
NAVFAC IGS-02530 (MARCH 2003)

Supercedes IGS 02530 (06/02)
Preparing Activity: LANTNAVFACENGCOM Based on UFGS-02530N

ITALIAN GUIDE SPECIFICATIONS

Use for ITALIAN projects only

SECTION 02530

SANITARY SEWERAGE
03/03

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

NOTE: This guide specification covers the requirements for piping and appurtenant structures for an exterior sanitary sewer system.

Comments and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of the 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.

NOTE: On the project drawings, show:

1. Plan and location of new pipelines, including type of service and size of pipe
2. Location, size, and type of service of existing connecting, intersecting, or adjacent pipelines and other utilities
3. Paved areas and railroads which pass over new pipelines
4. Profile, where necessary to show unusual

conditions

5. Invert elevations at beginning and end of pipelines and at manholes or similar structures
6. Class or strength of pipe and limits for same where class or strength will be different for different sections of pipeline
7. Design details for pertinent manholes, septic tank(s), and sewage absorption trench
8. Bedding conditions, where different from those specified in the appropriate specification and location of cradle(s), when cradle is required, if not covered
9. Maximum working pressure for pressure sewers
10. Location and size of thrust blocks on pressure lines
11. Location of flanged joints on pressure sewers
12. Location of mechanical joints on ductile-iron piping (when used on only part of the system).

NOTE: Consider the following in the project design.

1. Allowable piping materials:
 - a. The project specification should allow the use of piping materials for each application which are suitable for the project, each to be permitted as a Contractor's option.
 - b. Refer to the appropriate NAVFACENGCOM Design Manual/Military Handbook for general information on piping materials suitable for use on the applications covered by this specification.
 - c. Pipe materials which are known to be unsuitable for local conditions (i.e., corrosion, root penetration, etc.) should not be permitted for the project. However, consideration should be given to use of more effective protective coatings and jointing methods where economically feasible.
 - d. In areas where problems with root penetration are anticipated, specify pipe which has the kind of joint which will successfully resist root penetration. Generally speaking, the more watertight

the joint, the greater will be the resistance to root penetration. Rubber-gasketed and compression-type joints are considered to give the best performance for this application.

e. It is assumed that corrosive fluids (acids, alkalies, toluene, etc.) will not be reaching the exterior sewer system in relatively undiluted condition. If such will not be the case, investigate the materials specified herein for resistance to the particular chemical involved. If necessary, corrosion-resistant materials other than those specified herein may be used.

f. Further information on clay pipe may be found in the Clay Pipe Engineering Manual (1985 Edition) of the National Clay Pipe Institute.

g. For further information on the selection of concrete sewer pipe and jointing materials, see the Concrete Pipe Design Manual (1980 Edition) and the Concrete Pipe Handbook (1980 Edition), both published by the American Concrete Pipe Association.

h. Where required for special applications, reinforced concrete arch pipe conforming to ASTM C 506 or reinforced concrete elliptical pipe conforming to ASTM C 507 may be specified.

i. Plastic pipe is subject to temperature limitations which must be observed when specifying plastic pipe for service from laundries, kitchens, and other facilities discharging large quantities of water at elevated temperatures (the temperature limit given is for short-time, nonpressure use only; lower temperature limit is required for long-time use or for pressure use):

ABS 82 degrees C
PVC 71.degrees C

j. Do not use ABS pipe for applications where high chemical resistance is desired, such as in lines from laboratories or hospitals.

k. Use caution if considering concrete pipe for septic flows. Depending on septicity, these pipes may not be satisfactory.

2. Pipe design:

a. Specify equivalent pipe design for the project conditions (using the applicable criteria for each pipe material) for each pipe material insofar as is

practicable. American Society of Civil Engineers (ASCE Manual No. 37, "Design and Construction of Sanitary and Storm Sewers," contains methods of calculation for structural requirements of pipe; from these, the required strengths for pipe of various materials may be determined. Investigate external loads, including earth loads, truck loads, seismic loads, and impact, in the design stage of the project.

b. Give special attention in the design stage of project to plastic pipe materials, particularly with respect to superimposed external loads which could cause excessive deflection of the pipe. The degree of sidefill compaction should be considered realistically, particularly in marginal cases.

c. Where different classes, strengths, etc., of pipe are required for different sections of long pipelines due to significant differences in external loading, expand or modify the applicable paragraphs of this specification accordingly. Show the limits for each class, strength, etc., either on the project drawings or appropriately describe them in the applicable paragraph of the project specification.

3. Pipe joints: When more than one type of joint is applicable for the specified piping, permit each as a contractor's option except where watertight joints are necessary in areas where root penetration problems are anticipated. In these cases, rubber-gasketed or compression-type, or solvent-cemented joints are preferred. Use fuel resistant joint gaskets when required.

4. It may be necessary to modify chemical requirements for cement under certain conditions. Sulfate resistance is required for concrete pipe when pipe is carrying sulfate-bearing waters, or when pipe is buried in soil containing sulfates. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as SO₄) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement.

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 FOR TESTING AND MATERIALS (ASTM)

ASTM C 478M	(1997) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 828	(1990) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 923M	(1996) Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)
ASTM C 969M	(1994) Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM C 990M	(1996) Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM F 758	(1995) Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

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.M. 12/12/85	(1985) Technical Norms pertinent to piping
D.M. 23	(February 1971) Technical norms for crossings and for parallelism of sewer, drain and gas lines with railroads and other transportation routes.
D.L. 152	(11/5/99) Instructions on protection of water from pollution and reception of CEE 91/271 directive regarding treatment of city wastewater, and of CEE 91/676

directive regarding protection of water from pollution caused by nitrate coming from agricultural sources

D.L. 494 (14/8/96) Implementation of the instruction CEE 92/57 concerning the minimum safety and health requirements to be accomplished in temporary or mobile work sites

ITALIAN INSTITUTE OF PLASTICS (IIP)

IIP, Pub.n.3 (Nov. 1984) Installation of PVC Sewer Systems. Calculations and Installation of PVC Underground Sewers and Industrial Drains.

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 E13.08.497.0 (1990) Unplasticized PVC pipes under pressure - Types, dimensions and requirements

UNI 5732 (1965) Cup square bolts with hexagon nut. ISO metric coarse thread - Finish C

UNI 6609 (1969) Metallic pipe flanges - Bolts - Types, materials and ratings

UNI 7601 (1984) Spheroidal graphite iron sand castings - Deviations in dimensions without tolerance indication and machining allowances

UNI 8696 (1985) Vulcanized rubber - Determination of stress relaxation in compression at normal and elevated temperatures

UNI 9048 (1987) Vulcanized rubber - Analysis of multi-peak traces obtained in determinations of tear strength and adhesion strength

UNI 9163 (1987) Ductile iron pipes, fittings and accessories for pressure pipe-lines - Automatic flexible joint - Coupling

dimensions and joint accessories

UNI 9164 (1994) Ductile iron pipes, fittings and accessories for pressure pipe-lines - Mechanical flexible joint - Coupling dimensions and joint accessories

UNI 9542 (1990) Rubber, ethylene-propylene-diene (EPDM) raw general purpose types - Evaluation procedures

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 124 (1995) Gully tops and manhole tops for vehicular and pedestrian areas - Design requirements, type testing, marking, quality control

UNI EN 206-1 (2001) Concrete - Part 1: Specification, performance, production and conformity

UNI ISO 228-1 (1983) Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation

UNI EN 295-1/A1/A2/A3 (1992/99/99/99) Vitrified clay pipes and fittings and pipe joints for drains and sewers - Part 1: Requirements

UNI EN 295-5 (1995) Vitrified clay pipes and fittings and pipe joints for drains and sewers - Part 5: Requirements for perforated vitrified clay pipes and fittings

UNI EN 545 (1995) Ductile iron, pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods

UNI EN 681-1/A1 (1997/00) Elastomeric seals - Materials requirements for pipe joint seals used in water and drainage applications - Part 1: Vulcanized rubber

UNI EN 714	(1995) Thermoplastics piping systems - Non-end-load-bearing elastomeric sealing ring type joints between pressure pipes and moulded fittings - Test method for leaktightness under internal hydrostatic pressure without end thrust
UNI EN ISO 898-1	(2001) Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs
UNI EN ISO 898-6	(1996) Mechanical properties of fasteners - Part 6: Nuts with specified proof load values - Fine pitch thread
UNI EN 1092-2	(1999) Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 2: Cast iron flanges
UNI EN 1401-1	(1998) Plastic piping system for non-pressure underground drainage and sewerage - Unplasticized poly (vinyl chloride) (PVC-U)
UNI EN 1452-2	(2001) Plastics piping systems for water supply - Unplasticized poly(vinyl chloride) (PVC-U) - Part 2: Pipes
UNI EN 1452-3	(2001) Plastics piping systems for water supply - Unplasticized poly(vinyl chloride) (PVC-U) - Part 3: Fittings
UNI EN 1561	(1998) Founding - Grey cast iron
UNI EN 1562	(1999) Founding - Malleable cast iron
UNI EN 1563	(1998) Founding - Spheroidal graphite cast irons
UNI ISO 4179	(1987) Ductile iron pipes for pressure and non-pressure pipelines - Centrifugal cement mortar lining - General requirements
UNI ISO 6594	(1987) Cast iron drainage pipes and fittings - Spigot series
UNI ISO 6943	(1994) Rubber, vulcanized - Determination of tension fatigue
UNI ISO 8180	(1986) Ductile iron pipes - Polyethylene sleeving
UNI ISO 10802	(1994) Ductile iron pipelines -

Hydrostatic testing after installation

UNI EN 29519

(1995) Shipbuildings and marine structures
- Rungs for dog-step ladders

1.2 SYSTEM DESCRIPTION

1.2.1 Sanitary Sewer Gravity Pipeline

Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 1.5 m outside of building walls.

1.2.2 Sanitary Sewer Pressure Lines

Provide pressure lines of [ductile iron pressure pipe] [concrete pressure pipe] [or] [polyvinyl chloride (PVC) plastic pressure pipe] [at the Contractor's option].

1.3 SUBMITTALS

NOTE: Where a "G" in submittal tags follows a submittal item, it indicates Government approval for that item. Add "G" in submittal tags following any added or existing submittal items deemed sufficiently critical, complex, or aesthetically significantly to merit approval by the Government. Submittal items not designated with a "G" will be approved by the QC organization.

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

SD-02 Shop Drawings

Precast concrete manhole

Metal items

Frames, covers, and gratings

SD-03 Product Data

Pipeline materials including joints, fittings, and couplings

Submit manufacturer's standard drawings or catalog cuts.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

1.4.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store [plastic piping and jointing materials and] rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.4.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.4.1.3 Cement, Aggregate, and Reinforcement

NOTE: Delete these paragraphs if not used or insert applicable concrete requirements here.

As specified in Section 03300, "Cast-In-Place Concrete."

1.4.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. [Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs.] Carry, do not drag, pipe to trench.

PART 2 PRODUCTS

2.1 SOURCE MANUFACTURERS

2.1.1 Cast Iron Piping

The following manufacturers provide cast iron piping that generally complies with these specifications:

HYDROMAT ITALIA S.r.l.
Via Plino, 56
80058 - Torre Annunziata NAPOLI (NA) ITALY
Tel: 39 081 8624005
Fax: 39 081 8611097

TUBI GHISA S.p.A.
Via Allegro, 1
16016 Cogoleto GENOVA (GE) ITALY
Tel. 39 010 9171101
Fax: 39 010 9171401

2.1.1 Clay Piping

The following manufacturers provide clay piping that generally complies with these specifications:

SOCIETA'DEL GRES
Via G. Marconi, 1
24010 Petosino (BG)
Tel: 035/579111
Fax: 035/579384

GREENPIPE
Via Modena, 48b
42015 Correggio (RE)
Tel. 0522/633123
Fax: 0522/633124
www.greenpipe.it

2.1.2 Ductile Iron

The following manufacturers provide ductile iron piping materials that generally comply with these specifications:

TUBI GHISA
Via Allegro, 1
16016 Cogoleto Ge
Tel: 010/91711
Fax: 010/9171401

SOCIETA'DEL GRES/SERTUBI
Via G. Marconi, 1
24010 Petosino (BG)
Tel: 035/579111
Fax: 035/579384

HYDROMAT ITALIA S.r.l.
Via Plinio, 56
80058 - Torre Annunziata (NA)
Tel: 081/8624005
Fax: 081/8611097
e-mail: hydro.it@globalink.it

2.1.3 PVC

The following manufacturers provide PVC piping materials that generally comply with these specifications:

DALMINE
41100 Modena
Tel: 059/826307
Fax: 059/827090

ATE Alta Tecnologia Estrusione S.p.A.
38066 RIVA DEL GARDA (TN) Loc. Ceole, 3/c

Tel: (0464) 520520
Fax: (0464) 521752 - 556820

UNIPLAST TUBI
Via s. Lazzaro, 1
42021 Ghiardo di Bibbiano (RE)
Tel: 0522/2512
Fax: 0522/883411
e-mail: contact@uniplast-tubi.it

2.1.4 Frame, Covers, and Gratings for Manholes

The following manufacturers provide manhole frames, covers, and gratings that generally comply with these specifications:

TUBI GHISA
Via Allegro, 1
16016 Cogoleto Ge
Tel: 010/91711
Fax: 010/9171401

GREENPIPE
Via Modena, 48b
42015 Correggio (RE)
Tel. 0522/633123
Fax: 0522/633124
www.greenpipe.it

2.1.5 Manhole Steps

The following manufacturers provide that generally comply with these specifications:

EDILMAFER S.r.l.
Via delle Forze Armate, 316 - 20152 Milano
Tel: +39 02 48910850
Fax: +39 02 4568254
e-mail:posta@edilmafer.it
vendite@edilmafer.it

FALZONI
Via Paolo Veronese 227
10148 Torino
Tel: 011 220 48 15 - 220 48 16

2.2 PIPELINE MATERIALS

2.2.1 Cast-Iron Soil Piping

2.2.1.1 Cast-Iron Hub and Spigot Soil Pipe and Fittings

UNI ISO 6594, [service] [extra heavy], with UNI EN 681-1/A1 compression-type rubber gaskets.

2.2.2 Clay Piping

2.2.2.1 Clay Pipe and Fittings

 NOTE: Tables of trench loadings, trench backfill loads, and supporting strengths of clay pipe are included in the Clay Pipe Engineering Manual (1982 edition) of the National Clay Pipe Institute. The required strength of clay pipe can be derived from these tables when depth of trench is known.

 NOTE: Specify "bell-and-spigot piping only" in areas where corrosion problems may be anticipated with the stainless steel parts of the couplings used for plain-end piping.

UNI EN 295-1/A1/A2/A3, Class Number [____]. Pipe joints shall be [socket] [or] [spigot] controlled jointing systems.

2.2.2.2 Clay Piping Jointing Materials

UNI EN 681-1/A1.

2.2.3 Ductile Iron Gravity Sewer Pipe and Associated Fittings

2.2.3.1 Ductile Iron Gravity Pipe and Fittings

 NOTE: ASTM A 746 also contains design information and methods by which the required Thickness Class of Pipe can be determined when depth of trench is known.

 NOTE: Delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

Ductile iron pipe shall conform to UNI EN 545, Thickness Class [____]. Fittings shall conform to UNI EN 545. Fittings shall have strength at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the joints specified hereinafter. Pipe and fittings shall have cement-mortar lining conforming to UNI ISO 4179, standard thickness.

2.2.3.2 Ductile Iron Gravity Joints and Jointing Materials

NOTE: Delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

Pipe and fittings shall have [push-on joints] [or] [mechanical joints], except as otherwise specified in this paragraph. [Mechanical joints only shall be used where indicated.] [Push-on joint pipe ends and fitting ends, gaskets, and lubricant for joint assembly shall conform to UNI 9163.] [Mechanical joint requirements for pipe ends, glands, bolts and nuts, and gaskets shall conform to UNI 9164.]

2.2.4 Ductile Iron Pressure Piping

NOTE: Ductile iron pipe is used for sizes 75 mm to 1600 mm.

2.2.4.1 Ductile Iron Pressure Pipe and Fittings

NOTE: Use Thickness Class 52 for LANTNAVFACENGCOM projects.

Ductile-iron pipe shall conform to UNI EN 545, Thickness Class [_____]. [Flanged pipe and fittings shall conform to UNI EN 545, with flanges conforming to UNI EN 1092-2.] Fittings shall have pressure rating at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the joints specified hereinafter. Pipe and fittings shall have cement-mortar lining conforming to UNI ISO 4179, standard thickness.

2.2.4.2 Ductile Iron Pressure Joints and Jointing Materials

- a. Joints, general: Joints for pipe and fittings shall be [push-on joints] [or] [mechanical joints] except as otherwise specified in this paragraph. [Joints shall be mechanical-joints where indicated.] [Joints shall be flanged joints where indicated.] [Joints made with sleeve-type mechanical coupling may be used in lieu of push-on joint.] [[Grooved] [or] [shouldered] type joints may be used in lieu of push-on joint [or flanged joint], except where joint is buried.]
- b. Push-on joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly shall conform to UNI 9163 and UNI EN 545.
- c. Mechanical joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets shall conform to UNI 9164 and UNI EN 545.

- d. Flanged joints: Bolts, nuts, and gaskets for flanged connections shall be UNI EN 1092-2 and UNI 6609. Flange for setscrewed flanges shall be of ductile iron, UNI 7601, Grade [] and shall conform to the applicable requirements of UNI EN 1092-2, Class []. Setscrews for setscrewed flanges shall be 1310 MPa tensile strength, heat treated, and zinc-coated steel. Gasket for setscrewed flanges shall conform to the applicable requirements for mechanical-joint gaskets specified in UNI 9164. Design of setscrewed gasket shall provide for confinement and compression of gasket when joint to adjoining flange is made.

NOTE: At the text below, delete "or steel" when middle ring of cast iron only is considered necessary due to anticipated corrosion problems. Delete requirement for strength of steel when steel is not allowed as a material for middle ring.

NOTE: At the text below, minimum numbers of bolts for each pipe size should be as follows: 75 mm, 3; 100 mm, 4; 150 mm, 5; 200 mm, 6; 250 mm, 7; 300 and 350 mm, 8; 400 mm, 9; 450 mm, 10; 500 mm, 12; 550 mm, 13; 600 mm, 14.

- e. Joints made with sleeve-type mechanical couplings: Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat, two follower rings, two resilient tapered rubber gaskets, and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. Middle ring shall be of cast-iron [or steel], and the follower rings shall be of malleable iron or ductile iron. Cast iron shall conform to UNI EN 1561, and shall be not less than Class []. Malleable iron shall conform to UNI EN 1562. Ductile iron shall conform to UNI EN 1563. [Steel shall have a strength not less than that of the pipe.] Gaskets shall be designed for long life and resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in UNI 9164. Bolts shall be track-head type; bolts and nuts shall be either of the following: bolts conforming to the tensile requirements of UNI EN ISO 898-1, Grade []with nuts conforming to the tensile requirements of UNI EN ISO 898-6, Grade []; or round-head square-neck type bolts conforming to UNI 5732 with hex nuts conforming to UNI EN ISO 898-6. Bolts shall be 16 mm in diameter; minimum number of bolts for each coupling shall be [_____] [for [_____] mm pipe [, [_____] for [_____] mm pipe,] and [_____] for [_____] mm pipe]. Bolt holes in follower rings shall

be of a shape to hold fast the necks of the bolts used. Sleeve-type mechanical couplings shall not be used as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint.

- f. [Grooved] [and] [Shouldered] Type Joints: [Grooved pipe ends] [Shouldered pipe ends] and couplings shall conform to UNI EN 545. Joint dimensions shall be as specified in UNI EN 545 for rigid joints.

2.2.5 PVC Plastic Gravity Sewer Piping

2.2.5.1 PVC Plastic Gravity Pipe and Fittings

UNI EN 1401-1 with ends suitable for elastomeric gasket joints. [ASTM F 949 with solvent cement or elastomeric gasket joints.]

2.2.5.2 PVC Plastic Gravity Joints and Jointing Material

UNI EN 681-1/A1 elastomeric gasket joints; UNI EN 804 solvent cement joints. Gaskets shall conform to UNI EN 681-1/A1.

2.2.6 PVC Plastic Pressure Pipe and Associated Fittings

2.2.6.1 PVC Plastic Pressure Pipe and Fittings

- a. Pipe and Fittings Less Than 100 mm Diameter: Pipe, couplings and fittings shall be manufactured of materials conforming to UNI E13.08.497.0 and UNI EN 1452-3, Class [].

(1) Screw-Joint: Pipe shall conform to dimensional requirements of UNI E13.08.497.0, Schedule [], with joints meeting requirements of 1.03 Mpa working pressure, 1.38 Mpa hydrostatic test pressure, unless otherwise shown or specified. Fittings for threaded pipe shall conform to requirements of UNI EN 1452-3, threaded to conform to the requirements of UNI ISO 228-1 for use with Schedule 80 pipe and fittings. Pipe couplings when used, shall be tested as required by UNI EN 714.

(2) Push-On Joint: UNI EN 1452-2, with UNI EN 681-1/A1 gaskets. Fittings for push-on joints shall be iron conforming to UNI EN 545 or UNI 9163. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with UNI ISO 4179.

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of UNI E13.08.497.0 with joints meeting the requirements of 1.03 Mpa working pressure and 1.38 Mpa hydrostatic test pressure. Fittings for solvent cement jointing shall conform to UNI EN 1452-3.

- b. Pipe and Fittings 100 mm Diameter to 315 mm: Pipe shall conform to UNI E13.08.497.0 and shall be plain end or gasket bell end, Pressure Class [] (DR 18), with cast-iron-pipe-equivalent OD.

Fittings shall be gray-iron or ductile-iron conforming to UNI EN 545 and shall have cement-mortar lining conforming to UNI ISO 4179, standard thickness. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that bell design shall be modified, as approved, for push-on joint suitable for use with the PVC plastic pressure pipe specified in this paragraph.

2.2.6.2 PVC Plastic Pressure Joints and Jointing Material

Joints for pipe, 100 mm to 315 mm diameter, shall be push-on joints as specified in UNI E13.08.497.0 and UNI EN 1452-3. Joints between pipe and fittings shall be push-on joints as specified in UNI E13.08.497.0 and UNI EN 1452-3 or shall be compression-type joints/mechanical-joints as respectively specified in UNI E13.08.497.0 and UNI EN 1452-3 and UNI EN 681-1/A1. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to UNI EN 681-1/A1. Gaskets for push-on joints and compression-type joints/mechanical-joints for joint connections between pipe and fittings shall be as specified in UNI EN 681-1/A1, respectively, for push-on joints and mechanical-joints.

2.2.7 Piping Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, piping shall conform to the specifications for pipelines conveying nonflammable substances in D.M. 23, except as otherwise specified in this paragraph. For casing pipe provide ductile-iron pipe in lieu of cast-iron soil pipe. Ductile-iron pipe shall conform to and have strength computed in accordance with UNI EN 545.

2.3 CONCRETE MATERIALS

NOTE: Delete these paragraphs if not used or insert applicable concrete requirements here.

Concrete materials shall be as specified in Section 03300, "Cast-In-Place Concrete."

2.4 MISCELLANEOUS MATERIALS

2.4.1 Precast Concrete and Associated Materials

2.4.1.1 Precast Concrete Manhole Sections

Precast concrete manhole risers, base sections, and tops shall conform to ASTM C 478M. Base and first riser shall be monolithic.

2.4.1.2 Gaskets and Connectors

Gaskets for joints between manhole sections shall conform to UNI EN 681-1/A1. Resilient connectors for making joints between manhole and pipes entering

manhole shall conform to ASTM C 923M or ASTM C 990M.

[2.4.1.3 External Preformed Rubber Joint Seals

An external preformed rubber joint seal shall be an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" shall be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal shall be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Di Monomer (EPDM) rubber with a minimum thickness of 1.5 mm. Each unit shall consist of a top and bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be a non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections shall cover up to two more adjusting rings. Properties and values are listed in the following table:

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals

Physical Properties	Test Methods	EPDM	Neoprene	Butyl mastic
Tensile, kPa	UNI ISO 6943	12,684	15,132	-
Elongation percent	UNI ISO 6943	553	295	350
Tear Resistance, N/mm	UNI 9048 (Die B)	49	28	-
Rebound, percent, 5 minutes	UNI 8696 (mod.)	-	-	11
Rebound, percent, 2 hours	UNI 8696	-	-	12

]2.4.2 Metal Items

2.4.2.1 Frames, Covers, and Gratings for Manholes

UNI EN 124, cast iron; minimum class [A15] [B125] [C250] for non-traffic areas and minimum class [D400] [E600] [F900] for traffic areas. Cast in the word "SANITARY" on the cover.

2.4.2.2 Manhole Steps

[Zinc-coated steel] [as indicated] conforming to UNI EN 29519. [As an option, plastic or rubber coating pressure-molded to the steel may be used. Plastic coating shall conform to UNI 9542, copolymer polypropylene. Rubber shall conform to UNI EN 681-1/A1, except shore A durometer hardness shall be 70 plus or minus 5.] Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 1.2 m deep.

2.4.2.3 Septic Tank Piping

Cast iron soil pipe and fittings.

2.4.2.4 Siphon for Septic Tank

Welded steel or close-grained cast iron free from flaws, of an approved standard design, and prompt and positive in action.

2.4.3 Sewage Absorption Field Materials

[Pipe shall be perforated bell-and-spigot clay pipe conforming to UNI EN 295-5, clay drain tile or PVC plastic pipe conforming to ASTM F 758. Covering for open joints in drain tile lines shall be asphalt-treated paper or asphalt-covered fibrous glass cloth. Wire for fastening covering to tile shall be 1.2 mm, nonferrous metal composition.]

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 General Requirements for Installation of Pipelines

Apply except where specific exception is made in the following paragraphs entitled "Special Requirements"; intallation shall conform to D.M. 12/12/85 and D.L. 494.

NOTE: Select the applicable paragraph from the following:

3.1.1.1 Location

NOTE: Choose one of the following options.

The work covered by this section shall terminate at a point approximately 1.5 m from the building [, unless otherwise indicated]. [Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 3 m to a water main or service line.] [Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 0.60 m below bottom of water line.] [Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 3 m on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance.] [Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 0.9 m, horizontal distance, to the water line.]

a. Sanitary piping installation parallel with water line:

- (1) Normal conditions: Sanitary piping or manholes shall be laid

at least 3 m horizontally from a water line whenever possible. The distance shall be measured edge-to-edge.

(2) Unusual conditions: When local conditions prevent a horizontal separation of 3 m, the sanitary piping or manhole may be laid closer to a water line provided that:

(a) The top (crown) of the sanitary piping shall be at least 450 mm below the bottom (invert) of the water main.

(b) Where this vertical separation cannot be obtained, the sanitary piping shall be constructed of UNI EN-approved ductile iron water pipe pressure tested in place without leakage prior to backfilling.

(c) The sewer manhole shall be of watertight construction and tested in place.

b. Installation of sanitary piping crossing a water line:

(1) Normal conditions: Lay sanitary piping crossing water lines to provide a separation of at least 450 mm between the top of the sanitary piping and the bottom of the water line whenever possible.

(2) Unusual conditions: When local conditions prevent a vertical separation described above, use the following construction:

(a) Sanitary piping passing over or under water lines shall be constructed of UNI EN-approved ductile iron water pipe, pressure tested in place without leakage prior to backfilling.

(b) Sanitary piping passing over water lines shall, in addition, be protected by providing:

1. A vertical separation of at least 450 mm between the bottom of the sanitary piping and the top of the water line.

2. Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.

3. That the length, minimum 6.1 m, of the sanitary piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the water line.

c. Sanitary sewer manholes: No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

3.1.1.2 Earthwork

NOTE: Earthwork requirements, including bedding, for pipe trenches and utility structures are covered in Section 02315, "Excavation and Fill" and in

Section 02302, "Excavation, Backfilling, and Compacting for Utilities." The above referenced section number and title are subject to change. The specifier should verify the current specification and revise if different.

Perform earthwork operations in accordance with Section [_____, "_____."]

3.1.1.3 Pipe Laying and Jointing

NOTE: Delete requirement for tongue-and-groove pipe (concrete pipe) when not allowed for the project.

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell [or groove] ends in the upgrade direction. Adjust spigots in bells [and tongues in grooves] to give a uniform space all around. Blocking or wedging between bells and spigots [or tongues and grooves] will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 7.50 m apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose.

3.1.1.4 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.1.2 Special Requirements

3.1.2.1 Installation of Clay Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the written instructions and recommendations of the manufacturer, for pipe laying. Make joints with a compression joint material specified for clay pipe joints and assemble in accordance with the recommendations of the manufacturer of the pipe.

3.1.2.2 Installation of Ductile Iron Gravity Sewer Pipe

Unless otherwise specified, install pipe and associated fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the written instructions and recommendations of manufacturer for pipe installation and joint assembly.

NOTE: At the text below, delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

- a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the written instructions and recommendations of the manufacturer for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint and assemble in accordance with the written instructions and recommendations of the manufacturer for joint assembly.

NOTE: At the text below, delete the paragraph except when required. See the NAVFACENGCOM Design Manual on Water Supply Systems for guidance. See Foreword to AWWA C105/A21.5 for guidance on selecting Class of polyethylene film.

- b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with UNI ISO 8180, using [Class ____] polyethylene film.

3.1.2.3 Installation of Ductile-Iron Pressure Lines

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the written instructions and recommendations of the manufacturer for pipe installation, joint assembly, and valve-and-fitting installation.

- a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the written instructions and recommendations of the manufacturer for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the written instructions and recommendations of the manufacturer for joint assembly. [Make flanged joints with gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight, taking care to avoid undue strain on flanges, fittings, and other accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fittings have dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.] [Assemble joints made with sleeve-type mechanical couplings in accordance with the

recommendations of the coupling manufacturer, as approved.] [Make [grooved] [and] [shouldered] type joints with the couplings previously specified for this type joint connecting pipe with the [grooved] [or] [shouldered] ends specified for this type joint and assemble in accordance with the recommendations of the coupling manufacturer, as approved. [Groove pipe in the field only with approved groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.]]

**NOTE: Delete the text below except when required.
See the NAVFACENCOM Design Manual on Water Supply
Systems for guidance. See Foreword to AWWA
C105/A21.5 for guidance on selecting Class of
polyethylene film.**

- b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with UNI ISO 8180, using [Class ____] polyethylene film.
- c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to UNI EN 206-1 having a minimum compressive strength of 13.80 MPa at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.1.2.4 Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of IIP, Pub.n.3 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of IIP, Pub.n.3 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.1.2.5 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section; with the requirements of IIP, Pub.n.3 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in IIP, Pub.n.3.

- a. Pipe Less Than 100 mm Diameter:
 - (1) Threaded joints shall be made by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. The joints shall be

tightened with strap wrenches which will not damage the pipe and fittings. The joint shall be tightened no more than 2 threads past hand-tight.

(2) Push-On Joints: The ends of pipe for push-on joints shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. The gasket shall be lubricated to prevent displacement. Care shall be exercised to ensure that the gasket remains in proper position in the bell or coupling while making the joint.

(3) Solvent-weld joints shall comply with the manufacturer's instructions.

- b. Pipe 100 mm Joints: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to fittings, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of IIP, Pub.n.3 for laying the pipe and the recommendations in IIP, Pub.n.3, Chapter 6, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings in accordance with the requirements of IIP, Pub.n.3 for joining PVC pipe to fittings and accessories and with the applicable requirements of IIP, Pub.n.3 for joint assembly and connection with ductile iron piping. Make compression-type joints/mechanical-joints with the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of IIP, Pub.n.3 for joining PVC pipe to fittings and accessories, with the applicable requirements of IIP, Pub.n.3 for joint assembly with ductile iron piping, and with the recommendations of the manufacturer. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel.
- c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to UNI EN 206-1 having a minimum compressive strength of 13.80 MPa at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.1.2.6 Pipeline Installation Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, install piping in accordance with the specifications for pipelines conveying nonflammable substances in D.M. 23.

3.1.2.7 Cleanouts

Construct cleanouts of cast iron soil pipe and fittings.

3.1.3 Concrete Work

NOTE: Delete these paragraphs if not used or insert applicable concrete requirements here.

Cast-in-place concrete is included in Section 03300, "Cast-In-Place Concrete."

3.1.4 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Cast-in-place concrete work shall be in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.1.5 Miscellaneous Construction and Installation

3.1.5.1 Metal Work

- a. Workmanship and finish: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

NOTE: Delete the text below when painting of cast

iron items is not in accordance with local station practice.

- b. Field painting: After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

3.1.5.2 Sewage Absorption Trench Construction

Grade pipe lines uniformly downward to the outlet. Lay perforated pipe with the perforations downward. Lay drain tile with 6 mm open joints. Cover open joints of drain tile with the cover material specified so that it extends not less than 1.75 rad on each side of the vertical center line of the tile. Wire covering in place.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing[, except that water and electric power needed for field tests will be furnished as set forth in Section [_____, "_____"]]. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications. The Contractor shall also verify the sewer lines perfect hydraulic seals in accordance with D.L. 152 concerning the protection from water pollution.

3.2.2 Tests for Nonpressure Lines

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line. When pressure piping is used in a nonpressure line for nonpressure use, test this piping as specified for nonpressure pipe.

3.2.2.1 Leakage Tests

Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

- a. Infiltration tests and exfiltration tests: Perform these tests for sewer lines made of the specified materials, not only concrete, in accordance with ASTM C 969M. Make calculations in

accordance with the Appendix to ASTM C 969M.

b. Low-pressure air tests: Perform tests as follows:

(1) Clay pipelines: Test in accordance with ASTM C 828. Allowable pressure drop shall be as given in ASTM C 828. Make calculations in accordance with the Appendix to ASTM C 828.

(2) Ductile-iron pipelines: Test in accordance with the applicable requirements of UNI ISO 10802. Allowable pressure drop shall be as given in UNI ISO 10802. Make calculations in accordance UNI ISO 10802.

(3) PVC plastic pipelines: Test in accordance with IIP, Pub.n.3. Allowable pressure drop shall be as given in IIP, Pub.n.3. Make calculations in accordance IIP, Pub.n.3.

3.2.2.2 Deflection Testing

NOTE: Specify deflection testing only when warranted by scope or size of project.

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with IIP, Pub.n.3. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:

(1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

(2) Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 4 degrees C, and shall have a surface Brinell hardness of not less than 150.

(3) Center bored and through-bolted with a 6 mm minimum diameter steel shaft having a yield strength of not less than 483 MPa, with eyes or loops at each end for attaching pulling cables.

(4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

- b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.
- c. Pull-through device procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.
- d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

3.2.3 Tests for Pressure Lines

Test pressure lines in accordance with the applicable standard specified in this paragraph, except for test pressures. For hydrostatic pressure test, use a hydrostatic pressure 345 kPa in excess of the maximum working pressure of the system, but not less than 690 kPa, holding the pressure for a period of not less than one hour. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test. [Test ductile-iron pressure lines in accordance with the requirements of UNI ISO 10802 for hydrostatic testing. Leakage on ductile-iron pipelines with mechanical-joints [or push-on joints] shall not exceed the amounts given in UNI ISO 10802; allow no leakage at joints made by other methods.] [Test PVC plastic pressure lines in accordance with the requirements of IIP, Pub.n.3 for pressure and leakage tests, using the allowable leakage given therein.]

3.2.4 Field Tests for Concrete

NOTE: Delete these paragraphs if not used or insert applicable concrete requirements here.

Field testing requirements are covered in Section [_____, "_____."]

-- End of Section --