

SECTION 33 30 00

SANITARY SEWERAGE
05/18

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 within the text by the basic designation only.

JAPANESE STANDARDS ASSOCIATION (JSA)

JIS A 5001	(2008) Crushed Stone for Road Construction
JIS A 5005	(2009) Crushed Stone and Manufactured Sand for Concrete
JIS A 5308	(2014) Ready-Mixed Concrete
JIS A 5314	(2014) Mortar Lining for Ductile Iron Pipes
JIS A 5372	(2016) Precast Reinforced Concrete Products
JIS A 5506	(2008) Manhole Covers for Sewerage Works
JIS B 1171	(2015) Cup Head Square Neck Bolts (Amendment 1)
JIS B 1180	(2014) Hexagon Head Bolts and Hexagon Screws
JIS B 1181	(2014) Hexagon Nuts and Hexagon Thin Nuts
JIS B 2404	(2018) Dimensions of Gaskets for Use with Pipe Flanges
JIS G 3101	(2020) Rolled Steels for General Structure
JIS G 5526	(2014) Ductile Iron Pipes
JIS G 5527	(2014) Ductile Iron Fittings
JIS H 8641	(2021) Hot Dip Galvanized Coatings
JIS K 0102	(2019) Testing Methods for Industrial Wastewater (Amendment 1)
JIS K 6353	(2011) Rubber Goods for Water Works
JIS K 6739	(2016) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipe Fittings for Drain
JIS K 6741	(2016; R 2021) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipes

JIS K 6742 (2016) Unplasticized poly (vinyl chloride)
(PVC-U) pipes for water supply

JIS K 6743 (2016) Unplasticized Poly (Vinyl Chloride)
(PVC-U) Pipe Fittings for Water Supply

JIS R 5210 (2009) Portland Cement

JAPAN WATER WORKS ASSOCIATION (JWWA)

JWWA K 158 (2017) Polyethylene Sleeve for Ductile
Cast Iron Pipe for Water Supply

JAPAN SEWAGE WORKS ASSOCIATION (JSWA)

JSWAS K-1 (2010) Rigid PVC Pipe for Sewer

THE SOCIETY OF HEATING, AIR-CONDITIONING AND SANITARY ENGINEERS OF
JAPAN (SHASE)

SHASE-S 209 (2009) Manhole Cover

JAPAN DUCTILE IRON PIPE ASSOCIATION (JDPA)

JDPA Z 2010 (2009) Synthetic Resin Coating for Ductile
Iron Pipes and Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation;
submittals not having a "G" designation are for information only. When
used, a designation following the "G" designation identifies the office
that will review the submittal for the Government. Submittals with an "S"
are for inclusion in the Sustainability eNotebook, in conformance to
Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Pressure Pipe; G

Sewage Treatment Tanks; G

SD-06 Test Reports

Hydrostatic Sewer Test

Infiltration Tests or Exfiltration Tests

Tests For Pressure Lines; G

Deflection Testing

SD-07 Certificates

Gaskets

Pre-Installation Inspection Request; G

Post-Installation Inspection; G

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

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.

1.3.1.1 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.

1.3.1.2 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.3.2 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. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Sanitary Sewer Gravity Pipeline

Provide mains and laterals of concrete pipe or polyvinyl chloride (PVC) plastic pipe. Provide building connections of polyvinyl chloride (PVC) plastic pipe. 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.

2.1.2 Sanitary Sewer Pressure Lines

Provide pressure lines of ductile iron pressure pipe or polyvinyl chloride (PVC) plastic pressure pipe.

2.2 MATERIALS

Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification, standard drawings or catalog cuts.

2.2.1 Gravity Pipe

2.2.1.1 Concrete Gravity Sewer Piping

2.2.1.1.1 Concrete Gravity Pipe

Provide reinforced concrete pipe conforming to JIS A 5372, external pressure type, Class 1 or Class 2, Type B.

2.2.1.1.2 Jointing Materials for Concrete Gravity Piping

Provide gaskets and pipe ends for rubber gasket joint conforming to JIS K 6353. Use gaskets suitable for use with sewage.

Submit certificates of compliance stating that the fittings or gaskets used for waste drains or lines are oil resistant.

2.2.1.2 PVC Gravity Sewer Piping

2.2.1.2.1 Pipe and Fittings

a. Pipe: JIS K 6741, Class VP or VU.

b. Fittings: JIS K 6739

2.2.1.2.2 Joints and Jointing Material

Jointing Materials: Rubber gasket conforming to JIS K 6353. Gaskets shall be suitable for use in sewerage.

2.2.1.2.3 PVC Branch Pipe Connectors

Shall be standard product compatible with the PVC plastic pipe and conforming to JSWAS K-1 and JIS K 6739. Adhesive materials shall be as per branch pipe manufacturer's recommendation.

2.2.2 Pressure Pipe

2.2.2.1 Ductile Iron Pressure Piping

2.2.2.1.1 Ductile Iron Pressure Pipe and Fittings

Provide mechanical joint or flanged ductile-iron pipe conforming to JIS G 5526. Provide fittings conforming to JIS G 5527. Use fittings which have a pressure rating at least equivalent to that of the pipe. Pipe and fittings are to have interior cement-mortar lining conforming to JIS A 5314 and exterior pipe coating conforming to JDPA Z 2010.

2.2.2.1.2 Ductile Iron Pressure Joints and Jointing Materials

a. Joints, general: Use mechanical joints for pipe and fittings. Use flanged joints where indicated. Joints made with sleeve-type mechanical coupling may be used in lieu of push-on joint.

- b. Mechanical joints: Gaskets are to conform to JIS B 2404.
- c. Flanged joints: Provide bolts, nuts, and gaskets for flanged connections compatible with JIS G 5527 joints.
- d. Joints made with sleeve-type mechanical couplings: Provide bolts conforming to the tensile requirements of JIS B 1180 with nuts conforming to the tensile requirements of JIS B 1181 or round-head square-neck type bolts conforming to JIS B 1171 with hex nuts conforming to JIS B 1181.

2.2.2.2 PVC Pressure Pipe and Associated Fittings

2.2.2.2.1 Pipe and Fittings

Pipe, couplings and fittings are to be manufactured of materials conforming to JIS K 6742 and fittings conforming to JIS K 6743.

2.2.2.2.2 Solvent Cement Joint

Provide solvent cement joint per pipe manufacturer's recommendation.

2.2.3 Piping Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, piping is to conform to the specifications for pipelines conveying nonflammable substances. For casing pipe provide ductile-iron pipe in lieu of cast-iron soil pipe. Ductile-iron pipe is to conform to and have strength computed in accordance with JIS G 5526.

2.2.4 Portland Cement

Portland cement shall conform to JIS R 5210.

2.2.5 Portland Cement Concrete

Provide portland cement concrete conforming to JIS A 5308, compressive strength of 24 MPa at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement is to have a compressive strength of 18 MPa minimum at 28 days. Protect concrete in place from freezing and moisture loss for 7 days.

2.2.6 Precast Concrete Manholes

Approved commercial products as shown on drawings and conforming to JIS A 5372 or JSWAS K-1. Joints between precast concrete manhole sections shall be made with flexible watertight, rubber-type gaskets per manhole manufacturer's standards.

2.2.7 Invert Mortar

Mortar for forming manhole inverts shall be composed of cement, sand and water mixed in proportion of 1 part cement to 2 parts of sand, sufficient water to produce a workable mixture. Mortar shall be used in the work within one hour after mixing.

2.2.8 Gaskets and Connectors

Resilient connectors for making joints between manhole and pipes entering manhole are to conform to pipe manufacturer's standards.

2.2.9 Sewage Treatment Tanks

Shall be three functions of primary, secondary, and final sewage treatment and shall meet the requirements of biochemical oxygen demand (BOD) value as indicated by testing in accordance with JIS K 0102.

2.2.10 Frames And Covers for Manholes

Shall be local manufacturer's standard product conforming to SHASE-S 209, and shall be of cast iron per JIS A 5506. Size, configuration and loading capacity shall be as indicated on drawings. A letter "S" shall be stamped or cast into covers.

2.2.11 Manhole Steps

Materials shall conform to JIS G 3101, Type SS400, galvanized, and of the size and configuration as shown on drawing. Manhole steps are not required in manholes and inlets less than 1.2 m deep.

2.2.12 Manhole Ladders

Provide a steel ladder conforming to JIS G 3101 where the depth of a manhole exceeds 3.6 m. The ladder is not to be less than 406 mm in width, with 19 mm diameter rungs spaced 305 mm apart. The two stringers are to be a minimum 10 mm thick and 51 mm wide. Galvanize ladders and inserts after fabrication in conformance with JIS H 8641.

2.2.13 Miscellaneous Items

2.2.13.1 Warning Tape

Provide in accordance with requirements as specified in Section 31 00 00 EARTHWORK

2.2.13.2 Sand Fill

Fill around PVC drainage pipes shall be cleaned sand conforming to JIS A 5005.

2.2.13.3 Gravel Base Course

Crushed stone for base course at concrete structures shall be crusher run conforming to JIS A 5001, RC-40.

2.2.13.4 Surface Cleanouts

Surface cleanout shall have cast iron cover and fitting adaptable for connection to the lower PVC pipe. Traffic loading capacity shall be as required for the manhole covers located within the same ground surface condition.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Installation Drawings

Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

3.2 INSTALLATION

Backfill after inspection by the Contracting Officer. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer.

3.2.1 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.

3.2.2 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.2.2.1 Location

Terminate the work covered by this section at a point approximately 1.5 m from the building, unless otherwise indicated. 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. When these separation distances can not be met, contact the Contracting Officer for direction.

3.2.2.1.1 Sanitary Piping Installation Parallel with Water Line

3.2.2.1.1.1 Normal Conditions

Install sanitary piping or manholes at least 3 m horizontally from a water line whenever possible. Measure the distance from edge-to-edge.

3.2.2.1.1.2 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 is to be at least 450 mm below the bottom (invert) of the water main.
- b. Where this vertical separation cannot be obtained, construct the sanitary piping with JWWA-approved ductile iron water pipe pressure and conduct a hydrostatic sewer test without leakage prior to backfilling.
- c. The sewer manhole is to be of watertight construction and tested in place.

3.2.2.1.2 Installation of Sanitary Piping Crossing a Water Line

3.2.2.1.2.1 Normal Conditions

Lay sanitary sewer piping by crossing under 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.

3.2.2.1.2.2 Unusual Conditions

When local conditions prevent a vertical separation described above, use the following construction:

- a. Construct sanitary piping passing over or under water lines with JWWA-approved ductile iron water pressure piping and conduct a hydrostatic sewer test without leakage prior to backfilling.
- b. Protect sanitary piping passing over water lines 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 are equidistant and as far as possible from the water line.

3.2.2.1.3 Sanitary Sewer Manholes

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

3.2.2.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK 31 23 00.00 20 EXCAVATION AND FILL.

3.2.2.3 Pipe Laying and Jointing

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 to give a uniform space all around. Blocking or wedging between bells and spigots 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. Construct branch connections by use of regular fittings or with matching branch pipe connectors from the same pipe manufacturer.

3.2.3 Special Requirements

3.2.3.1 Installation of Concrete Gravity Sewer Piping

Make joints with the gaskets specified for concrete gravity sewer pipe joints. Clean and dry surfaces receiving lubricants, cements, or adhesives. Affix gaskets to pipe not more than 24 hours prior to the installation of the pipe. Protect gaskets from sun, blowing dust, and other deleterious agents at all times. Before installation of the pipe, inspect gaskets and remove and replace loose or improperly affixed gaskets. Align each pipe section with the previously installed pipe section, and pull the joint together. If, while pulling the joint, the gasket becomes loose and can be seen through the exterior joint recess when the pipe is pulled up to within 25 mm of closure, remove the pipe and remake the joint.

3.2.3.2 Installation of Ductile-Iron Pressure Lines

- a. Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint. 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.
- b. Exterior protection: Completely wrap buried ductile iron pipelines with 8 mil (minimum) polyethylene sheet in conformance with JWWA K 158.
- c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to JIS A 5308 having a minimum compressive strength of 18 MPa at 28 days.

3.2.3.3 Installation of PVC Piping

Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.3.4 Installation of PVC Pressure Pipe

3.2.3.4.1 Pipe

Make push-on joints with elastomeric gasket . 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, use cut spigot end of pipe off square, marked to match the manufacturer's insertion line and beveled to match factory supplied bevel. . 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 the pipe manufacturer for laying the pipe. Assemble push-on joints for connection to fittings in accordance with the requirements of the pipe manufacturer for joining PVC pipe to fittings and accessories.

3.2.3.4.2 Pipe Anchorage

Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to JIS A 5308 having a minimum compressive strength of 18 MPa at 28 days.

3.2.3.5 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.

3.2.4 Concrete Work

Cast-in-place concrete is included in Section 03 30 00 CAST-IN-PLACE CONCRETE. Support the pipe on a concrete cradle, or encased in concrete where indicated or directed.

3.2.5 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make invert 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. Perform cast-in-place concrete work 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.

3.2.6 Miscellaneous Construction and Installation

3.2.6.1 Connecting to Existing Manholes

Connect pipe to existing manholes such that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. Center the connection on the manhole. Holes for the new pipe are to be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cut the manhole in a manner that will cause the least damage to the walls.

3.2.6.2 Metal Work

3.2.6.2.1 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.

3.2.6.2.2 Field Painting

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

3.2.7 Installations of Wye Branches and Branch Connectors

Install wye branches and branch connectors in an existing sewer using a method which does not damage the integrity of the existing sewer. Do not cut into piping for connections except when approved by the Contracting Officer. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, support on a concrete cradle as directed by the Contracting Officer. Provide and install concrete required because of conditions resulting from faulty construction methods or negligence without any additional cost to the Government. Do not damage the existing sewer when installing wye branches in an existing sewer.

3.2.8 Construction of Sewage Treatment Tanks

Construct sewage tank in accordance with approved drawings and manufacturer's catalog data.

3.3 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.3.1 Tests

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 [____].

3.3.1.1 Hydrostatic Sewer Test

When unusual conflicts are encountered between sanitary sewer and waterlines a hydrostatic pressure sewer test will be performed in accordance with the applicable JWWA standard for the piping material with a minimum test pressure of 200 kPa.

3.3.1.2 Leakage Tests for Nonpressure Lines

Test lines for leakage by either infiltration tests or exfiltration 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 exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. When the water table is 60 cm or more above top of pipe at upper end of pipeline section to be tested, measure infiltration using a suitable weir or other acceptable device. When the water table is less than 60 cm above top of pipe at upper end of pipeline section to be tested, make exfiltration test by filling the line to be tested with water so that the head will be at least 1.2 m above top of pipe at upper end of pipeline section being tested. Allow filled pipeline to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, reestablish the head and measure amount of water needed to maintain this water level during a 2-hour test period. Amount of leakage, as measured by either infiltration or exfiltration test shall not exceed one liter per cm of diameter per hour per 100 m of pipeline. When leakage exceeds the amount specified, make satisfactory correction and retest pipeline section in the same manner as previously specified. Correct all visible leaks regardless of leakage test results.

3.3.1.3 Tests for Pressure Lines

Test pressure lines in accordance with the applicable standards as recommended by pipe manufacturer's installation manual for the respective pressure pipes specified in this specification. 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.

3.3.1.4 Deflection Testing

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. Deflection of pipe in the installed pipeline under external loads is not to 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.

3.3.1.4.1 Pull-Through Device

This device is to be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Space circular sections on the shaft so that the distance from external faces of front and back sections will equal or exceed the diameter of the circular section. Pull-through device may also be of a design recommended by the pipe manufacturer, 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 are to conform to the following:

- a. 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.
- b. Homogeneous material throughout, is to have a density greater than 1.0 as related to water at 4 degrees C, and a surface Brinell hardness of not less than 150.
- c. 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.
- d. Suitably Back each eye or loop with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

3.3.1.4.2 Deflection Measuring Device

Sensitive to 1.0 percent of the diameter of the pipe being tested and be accurate to 1.0 percent of the indicated dimension. Prior approval is required for the deflection measuring device.

3.3.1.4.3 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.

3.3.1.4.4 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.

3.3.2 Field Tests for Cast-In-Place Concrete

Field testing requirements are covered in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3.3 Inspection

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; the light must show a practically full circle of light through the pipeline when viewed from the adjoining end of line.

3.3.3.1 Pre-Installation Inspection

Prior to connecting the new service, perform pre-installation inspection after trenching and layout is complete. Submit pre-installation inspection request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the pre-installation inspection.

3.3.3.2 Post-Installation Inspection

Perform a post-installation inspection after connection has been made and before the connection is buried. Submit post-installation inspection request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the post-connection inspection.

-- End of Section --