UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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USACE / NAVFAC / AFCEC / NASA	**UFGS-33 61 13.13 (February 2016)**

Preparing Activity: USACE	**Superseding**
	UFGS-33 61 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 33 61 13.13

PREFABRICATED UNDERGROUND HYDRONIC ENERGY DISTRIBUTION
02/16

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NOTE: This guide specification covers the requirements for prefabricated underground distribution system for chilled water, low temperature hot water (less than 95 degrees C 200 degrees F) or dual temperature water.

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).
****

PART 1 GENERAL

****
NOTE: Provide one or two sump pumps in valve manholes. Units should discharge by buried piping to the nearest storm sewer if possible. Where not economical to discharge to a storm sewer, pumps are to discharge above grade. Plan discharge locations carefully so water will not be discharged over valve manhole tops, sidewalks, etc. Check available NPSH versus required NPSH for pump selected. Coordinate power requirements with electrical designer and provide tell-tale light above ground to indicate sump pump failure. Drawings will show the following:

(a) a dedicated circuit

(b) lockable switches and circuit breakers that can both be locked "ON"

(c) permanent labels at key positions indicated on the drawings so that personnel can understand that the circuit should be left "ON".

The label shall be on a corrosion resistant metal plate and shall read as follows: "THIS CIRCUIT SUPPLIES POWER TO THE ELECTRIC SUMP PUMPS IN THE UNDERGROUND HEAT DISTRIBUTION SYSTEM. THIS CIRCUIT MUST BE "ON" AT ALL TIMES, OTHERWISE EXTENSIVE DAMAGE WILL OCCUR TO THE UNDERGROUND HEAT DISTRIBUTION SYSTEM AND PREMATURE FAILURE WILL OCCUR".

Where plastic chilled water piping is interconnected with heating system changeover valves, ensure that design includes means to preclude damage to plastic chilled water piping. This can be accomplished either by using changeover valves that ensure tight shut-off or by using enough metal piping on chilled water side of changeover valve to prevent damage to plastic chilled water piping.

****

1.1 SUMMARY

The system consists of a buried prefabricated [chilled water] [and] [low temperature hot water] [dual temperature] distribution system including service connections to a point 150 mm 6 inches inside of the building. The contract drawings show the specific arrangement of piping, sizes and grades of pipe, and other details. The system is designed for an operating pressure of [_____] kPa psig and an operating temperature of [[_____] degrees C F for hot water] [and] [[_____] degrees C F for chilled water].

1.2 REFERENCES

****

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.

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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 SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	(2020) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2015) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2018) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) 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 A234/A234M	(2019) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C518	(2017) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C591	(2020) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2997	(2015) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3139	(2019) Joints for Plastic Pressure Pipes

	Using Flexible Elastomeric Seals
ASTM D3350	(2012) Polyethylene Plastics Pipe and Fittings Materials
ASTM D5685	(2019) Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

1.3 SUBMITTALS

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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, Air Force, and NASA 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.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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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.][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-02 Shop Drawings

Fabrication and Assembly Drawings

SD-03 Product Data

Support of the Equipment

Markers For Underground Piping

SD-07 Certificates

Welding

Written Certification

SD-10 Operation and Maintenance Data

Maintenance; G[, [_____]]

1.4 QUALITY ASSURANCE

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NOTE: If need exists for more stringent requirements for weldments, delete the first bracketed statement.
****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Prior to welding operations, submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Notify the Contracting Officer 24 hours in advance of tests performed at the work site, if practicable. Apply welder's personal assigned symbol near each weld made as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.5 DELIVERY, STORAGE, AND HANDLING

After delivery to the jobsite, protect all materials and equipment from anything which could cause damage to the material or equipment. Seal piping at each end to keep the interior clean and free of dirt and debris. Keep fittings together and keep their interior surfaces clean at all times. Keep insulation dry and clean.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide system components which are standard products of a manufacturer

regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide a service organization that is, in the opinion of the Contracting Officer, convenient to the site.

Equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Submit detail drawings consisting of fabrication and assembly drawings, for all parts of the work in sufficient detail to check conformity with the requirements of the contract documents, prior to installation. In the detail drawings show complete piping, wiring and schematic diagrams and any other details to demonstrate that the system has been coordinated and will properly function as a unit. Show on the drawings proposed layout, method of compensation for pipe expansion and contraction, anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances required for maintenance and operation.

b. Submit the manufacturer's or system fabricator's written certification stating that the distribution system furnished meets all the requirements of this specification. Clearly identify on the drawings any proposed deviations from the requirements of the contract documents.

2.2 PIPING AND CASING MATERIALS

2.2.1 General

Provide metallic pressure pipe, fittings, and piping accessories that conform to the requirements of ASME B31.1 and are types suitable for the temperature and pressure of the water.

2.2.2 Piping

****

NOTE: Designer will eliminate only the materials which are not satisfactory for his design. All carrier pipe is acceptable for chilled water systems. All carrier pipe except PVC is acceptable for low temperature hot water. Do not allow Reinforced Thermosetting Resin Pipe (RTRP) in locations where heating water temperature cannot be assured to be less than 93 degrees C (200 degrees F).

****

2.2.2.1 Steel Pipe

Provide piping conforming to ASTM A53/A53M, Grade B, standard weight, black or to ASTM A106/A106M, Grade B, standard weight.

2.2.2.2 Copper Tubing

Provide tubing conforming to ASTM B88M ASTM B88, Type K or L.

2.2.2.3 Reinforced Thermosetting Resin Pipe (RTRP)

Provide RTRP conforming to [ASTM D2996][ASTM D2997].

2.2.2.4 Polyvinyl Chloride (PVC) Pipe

****

NOTE: PVC carrier pipe is limited to 24 degrees C 75 degrees F service. Pressure rating of plastic piping varies with temperature and must be considered in design. PVC pipe with SDR 26 is rated for 1100 kPa 160 psi working pressure at 23 degrees C 73 degrees F.

****

Provide PVC piping conforming to ASTM D2241 with a Standard Thermoplastic Pipe Dimension Ratio (SDR) of 26 and PVC 1120 or 1220 as the material.

2.2.2.5 Joints and Fittings for Copper Tubing

Provide wrought copper and bronze solder-joint pressure fittings that conform to ASME B16.22 and ASTM B75/B75M. Provide cast copper alloy solder-joint pressure fittings conforming to ASME B16.18. Provide cast copper alloy fittings for flared copper tube conforming to ASME B16.26 and ASTM B62. 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 produced with an acceptable tool and installed as recommended by the manufacturer may be used. Design grooved mechanical joints and fittings for not less than 862 kPa 125 psig service. Provide grooved mechanical joints and fittings that are the product of the same manufacturer. Provide grooved fitting and mechanical coupling housing of ductile iron conforming to ASTM A536, with molded synthetic polymer of pressure responsive design conforming to ASTM D2000 for circulating medium up to 110 degrees C230 degrees F and grooved joints conforming to AWWA C606. Provide steel nuts and bolts conforming to ASTM A183 for coupling for use in grooved joints..

2.2.3 Casings

2.2.3.1 Polyvinyl Chloride (PVC) Casing

Provide PVC casings that conform to ASTM D1784, Class 12454-B with a minimum thickness equal to the greater of 1/100 the diameter of the casing or 1.50 mm 60 mils.

2.2.3.2 Polyethylene (PE) Casing

****

NOTE: If the distribution system is to be installed when the temperature is cold, the polyethylene casing is less susceptible to cracking from the cold.

****

Provide polyethylene casings conforming to ASTM D3350, Type III, Class C, Category 3 or 4, Grade P 34 with thickness as follows:

Casing Diameter (mm) (inches)	Minimum Thickness (mm) (mils)
250 10 and smaller	3 125
250 to 450 10 to 18	4 150
450 through 600 18 through 24	5 200
over 600 24	6 225

2.2.3.3 Reinforced Thermosetting Resin Pipe (RTRP) Casing

Provide RTRP casing of the same material as the pipe, with casing thickness as follows:

Casing Diameter (mm) (inches)	Minimum Thickness (mm) (mils)
200 8 and smaller	1.2 70
250 10	2 80
300 12	2.7 105
350 14	2.9 115
400 to 450 16 to 18	3 120
500 20	3.2 125
600 24	3.9 155

2.3 PIPING CONNECTIONS

2.3.1 Steel Pipe

For pipe smaller than 19 mm 0.75 inch, provide Schedule 80 steel pipe with threaded end connections conforming to ASME B1.20.2M ASME B1.20.1. Weld all steel pipe 19 mm 0.75 inch and larger. Provide steel welding fittings conforming to the requirements of ASTM A105/A105M or ASTM A234/A234M. Provide welding fittings conforming to ASME B16.9 for buttweld fittings and ASME B16.11 for socket-weld fittings. Use long radius buttwelding elbows conforming to ASME B16.9 whenever space permits.

2.3.2 Copper Pipe

Braze or provide insulated pipe couplings for copper pipe connections with wrought copper or cast copper alloy solder joint pressure fittings conforming to AWS B2.2/B2.2M and CDA A4015. Provide cast bronze containing an O-ring seal on each end, jacketed and sealed, to act as an expansion joint for insulated pipe couplings for copper pipe.

2.3.3 Plastic Pipe

a. Provide adhesive bell and spigot type end connections for pipe, fittings, flanges, and couplings. Threaded piping, including pipe, fittings, flanges, and couplings, will not be permitted.

b. Flanged Connections: Provide flat face flanged connections between plastic piping and metal piping suitable for connection to ASME Class 150 flanges.

c. RTRP Piping Sizes: Provide the next larger size where piping sizes other than 50, 75, 100, 150, and 200 mm 2, 3, 4, 6, and 8 inches are indicated with piping connections of the same size or increased to meet the next size of RTRP piping.

2.3.3.1 Plastic Fittings

Provide plastic fittings of the same type and grade of material as the piping to which they will be connected and furnished by the manufacturer who supplies the pipe. Provide temperature and pressure rating for fittings not less than those of the connecting piping.

2.3.3.2 Polyvinyl Chloride (PVC)

Provide solvent welded or connected using bell and spigot connections for polyvinyl chloride (PVC) pipe with solvent used to connect fittings and pipe conforming to the requirements of ASTM D2564. Bell and spigot joints utilizing elastomeric seals conforming to the requirements of ASTM D3139. The elastomeric seals must conform to ASTM F477.

2.3.3.3 Reinforced Thermosetting Resin Plastic (RTRP)

Join reinforced thermosetting resin plastic pipe using fittings and adhesive furnished by the pipe manufacturer in accordance with ASTM D5685.

2.4 END SEALS

Provide pre-insulated sections of pipe with complete sealing of the insulation to provide a permanent water and vapor seal at each end of the pre-insulated section of piping. Provide field modified pre-insulated sections of piping with an end seal which is equivalent to the end seals furnished with the pre-insulated section of piping. Test and certify end seals in accordance with paragraph Casing and End Seal Testing and Certification.

2.4.1 Types

Provide end seals of one of the following types:

a. Carrying the outer casing over tapered pipe insulation ends and extending it to the carrier pipe. Provide sufficient surface bonding area between the casing and the carrier pipe.

b. Using specially designed molded caps made of polyethylene or rubber of standard manufactured thickness. Provide a minimum of 40 mm 1.5 inch surface bonding area between the cap and both the casing and carrier pipe.

c. Using elastomeric-ring end seals designed and dimensioned to fit in

the annular space between the casing and the carrier pipe.

d. Using a waterproof mastic seal vapor barrier over the exposed insulation ends.

e. Shrink sleeves.

2.4.2 Casing and End Seal Testing and Certification

Demonstrate that testing and certification procedures by an independent testing laboratory, for casings and end seals, are capable of resisting penetration of water into the casing and insulation. Perform the test on each type of prefabricated system to be furnished. Provide hot and cold cycle testing followed by immersion in a water filled chamber with a head pressure, consisting of 14 days of temperature cycling. Circulate a fluid with a temperature of 5 degrees C 40 degrees F through the carrier pipe alternating every 24-hours with a fluid with a temperature of 95 degrees C 200 degrees F circulating through the carrier pipe for a low temperature hot water or dual temperature service or 24 degrees C 75 degrees F for a chilled water service. While the hot and cold cycle test is being performed, the test sample is either buried or encased in dry bedding sand with a minimum of 300 mm 12 inches of sand all around the test sample. Restrain the 80 mm 3 inches diameter carrier pipe of the test sample during the test period. Provide an insulation thickness not to exceed the maximum thickness provided for the piping in the project. Do not exceed transition times for temperature cycle testing of 15 minutes in going from cold to hot and 30 minutes in going from hot to cold. The fluid in the carrier pipe may be water, oil or heat transfer fluid. Immerse the test sample in a water filled chamber following the hot and cold cycling test. Provide a pressure of not less than 60 kPa 20 feet of water head pressure at the highest point over the entire length of the 2.4 m 8 foot test sample for a minimum of the 48 hour test period. Provide water containing a dye penetrant to check for end seal leakage. Upon completion of the pressure test, cut the test sample open using a light that will readily show the presence of the dye that was in the water, inspect the test sample. Evidence of the dye inside the test sample indicates that the end seal is not acceptable and cannot be certified.

2.5 INSULATION

2.5.1 Factory Applied Insulation

****

NOTE: An insulation thickness of 20 mm 0.9 inch is normally sufficient for these systems. However, in cases where the cost of energy used for these systems is high, a life cycle cost analysis should be performed to determine whether additional insulation is cost effective.

****

Provide factory insulated pre-fabricated pipe and fittings with polyurethane (polyisocyanurate) foam meeting the requirements of ASTM C591 having a density not less than 32 kg per cubic meter 2 pounds per cubic foot (pcf). Provide the polyurethane (polyisocyanurate) foam completely filling the annular space between the carrier pipe and the casing with an insulation thickness of a minimum of [20] [_____] mm [0.9] [_____] inches. Provide an insulation thermal conductivity factor not exceeding the numerical value of 0.02 W/mK 0.15 Btu-inch/square foot-degree F-hour at 24

degrees C 75 degrees F, when tested in accordance with ASTM C518. Provide a manufacturer's certification that the insulated pipe is free of insulation voids.

2.5.2 Field Applied Insulation

Provide polyurethane (polyisocyanurate) field applied insulation for fittings, and field casing closures and other piping system accessories, as required, with thickness matching adjacent piping insulation thickness. For buried fittings and accessories, provide field applied polyurethane (polyisocyanurate) insulation to match adjacent piping with a protective covering matching the pipe casing. Provide shrink sleeves with a minimum thickness of 1.3 mm 50 mils over casing connection joints.

2.6 CONCRETE VALVE MANHOLES

****

NOTE: Valve manholes must be detailed on the drawings with complete concrete structural details including details of any waterproofing.

****

Provide concrete valve manholes in accordance with Section 33 61 13.19 VALVES, PIPING AND EQUIPMENT IN VALVE MANHOLES and manufactured in accordance with [Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION][Section 03 41 16.08 PRECAST CONCRETE SLABS (MAX. SPAN 8 FEET O.C.)].

2.7 PIPING AND EQUIPMENT IN VALVE MANHOLES

Provide piping and equipment in valve manholes in accordance with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

2.8 TREATED WATER

****

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. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.

****

Provide a [_____] percent glycol concentration, by volume, of industrial grade [ethylene] [propylene] for the system. Test glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. Provide corrosion inhibitors in glycol solution compatible with pump seals, water treatment chemicals used within the system, and other elements of the system. Silicate based inhibitors are not allowed.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

For all pre-insulated, prefabricated systems, obtain the services of a trained representative of the pipe system manufacturer to instruct the Contractor's work forces in the installation procedures to ensure that the system is installed in accordance with the manufacturer's published instructions and the plans and specifications. Provide a manufacturer's representative who regularly performs such duties for the manufacturer. Furnish the Contracting Officer a list of names of personnel trained and certified by the pipe system manufacturer in the installation of this system. Only personnel whose names appear on a less than one year old list will be allowed to install the system.

3.3 PIPING SYSTEMS

3.3.1 Buried Insulated Systems

Provide carrier pipe, insulation, casing, end seals, fittings and accessories for buried insulated systems.

3.3.2 Buried Un-insulated Systems

****

NOTE: Buried un-insulated piping systems shall be used only where justified by a life cycle cost analysis that includes the decreased initial cost of the distribution system, increased operating energy cost due to the heat gain or heat loss in the piping system, leakage and the cost of any increased heating or cooling equipment capacity. Buried uninsulated steel pipe must have a protective coating in all cases and cathodic protection where required by soil conditions.

****

Provide carrier pipe, fittings and accessories for buried un-insulated systems.

3.4 VALVE MANHOLES AND PIPING EQUIPMENT IN VALVE MANHOLES

Install valve manholes and piping and equipment in valve manholes in accordance with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

3.5 THRUST BLOCKS

****

NOTE: Designer will indicate dimensions and locations of required thrust blocks on the drawings. Blocks will be sized for specific fittings and for allowable in situ soil pressures.

Thrust blocks shall be designed for the maximum test pressure specified.
****

Install thrust blocks at the locations shown or recommended by the pipe system manufacturer. Provide thrust blocks in accordance with manufacturer's recommendations. For systems requiring thrust blocks, at a minimum, provide thrust blocks at all changes in direction, changes in size, valves and terminal ends, such as plugs, caps and tees with concrete having a compressive strength of not less than 14 MPa 2000 psi after 28 days in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Place thrust blocks between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, pour the base and the thrust bearing sides of the thrust blocks directly against undisturbed earth. The sides of the thrust blocks not subject to thrust may be poured against forms. Locate thrust blocks so that the joints for all fittings will be accessible for repair wherever possible. Do not embed joints in concrete unless the assembly has previously been hydrostatically tested. Provide thrust blocks resisted by piles or tie rods to solid foundations in muck or peat, or replace peat or muck with ballast of sufficient stability to resist the thrust blocks.

3.6 INSTALLATION OF PIPING SYSTEMS

Prepare pipe ends to match factory coated ends and install the piping system in accordance with the manufacturer's instructions without springing or forcing other than what has been calculated for cold spring allowing free expansion and contraction without damage to joints or hangers. Do not install copper tubing in a trench with ferrous piping materials. Maintain a minimum vertical separation of 300 mm12 inches between pipes when nonferrous metallic pipe (e.g., copper tubing) crosses any ferrous piping material. Provide transition fittings approved by the manufacturer of the piping system for connections between different types of pipe and system components.

3.6.1 Pitching of Horizontal Piping

Pitch horizontal pipe at a grade of not less than 40 mm in 1 m1 inch in 20 feet toward the drain points unless otherwise indicated.

3.6.2 Open Ends

Provide an approved cap or plug for open ends of pipelines and equipment during installation.

3.6.3 Cutting Prefabricated Piping Sections

Provide new end seals similar to factory applied end seal for field cut prefabricated pipe sections in accordance with the manufacturer's instructions.

3.6.4 Joints

3.6.4.1 Welded Joints

Provide welded joints between sections of pipe and between pipe and fittings where specified or indicated.

3.6.4.2 Threaded Joints

No threaded joints are allowed to be used belowground. Make joints tight with polytetrafluoroethylene tape applied to the male threads only with no more than 3 threads showing after the joint is made up.

3.6.4.3 Grooved Mechanical Joints

Provide grooved fittings, couplings, and grooving tools with products of the same manufacturer. Prepare grooves complying with the tolerances specified by the coupling manufacturer in accordance with the coupling manufacturer's instructions. Measure field made groove diameters using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure and record each groove width and dimension from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints are not allowed in concealed locations.

3.6.4.4 Brazed Joints

Brazed joints for copper pipe and fittings must conform to CDA A4015. Utilize brazing alloys melting above 593.3 degrees C 1100 degrees F.

3.6.4.5 Nonmetallic Pipe Joints

Install nonmetallic pipe joints in accordance with the written instructions of the manufacturer.

3.6.5 Expansion Loops

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NOTE: In the design for expansion compensation, strive to use L- and Z-bends in lieu of expansion loops wherever possible.

****

If expansion compensation is needed, provide expansion loops and expansion bends (Z- and L- type) factory fabricated of casing, insulation, and carrier piping identical to that furnished for straight runs. Properly design expansion loops and bends in accordance with the allowable stress limits indicated in ASME B31.1 for the type of pipe used, and size to accommodate pipe movement. Ship expansion loops and bends to the jobsite in the maximum size sections feasible to minimize the number of field joints. Make field joints in straight runs of the expansion loops and bends, keeping the number to a minimum. For steel pipe, cold springing is not allowed when sizing the expansion loops and bends. Cold spring piping one-half the calculated maximum operational expansion during field assembly is allowed. Pipe stress in expansion loops and bends must conform to ASME B31.1.

3.6.6 Anchors

Provide factory fabricated, by the prefabricated system manufacturer, anchor design in accordance with the published data of the manufacturer and for prefabricated systems. Prevent water penetration, condensation, or vapor transmission from wetting/contacting the insulation.

3.6.7 Field Casing Closures

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NOTE: Whether or not to insulate the exposed section of pipe and cover with a casing at the joint between the sections of the pipe must be determined by a life cycle cost analysis. Factors to consider include heat loss/heat gain through the uninsulated section, cost to insulate and cover the uninsulated section, and the usage per year of the prefabricated system. Normally the exposed section is insulated and covered. The joint between the sections of pipe must be protected from corrosion.

****

Execution of field insulation and encasement of joints are to be accomplished after the visual and pressure tests specified are completed and in accordance with the manufacturer's written instructions. Provide foamed in place polyurethane insulation with thickness dimensions and casing materials not less than those of the adjoining prefabricated section. Install a standard polyethylene heat shrink sleeve with a 150 mm 6 inch minimum overlap at each end of the casing.

3.6.8 Underground Warning Tape

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NOTE: Select the proper tape for the project. Tape with metallic core is utilized for nonferrous pipe systems to locate piping with pipe location devices.

****

Provide underground 0.1 mm 0.004 inch thick, 150 mm 6 inches wide, printed with repetitive caution warnings along its length, [polyethylene tape] [polyethylene tape with metallic core] warning tape buried above the piping during the trench backfilling approximately 300 mm12 inchesdeep. Provide tapes, yellow in color with black letters; color and lettering must not be affected by moisture or other substances contained in the backfill material.

3.6.9 Markers for Underground Piping

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NOTE: Indicate the location of the markers on the drawings for projects that require markers. Delete the paragraph if not needed in the project.

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Submit catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents. Place markers for underground piping approximately 600 mm 2 feet to the right of the distribution system in reference to the fluid flow direction.

Provide concrete markers 150 mm 6 inch square or round section [600] [900] mm [2] [3] feet long with the top edge of the marker chamfered at a minimum of 13 mm .5 inch all around. Impress of cast letters on the top of the marker with letters [CHW] [LHW] [DTW] to indicate the type of system that is being identified. Form each letter with a V-shaped groove with a width of stroke at least 6 mm .25 inch at the top and depth of 6 mm .25

inch. Provide elevation of markers no more than [25] [50] [75] [100] mm [1] [2] [3] [4] inches above finished grade.

3.7 EARTHWORK

Perform earthwork in accordance with Section 31 00 00 EARTHWORK.

3.8 ELECTRICAL WORK

Perform electrical work in accordance with either Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION or Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

3.9 TESTING

Conduct tests before, during, and after installation of the system. Provide all instruments, equipment, facilities, and labor required to properly conduct the tests. Provide test pressure gauges for a specific test with dials indicating not less than 1.5 times nor more than 2 times the test pressure.

3.9.1 Metallic Pipe Welds

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NOTE: Where welding of piping is not required or there are no prior experiences which may warrant radiographic inspection of the welded joints this entire paragraph should be deleted.

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Perform radiographic testing in accordance with ASME B31.1. Perform radiographic examination of field welds by an approved independent testing firm or firms regularly engaged in radiographic testing, and interpreted by a Certified Level III Radiographer employed by the testing firm. Review and interpretation of all radiographs must be by a Certified Level III Radiographer employed by the testing firm. Remove, reweld and radiographically examine any welds found to be unacceptable in accordance with the above criteria.

3.9.2 Carrier Pipe Cleaning and Testing

Test distribution piping as required before backfilling, with all joints exposed. The area between joints may be backfilled as necessary to prevent pipe movement.

3.9.2.1 Cleaning Carrier Pipe

Prior to testing, clean the interior of the carrier pipe of foreign materials by thorough flushing with clean water with a circulating water velocity between 2 and 3 m/s (7 and 10 feet per second) for a minimum of 4 hours. Provide temporary and/or supplementary pumps if required to ensure that required velocity is achieved. Clean system strainers after the flushing operation is complete. Temporary strainers must be installed as required. Leave water in the system after flushing for testing of the system to ensure the pipe will maintain pressure and is not leaking.

3.9.2.2 Hydrostatic Pressure Cycling and Tests

Hydrostatic pressure tests consist of 4 cycles; .each cycle consisting of

a 10 minute period with the first cycle at 1000 kPa 150 psig followed by a 5 minute period at a pressure less than 350 kPa 50 psig. Begin the next cycle immediately following the completion of the previous cycle with the pressure rise and drop no more than 690 kPa 100 psi per minute. Locate the pressure gauge and take the pressure measurement at the opposite end of the system from where the pressure is applied. After completion of the hydrostatic pressure cycling, perform the first hydrostatic pressure test proving the system tight at a pressure of 1.5 times the working pressure up to 1000 kPa 150 psig and held for a minimum of 1 hour. Disconnect the pressurizing apparatus from the system before starting the 1 hour pressure holding period. Correct any test failures and repeat the hydrostatic pressure cycling and first hydrostatic pressure test until the system can hold the required pressure for at least 1 hour. After successful completion of the first hydrostatic pressure test, drain piping system and fill the piping system as defined in paragraph TREATED WATER for the remaining tests and for permanent operation of the system. Repeat the hydrostatic pressure cycling and tests for the system after the system has been filled with treated water, using the same test conditions and criteria.

3.9.2.3 Operational Test

Perform operational test on the complete system or testable portions thereof and conduct with full design flows and operating temperatures in all runs of piping as if in service, to demonstrate satisfactory function and operating effectiveness. The operational test will have two cycles. Each cycle must consist of a 6-hour period with treated water in the system at the maximum operating temperature of [_____] degrees C F and maximum flow rate, and a period of at least 6-hours with no flow. For dual temperature systems, the first cycle must use the heating temperature of [_____] degrees C F and the second cycle the cooling temperature of [_____] degrees C F of the designed system. Supply temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired temperatures and flow rates. Re-circulate water through supply lines and return through the return piping to demonstrate that the pressure drop is compatible with the flow rate and size of pipe and to show that obstructions do not exist in the piping system. Any unusual indicated pressure drop will be investigated and any obstructions removed. Repair any leaks found. After any obstructions have been removed and any leaks repaired, repeat the operational test until successfully passed.

3.9.2.4 Final Hydrostatic Test

After successful completion of the operational test, pressurize system to 1.5 times the working pressure up to 1000 kPa 150 psig and hold for a minimum of 4 hours. Disconnect pressurizing apparatus prior to the start of the 4-hour pressure holding period. Upon test failure, determine the cause of the failure, correct and repeat all of the hydrostatic pressure cycling and pressure tests.

3.10 MAINTENANCE

Submit [6] [_____] [hard] [optic disk] copies of operation and [6] [_____] copies of maintenance manuals for the equipment furnished, 1 complete set prior to performance testing and the remainder upon acceptance. Provide details in the operation manuals showing the step-by-step procedures required for equipment startup, operation, and shutdown. Include in the operation manuals the manufacturer's name, model number, parts list, and

brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the maintenance manuals piping and equipment layout and simplified wiring and control diagrams of the equipment system as installed. Provide approved manuals prior to the field performance testing.

-- End of Section --