
NAVFAC IGS-02557 (MAY 2002)

Preparing Activity: LANTNAVFACENGCOM Based on NFGS-02557C

ITALIAN GUIDE SPECIFICATIONS

Use for ITALIAN projects only

SECTION 02557

EXTERIOR BURIED PREINSULATED WATER PIPING
05/02

NOTE: This guide specification is issued by the Atlantic Division, Naval Facilities Engineering Command for regional use in Italy.

NOTE: This guide specification covers requirements for exterior buried factory-prefabricated preinsulated water piping system, including hot domestic water piping, recirculating hot domestic water piping, chilled water piping, chilled-hot (dual temperature) water piping, and hot water piping from heat exchangers to each building. System design must conform to Military Handbook MIL-HDBK-1003/8A, "Exterior Distribution of Steam, High Temperature Water, Chilled Water, Natural Gas, and Compressed Air."

NOTE: On the drawings, show:

1. Configuration, slope, and sizes of each piping system;
2. Locations and details of expansion loops, thrust blocks, anchors, manholes, and connections between metal flanges and plastic carrier piping;
3. Trench cross section, sand bedding, and depth of bury; and
4. Detail sections of piping through manholes, walls, floors, entrance to buildings, and watershed to aboveground piping.

Comments and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- | | |
|-----------------|--|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME/ANSI B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B31.1 | (1998) Power Piping |
| ASME BPV IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|-------------------|--|
| ASTM A 105/A 105M | (1998) Carbon Steel Forgings for Piping Applications |
| ASTM A 234/A 234M | (1997) Piping Fittings of Wrought Carbon Steel for Moderate and High Temperature Service |
| ASTM D 1248 | (1984; R 1989) Polyethylene Plastics Molding and Extrusion Materials |
| ASTM D 1384 | (1997a) Corrosion Test for Engine Coolants in Glassware |

ASTM D 2564 (1996; Rev. A) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

ASTM D 3139 (1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

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

ASTM F 477 (1996) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook (1995) Copper Tube Handbook

ITALIAN LAWS AND NORMS (D.M.)(LAW)(CIRC.)

NOTE: Italian laws and normatives are the legislative regulations and decrees issued by the Italian government in the form of laws, norms, decrees, circulars, and letters. These Laws and Decrees concur together with Norms and Standards in forming the governing directives for construction.

D.P.R. 412 (26/08/93) Norms for the Design, Installation, Operation and Maintenance of Thermal Plant of Buildings Pertinent to the Containment of Energy Consumption for the Fulfillment of Art. 4, Paragraph IV, Law 10, dated 09/01/91

ITALIAN NATIONAL ASSOCIATION FOR UNIFICATION OF STANDARDS (UNI)

NOTE: A UNI Norm is a technical normative recognized as Italian Law, submitted by a private organization "Ente Nazionale Italiano di Unificazione" for Italy and is available only in the Italian language. It is the National Standard.

UNI 7091/FA 93 (1972/82) Unalloyed steel welded tubes - Plain end tubes for general uses

UNI 8863/FA 1 (1987/89) Unalloyed steel seamless and welded tubes suitable for screwing in accordance with UNI ISO 7/1

UNI 9032/FA1-4 (1988/94) Glass fibre reinforced (GFRP) thermosetting resins pipes with or without fillers - Types, dimensions and requirements

ITALIAN/EUROPEAN HARMONIZATION STANDARDS (UNI EN)(UNI ENV)(CEI EN)
(UNI EN ISO)(UNI ISO)

NOTE: A UNI EN, UNI ENV, CEI EN, UNI EN ISO or UNI ISO is a European Standard with a coincident Italian National Standard or International Standard. The two standards are identical, with most (but not all) EN's available in the English language and the UNI available only in the Italian language.

UNI EN 1057 (1997) Copper and copper alloys - Seamless, round copper tubes for water and gas in sanitary and heating applications

UNI EN 1254-5 (2000) Copper and copper alloys - Plumbing fittings - Part 5: Fittings with short ends for capillary brazing to copper tubes

UNI EN 1514-1 (1998) Flanges and their joints - Dimensions of gaskets for PN-designated flanges - Non-metallic flat gaskets with or without inserts

UNI EN 2910 (1999) Aerospace series - Shank nuts, self-locking, in heat resisting steel FE-PA92HT (A286) - Classification: 1100 MPa (at ambient temperature) 650°C

UNI EN ISO 3506-1 (2000) Mechanical properties of corrosion-resistant stainless-steel fasteners - Part 1: Bolts, screws and studs

UNI EN ISO 13783 (1999) Plastics piping systems - Unplasticized poly(vinyl chloride)(PVC-U) end-load-bearing double socket joints - Test method for leaktightness and strength while subjected to bending and internal pressure

1.2 DISTRIBUTION SYSTEM DESCRIPTION

Provide [new and modify existing] exterior buried factory-prefabricated preinsulated [and uninsulated] water piping system to the first piping connection aboveground or within each building complete and ready for operation. Piping system includes [hot domestic water piping,] [recirculating hot domestic water piping,] [chilled water piping,]

[chilled-hot (dual temperature) water piping,] [hot water piping,] and related work [from heat exchangers to each building]. [Hot domestic water piping within each building is specified under Section 15400, "Plumbing Systems."] [Chilled water piping, chilled-hot water piping, and hot water piping within each building is specified under] [Section 15181, "Chilled, Condenser, or Dual Service Water Piping"]

- a. Buried insulated systems shall consist of carrier pipe, insulation, casing, end seals, fittings and accessories as specified.

NOTE: Buried uninsulated 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.

- b. Buried uninsulated systems shall consist of carrier pipe, fittings and accessories as specified.

1.3 SUBMITTALS

NOTE:

Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item is required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Recommended codes for Army projects are "RE" for Resident Engineer approval, "ED" for Engineering approval, and "AE" for Architect-Engineer approval. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Distribution system

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. Detail drawings shall also contain 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. Drawings shall show 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. The drawings shall clearly identify any proposed deviations from the requirements of the contract documents.

SD-03 Product Data

Distribution system

Data composed of 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.

SD-07 Certificates

Distribution System

The manufacturer's or system fabricator's written certification stating that the distribution system furnished meets all the requirements of this specification.

Welding

Prior to welding operations, a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

List of names of personnel trained and certified

SD-08 Manufacturer's Instructions

Installation manual for buried factory-prefabricated preinsulated water piping distribution system

SD-10 Operation and Maintenance Data

Distribution system, Data Package 2

Submit in accordance with Section 01781, "Operation and Maintenance Data" prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for equipment startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the equipment system as installed. Manuals shall be approved prior to the field performance testing.

1.4 QUALITY ASSURANCE

1.4.1 Standard Products

System components shall be standard products of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The system shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.5 DELIVERY AND STORAGE

After delivery to the jobsite, all materials and equipment shall be protected from anything which could cause damage to the material or equipment. Pipe shall be sealed at each end to keep the interior clean and free of dirt and debris. Fittings shall be kept together and their interior surfaces shall remain clean. Insulation shall be kept dry and clean.

1.6 FIELD MEASUREMENTS

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

1.7 WELDING

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

[Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators.] Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

PART 2 PRODUCTS

2.1 SOURCE MANUFACTURERS

2.1.1 Distribution System

The following manufacturers provide buried factory-prefabricated preinsulated water piping systems that generally comply with these specifications:

ABB

V.le Edison 50
20099 Sesto S. Giovanni (Milano)
Tel: 02.26232028
Fax: 02.26232029

SOCOLOGSTOR

Via Risorgimento 60/A
45011 ADRIA (RO)
Tel: 0426.22077
Fax: 0426.900858

Therma Pipe ApS

Postboks 151
DK-5500 Middelfart
Telephone: (+45)64416890
FAX: (+45)64416820

2.2 BURIED FACTORY-PREFABRICATED PREINSULATED WATER PIPING DISTRIBUTION SYSTEM

Piping (pipe, fittings, and end connections) system shall be suitable for working pressure of 862 [____] kPag at 121 [____] degrees C, except plastic polyvinyl chloride (PVC) chilled water piping shall be suitable for working pressure of 862 [____] kPag at 24 degrees C. Piping system shall withstand a vehicle weight of not less than 9000 kg per axle and be installed at least 500 mm below wear course. Whenever such depth is not possible a reinforced concrete casing shall be provided in accordance with pipe manufacturer. Mark each section of conduit with fabricator's name, product identification, and publications to which the items conform. Provide each section of carrier pipe including factory-applied insulation and conduit, with waterproof conduit ends at both ends of each section of carrier pipe, except for piping systems which have the field joints insulated and covered with waterproof shrink sleeves.

2.2.1 Factory-Applied Insulation

Prefabricated pipe and fittings shall be insulated in the factory. Foam insulation for prefabricated insulated pipe and fittings shall be polyurethane or polyisocyanurate foam having a density not less than 32 kg per cubic meter. The insulating foam shall completely fill the annular space between the carrier pipe and the casing. Insulation thickness shall be a minimum of [20] [_____] mm. The insulation thermal conductivity factor shall not exceed the numerical value of 0.02 W/mK at 24 degrees C. Manufacturer shall certify that the insulated pipe is free of insulation voids.

2.2.2 Field Applied Insulation

Field applied insulation for fittings, and field casing closures, if required, and other piping system accessories shall match the pipe insulation material. Thickness shall match adjacent piping insulation thickness. Field applied insulation shall be protected with a covering matching the pipe casing. Shrink sleeves with a minimum thickness of 1.3 mm shall be provided over casing connection joints.

2.2.3 Factory-Applied Conduit

2.2.3.1 Conduit Size

Conduit size shall be as follows:

Carrier Pipe (mm)	Minimum Conduit Size (mm)
50 mm	100 mm
75 mm	150 mm
100 mm	200 mm
150 mm	250 mm
200 mm	300 mm
250 mm	350 mm

2.2.3.2 Conduit Material

Conduit material shall be as follows:

- a. Plastic PVC Pipe Conduit: UNI EN ISO 13783 extruded seamless PVC plastic pipe with a minimum thickness equal to the greater of 1/100 the conduit diameter or 1.5 mm.
- b. Reinforced Thermosetting Resin (RTR) Pipe Conduit: UNI 9032/FA1-4, filament-wound, fiberglass RTR plastic pipe, without liner. Provide casing thickness as follows:

Casing Diameter (in mm)	Minimum Thickness (in mm)
200 and smaller	1.2
250	2
300	2.7
350	2.9
400 to 450	3
500	3.2
600	3.9

- c. Plastic RTR factory lay-up conduit: Conduit shall be machine-applied continuous rovings of fiberglass strands saturated with isophthalic polyester or epoxy resin filament wound in helical pattern directly to the outer surface of the pipe insulation. Casing thickness shall match that specified for plastic RTR pipe conduit. In lieu of minimum conduit size for each size of carrier pipe, provide minimum of 25 mm thick insulation for 50 mm carrier pipe and provide minimum of 38 mm thick insulation for 75 mm and larger carrier pipe.
- d. High Density Polyethylene (HDPE) Casing: HDPE casings shall conform to ASTM D 1248, Type III, Class C, Category 3 or 4, Grade P 34 with thickness as follows:

Casing Diameter (in mm)	Minimum Thickness (in mm)
250 and smaller	3
250 to 450	4
450 to 600	5
over 600	6

2.2.4 Factory-Applied End Seals

Each preinsulated section of piping shall have a complete sealing of the insulation to provide a permanent water and vapor seal at each end of the preinsulated section of piping. Preinsulated sections of piping modified in the field shall be provided with an end seal which is equivalent to the end seals furnished with the preinsulated section of piping. Provide watertight end seal, or factory lay-up type end seal between carrier pipe and conduit. Provide sufficient surface bonding area between carrier pipe and conduit to ensure permanent watertight end seal suitable for use with temperature limits of carrier pipe.

2.2.5 Factory-Prefabricated Carrier Piping

Pipe, fittings, flanges, and couplings shall be marked with manufacturer's name, product identification, and publication to which items conform. Carrier piping shall be as specified in this section.

2.3 CARRIER PIPING

2.3.1 Copper Tubing

NOTE: Provide copper tubing for hot domestic water piping, recirculating hot domestic water piping, chilled water piping, chilled-hot water piping, and hot water piping.

Copper tubing shall conform to UNI EN 1057. Tube wall thicknesses shall be Type K or L as listed in Table II at the end of this section.

2.3.2 Steel Piping

NOTE: Provide steel piping for chilled water piping, chilled-hot water piping, and hot water piping.

Steel pipe shall conform to UNI 7091/FA 93 electric resistance welded, or UNI 8863/FA 1. Pipe wall thickness shall be Schedule 40, as listed in Table I at the end of this section.

[2.3.3 Plastic PVC Piping

NOTE: Provide plastic PVC piping only for chilled water piping.

Plastic PVC carrier pipe shall conform to UNI EN ISO 13783. Pipe wall thickness shall be Schedule 40.

]2.4 PIPING CONNECTIONS

2.4.1 Steel Pipe

Steel pipe smaller than 20 mm may be threaded; otherwise, all steel pipe shall be welded. Steel welding fittings shall conform to the requirements of ASTM A 105/A 105M or ASTM A 234/A 234M. Welding fittings shall also conform to ASME/ANSI B16.9 for butt welded fittings and ASME B16.11 for socket-weld fittings. Long radius butt welding elbows conforming to ASME/ANSI B16.9 shall be used whenever space permits. Pipe Threads shall conform to ASME B1.20.1. Pipe to be threaded shall be schedule 80, as listed in Table I at the end of this section.

2.4.1.1 Flanged Connections

Provide ASME Class 150 flat face flanged connections.

- a. Gaskets: UNI EN 1514-1, except Shore A durometer hardness shall be 55 to 65, 3 mm thick ethylene propylene. Provide one piece factory cut full-face gaskets.

- b. Bolts: UNI EN ISO 3506-1. Extend minimum of two full threads beyond nut with bolts tightened to required torque.
- c. Nuts: UNI EN 2910, with Teflon coated threads.
- d. Washers: Provide galvanized steel flat circular washers under bolt heads and nuts.
- e. Electrically isolating (insulating) gaskets for connections between metal flanges: Provide UNI EN 1514-1 electrical insulating material of 1000 ohms minimum resistance. Provide one piece factory cut insulating gaskets between flanges. Provide silicon-coated fiberglass insulating sleeves between bolts and holes in flanges; bolts may have reduced shanks of diameter not less than diameter at root of threads. Provide 3 mm thick high-strength insulating washers next to flanges and provide stainless steel flat circular steel washers over insulating washers and under bolt heads and nuts. Provide bolts 13 mm longer than standard length to compensate for thicker insulating gaskets and washers under bolt heads and nuts.

2.4.2 Copper Pipe

Copper pipe shall be brazed or connected using an insulated pipe coupling. Provide UNI EN 1254-5 wrought copper or cast copper alloy brazed joint pressure fittings, unions, and flanges; provide adaptors as required. Insulated pipe couplings for copper pipe shall be cast bronze containing an O-ring seal on each end and shall be jacketed and sealed to act as an expansion joint.

2.4.3 Plastic Pipe

- a. Pipe, fittings, flanges, and couplings shall have end connections of the adhesive bell and spigot type. Threaded piping, including pipe, fittings, flanges, and couplings, will not be permitted.
- b. Flanged Connections: Flat face flanged connections shall be provided between plastic piping and metal piping. Plastic flanges shall be suitable for connection to ASME Class 150 flanges.
- c. RTRP Piping Sizes: When piping sizes other than 50, 75, 100, 150, and 200 mm are indicated, the next larger piping size shall be provided. The connecting system piping shall be of the same size or increased to meet the next size of RTRP piping.

2.4.3.1 General

Plastic fittings shall be made of the same type and grade of material as the piping to which they will be connected and shall be furnished by the manufacturer who supplies the pipe. Fittings shall have temperature and pressure ratings, and wall thickness not less than those of the connecting piping.

2.4.3.2 Polyvinyl Chloride (PVC)

Polyvinyl chloride (PVC) pipe shall be solvent welded or connected using bell and spigot connections. The solvent used to connect fittings and pipe shall conform to the requirements of ASTM D 2564. Bell and spigot joints utilizing elastomeric seals shall conform to the requirements of ASTM D 3139. The elastomeric seals shall conform to ASTM F 477.

2.4.3.3 Reinforced Thermosetting Resin (RTR) Plastic

Reinforced thermosetting resin plastic pipe shall be joined using fittings and adhesive furnished by the pipe manufacturer in accordance with ASTM D 5686.

2.5 BURIED WARNING AND IDENTIFICATION TAPE

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 75 mm minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall read "CAUTION BURIED PREINSULATED WATER PIPING BELOW" or similar wording in both English and Italian languages. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.6 CONCRETE THRUST BLOCKS

Provide concrete thrust blocks as specified in Section 03300, "Cast-In-Place Concrete." Concrete shall be of 27.6 MPa minimum 28 day compressive strength, air-entrained admixture (0.13 kg per cubic meter) with water-reducing admixture (0.81 kg per cubic meter).

2.7 PIPE SLEEVES

Provide where piping passes entirely through walls and floors. Provide sleeves of sufficient length to pass through entire thickness of walls and floors. Provide 25 mm minimum clearance between exterior of pipe conduit, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

- a. Sleeves in masonry and concrete walls and floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron sleeves. Core drilling of masonry and concrete may be provided in lieu of sleeves when cavities in the core-drilled hole are grouted smooth.
- b. Sleeves in other than masonry and Concrete walls and floors: Provide 0.5 mm galvanized steel sheet.

2.8 ESCUTCHEON PLATES

Provide split hinge type metal plates for piping entering walls and floors in exposed spaces. 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.

2.9 CONCRETE VALVE MANHOLES

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

Concrete valve manholes shall be provided in accordance with Section 02559, "Valve Manholes and Piping and Equipment In Valve Manholes."

2.10 PIPING AND EQUIPMENT IN VALVE MANHOLES

Piping and equipment in valve manholes shall be provided in accordance with Section 02559, "Valve Manholes and Piping and Equipment In Valve Manholes."

2.11 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.

A [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol shall be provided for the system. Glycol shall be tested in accordance with ASTM D 1384 with less than 0.013 mm penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

PART 3 EXECUTION

3.1 INSTALLATION

For all preinsulated, prefabricated systems, the Contractor shall 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. The manufacturer's representative shall be a person who regularly performs such duties for the manufacturer. The Contractor shall 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 the list will be allowed to install the system. The list shall not be more than one year old.

- a. Valve manholes and piping and equipment in valve manholes shall be installed in accordance with Section 02559, "Valve manholes and piping and Equipment in Valve Manholes."
- b. Earthwork shall be performed in accordance with requirements of Section 02315, "Excavation and Fill"[Section 02302, "Excavation, Backfilling, and Compacting for Utilities"].
- c. Electrical work shall be performed in accordance with Section 16050, "Basic Electrical Materials and Methods" [and] [Section 16302, "Underground Transmission and Distribution"] [, and] [Section 16301, "Overhead Transmission and Distribution"].
- d. Concrete work for thrust blocks shall be performed in accordance with Section 03300, "Cast-in-Place Concrete".

3.2 BURIED FACTORY-PREFABRICATED PREINSULATED PIPE INSTALLATION

The piping system furnished shall be installed in accordance with the piping system manufacturer's instructions. Piping shall be installed without springing or forcing other than what has been calculated for cold spring. Pipe ends shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Nonmetallic pipe cut in the field shall be machined to fit couplings or joints and shall be coated or treated to match standard factory coated ends. Copper tubing shall not be installed in the same trench with ferrous piping materials. When nonferrous metallic pipe (e.g., copper tubing) crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes. Connections between different types of pipe and accessories shall be made with transition fittings approved by the manufacturer of the piping system.

3.2.1 Pitching of Horizontal Piping

Horizontal piping shall be pitched at a grade of not less than 40 mm in one m toward the drain points unless otherwise indicated.

3.2.2 Open Ends

Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt, water, and other foreign matter out of the system.

3.2.3 Cutting Prefabricated Piping Sections

Where prefabricated pipe sections are field cut, new end seals similar to the factory applied end seal shall be provided and installed in accordance with the manufacturer's instructions.

3.2.4 Joints

3.2.4.1 Welded Joints

Welded joints between sections of pipe and between pipe and fittings shall be provided where specified or indicated.

3.2.4.2 Threaded Joints

Threaded joints shall not be used below ground. Joints shall be made tight with polytetrafluoroethylene tape applied to the male threads only. Not more than 3 threads shall show after the joint is made up.

3.2.4.3 Brazed Joints

Brazed joints for copper pipe and fittings shall conform to CDA Tube Handbook. Brazing alloys melting above 593.3 degrees C shall be utilized.

3.2.4.4 Nonmetallic Pipe Joints

Nonmetallic pipe joints shall be installed in accordance with the written instructions of the manufacturer.

3.2.5 Expansion Loops

**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, expansion loops and expansion bends (Z- and L- type) shall be factory fabricated of casing, insulation, and carrier piping identical to that furnished for straight runs. Expansion loops and bends shall be properly designed in accordance with the allowable stress limits indicated in D.P.R. 412 for the type of pipe used. Expansion loops and bends shall be shipped to the jobsite in the maximum size sections feasible to minimize the number of field joints. The expansion loops and bends casing and insulation where applicable, shall be suitably sized to accommodate pipe movement. Field joints shall be made in straight runs of the expansion loops and bends, and the number shall be kept to a minimum. For steel pipe, cold springing shall not be allowed when sizing the expansion loops and bends, but piping shall be cold sprung one-half the calculated maximum operational expansion during field assembly. Pipe stress in expansion loops and bends shall conform to the requirements for expansion loops specified in D.P.R. 412.

3.2.6 Anchors

Anchor design shall be in accordance with the published data of the manufacturer and for prefabricated systems shall be factory fabricated by the prefabricated system manufacturer. In all cases, the design shall be such that water penetration, condensation, or vapor transmission will not wet the insulation.

3.2.7 Field Casing Closures

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.

Field insulation and encasement of joints shall be accomplished after the visual and pressure tests specified are completed. Field insulation and encasement shall be in accordance with the manufacturer's written instructions. Thickness dimensions of the insulation and casing materials shall not be less than those of the adjoining prefabricated section. Insulating material shall be foamed in place polyurethane. Care should be taken to ensure that field closures are made under conditions of temperature and cleanliness required to produce a sound, continuous vapor barrier. A standard polyethylene heat shrink sleeve shall be installed over the casing and shall have a 150 mm minimum overlap at each end.

3.2.8 Buried Warning and Identification Tape

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.

Underground warning tape shall be buried above the piping during the trench backfilling and shall be buried approximately 300 mm deep.

3.2.9 Markers for Underground Piping

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

Markers for underground piping shall be placed as indicated approximately 600 mm to the right of the distribution system and referenced to the flow

direction in the supply line. The marker shall be concrete 150 mm square or round section [600] [900] mm long. The top edge of the marker shall have a minimum 10 mm chamfer all around. The letters [CHW] [LHW] [DTW] shall be impressed or cast on the top of the markers to indicate the type of system that is being identified. Each letter shall be formed with a V-shaped groove and shall have a width of stroke at least 6 mm at the top and depth of 6 mm. The top of the marker shall protrude not more than [25] [50] [75] [100] mm above finished grade.

3.3 THRUST BLOCKS

NOTE: Designer shall 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.

Thrust blocks shall be installed at the locations shown or recommended by the pipe system manufacturer. Thrust blocks may not be required on all systems, and the need for thrust blocks shall be as recommended by the system manufacturer. Thrust blocks, if necessary, shall be installed at all changes in direction, changes in size, valves and terminal ends, such as plugs, caps and tees. Thrust blocks shall be concrete having a compressive strength of not less than 14 MPa after 28 days. Thrust blocks shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and the thrust bearing sides of the thrust blocks shall be poured directly against undisturbed earth. The sides of the thrust blocks not subject to thrust may be poured against forms. Thrust blocks shall be placed so that the joints for all fittings will be accessible for repair wherever possible. No pipe joint shall be embedded in concrete unless the assembly has previously been hydrostatically tested. The thrust blocks shall provide for transfer of thrusts and reactions without exceeding the allowable stress of the concrete and shall be installed in accordance with pipe manufacturer's instructions. In muck or peat, all thrusts shall be resisted by piles or tie rods to solid foundations or by removal of peat or muck which shall be replaced with ballast of sufficient stability to resist thrusts.

3.4 FIELD QUALITY CONTROL

Tests shall be conducted before, during, and after installation of the system. All instruments, equipment, facilities, and labor required to properly conduct the tests shall be provided by the Contractor. Test pressure gauges for a specific test shall have dials indicating not less than 1-1/2 times nor more than 2 times the test pressure. It shall be the Contractor's responsibility to make the pipe system workable at his expense.

3.4.1 Carrier Pipe Cleaning and Testing

Distribution piping shall be tested as required before backfilling and with all joints exposed. The area between joints may be backfilled as necessary

to prevent pipe movement.

3.4.1.1 Cleaning Carrier Pipe

Prior to testing, the interior of the carrier pipe shall be cleaned of foreign materials by thorough flushing with clean water. Water shall be circulated at a velocity between 2 and 3 m/s for a minimum of 4 hours. If required, temporary and/or supplementary pumps shall be provided to ensure that required velocity is achieved. System strainers shall be cleaned after the flushing operation is complete. Temporary strainers shall be installed as required. After flushing, the water shall remain in the piping system for testing of the system. All air shall be removed from the system prior to starting the tests.

3.4.1.2 Hydrostatic Pressure Cycling and Tests

Hydrostatic pressure cycling shall have 4 cycles. Each cycle shall consist of a 10 minute period at 1000 kPa followed by a 5 minute period at a pressure less than 350 kPa. The next cycle shall begin immediately following the completion of the previous cycle. Pressure rise and drop shall not exceed 690 kPa per minute. The pressure gauge shall be located and the pressure measured at the opposite end of the system from where the pressure is applied. After completion of the hydrostatic pressure cycling, the first hydrostatic pressure test shall be performed. During the first hydrostatic pressure test, the system shall be proven tight at a pressure of 1-1/2 times the working pressure up to 1000 kPa. This pressure shall be held for a minimum of one hour. The method of pressurizing the system shall be disconnected from the system before starting the 1 hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of pressure loss shall be determined, corrected and the hydrostatic pressure cycling and first hydrostatic pressure test shall be repeated until the system can hold the required pressure for at least 1 hour. After successful completion of the first hydrostatic pressure test, the water shall be drained out of the piping system and the piping system filled with treated water as defined in paragraph entitled "Water Treatment" for the remaining tests and for permanent operation of the system. The hydrostatic pressure cycling and tests shall be repeated after the system has been filled with treated water, using the same test conditions and criteria.

[3.4.1.3 Operational Test

Operational test shall be performed on the complete system or testable portions thereof. The test shall be conducted 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 shall consist of one 6 hour period with treated water in the system at the maximum operating temperature of [_____] degrees C and maximum flow rate, and a period of at least 6 hours with no flow. For dual temperature systems, the first cycle shall use the heating temperature of [_____] degrees C and the second cycle the cooling temperature of [_____] degrees C of the designed system. The Contractor shall supply temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired

temperatures and flow rates. Water shall be circulated through supply lines and returned 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. Any leaks found shall be repaired. After any obstructions have been removed and any leaks repaired, the operational test shall be repeated until successfully passed.

]3.4.1.4 Final Hydrostatic Test

After successful completion of the operational test, the system shall be pressurized to 1-1/2 times the working pressure up to 1000 kPa. This pressure shall be held for a minimum of 4 hours. Means of pressurizing shall be disconnected prior to the start of the 4 hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of the pressure loss shall be determined, corrected, and all of the hydrostatic pressure cycling and tests repeated.

]3.5 DISINFECTION

Disinfect new hot domestic water piping under Section 15400, "Plumbing Systems."

3.6 WATER TREATMENT

Provide water treatment of chilled water, heating water, and dual-temperature water systems as specified in Section 15181, "Chilled and Condenser Water Piping and Accessories".

TABLE I - STEEL PIPE DATA

Nominal Pipe Size	Pipe mm	Pipe Number Schedule	Wall Thickness mm	Inside Diameter mm
20		40	2.87	20.9
20		80	3.91	18.8
25		40	3.38	26.6
25		80	4.55	24.3
32		40	3.56	35.0
32		80	4.85	32.5
40		40	3.68	40.9
40		80	5.08	38.1
50		40	3.91	52.5

TABLE I - STEEL PIPE DATA

Nominal Size	Pipe mm	Pipe Number	Schedule	Wall Thickness mm	Inside Diameter mm
50		80		5.54	49.2
65		40		5.16	62.7
65		80		7.01	59.0
80		40		5.49	78.9
80		80		7.62	73.7
100		40		6.02	102.3
100		80		8.56	97.2
150		40		7.11	154.0
150		80		10.97	146.3
200		30		7.04	205.0
200		40		8.18	202.7
200		80		12.70	193.7
250		30		7.80	257.4
250		40		9.27	254.5
250				12.70	247.6
250		80		15.06	242.9
300		30		8.38	307.1
300		Standard		9.53	304.8
300		40		10.31	303.2
300		Extra Strong		12.70	298.4
300		80		17.45	288.9
350		30		9.53	336.5
350		40		11.10	333.4
350		Extra Strong		12.70	330.2
350		80		19.05	317.5

TABLE I - STEEL PIPE DATA

Nominal Size	Pipe mm	Pipe Number Schedule	Wall Thickness mm	Inside Diameter mm
400		30	9.53	387.3
400		40	12.70	381.0
450		Standard	9.53	438.1
450		30	11.10	435.0
450		Extra Strong	12.70	431.8
450		40	14.27	428.6
500		Standard	9.53	488.9
500		30	12.70	482.6
500		40	15.06	477.9

TABLE II - COPPER TUBE DATA

Nominal Size	Pipe mm	Type	Wall Thickness mm	Outside Diameter mm
8		K	0.89	9.53
8		L	0.76	9.53
10		K	1.24	12.70
10		L	0.89	12.70
10		M	0.64	12.70
15		K	1.24	15.88
15		L	1.02	15.88
15		M	0.71	15.88
15		K	1.24	19.05
15		L	1.07	19.05
20		K	1.65	22.23
20		L	1.14	22.23
20		M	0.81	22.23

TABLE II - COPPER TUBE DATA

Nominal Size	Pipe mm	Type	Wall Thickness mm	Outside Diameter mm
25		K	1.65	28.58
25		L	1.27	28.58
25		M	0.89	28.58
32		K	1.65	34.93
32		L	1.40	34.93
32		M	1.07	34.93
32		DWV	1.02	34.93
40		K	1.83	41.28
40		L	1.52	41.28
40		M	1.24	41.28
40		DMV	1.07	41.28
50		K	2.11	53.98
50		L	1.78	53.98
50		M	1.47	53.98
50		DWV	1.07	53.98
65		K	2.41	66.68
65		L	2.03	66.68
65		M	1.65	66.68
80		K	2.77	79.38
80		L	2.29	79.38
80		M	1.83	79.38
80		DWV	1.14	79.38
90		K	3.05	92.08
90		L	2.54	92.08
90		M	2.11	92.08

TABLE II - COPPER TUBE DATA

Nominal Pipe Size	Pipe mm	Type	Wall Thickness mm	Outside Diameter mm
100		K	3.40	104.78
100		L	2.79	104.78
100		M	2.41	104.78
100		DWV	1.47	104.78

-- End of Section --