, inspect each connected[cooling

tower][and][liquid chiller condenser] for problems due to corrosion, scale, and biological growth. If the equipment is found not to conform to the manufacturers recommended conditions, and the water treatment company recommendations have been followed, the water treatment company must provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

At the completion of one year of service, submit report in bound 216 by 279 mm 8-1/2 by 11 inch booklets. In the report, identify the condition of each cooling tower and condenser. Include a comparison of the condition of the cooling tower and condenser with the manufacturer's recommended operating conditions. Identify all actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.

] -- End of Section --