

**DIVISION 33 – UTILITIES**  
**SECTION 33 31 00 – SANITARY UTILITY SEWERAGE PIPING AND ACCESSORIES**

**PART 1 – GENERAL**

1.01 SECTION INCLUDES

- A. Force main sanitary sewer pipe, fittings, and related appurtenances.
- B. Gravity sanitary sewer pipe, fittings, and related appurtenances.
- C. Low pressure sanitary sewer force main pipe, fittings, and related appurtenances.
- D. See Section 33 32 00 for Pump Station Process Piping.

1.02 RELATED SECTIONS

- A. Section 31 23 33 – Trenching and Backfilling for Utilities.

1.03 REFERENCES

- A. The Pennsylvania Department of Environmental Protection's Domestic Wastewater Facilities Manual, latest edition.
- B. American Society for Testing and Materials:
  - 1. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 2. ASTM A312/A312M – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
  - 3. ASTM A536 – Standard Specification for Ductile Iron Castings.
  - 4. ASTM A733 – Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
  - 5. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
  - 6. ASTM C591 – Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
  - 7. ASTM C828 – Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.
  - 8. ASTM C 1173 – Standard Specification for Flexible Transition Couplings for Underground Piping Systems

9. ASTM D714 – Standard Test Method for Evaluating Degree of Blistering of Paints.
10. ASTM D1784 – Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
11. ASTM D2321 – Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
12. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of a Plastic Pipe by Parallel- Plate Loading.
13. ASTM D2467 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
14. ASTM D2683-10 – Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
15. ASTM D3034 – Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
16. ASTM D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
17. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
18. ASTM D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
19. ASTM D3261-10a – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
20. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
21. ASTM D 5926 – Standard Specification for Poly Vinyl Chloride (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
22. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
23. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
24. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
25. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

26. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.
  27. ASTM F2206 – Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock.
  28. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
  29. ASTM F2736 – Standard Specification for 6 to 30 in. Polypropylene Corrugated Single Wall and Double Wall Pipe.
  30. ASTM G95 – Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
- C. American Nation Standard Institute:
1. ANSI/ASME B16.50 – Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.
  1. ANSI B18.2 – Square & Hexagon Bolts & Nuts.
- D. American Water Works Association:
1. ANSI/AWWA C104/A21.4 – Cement Mortar Lining for Ductile-Iron.
  2. ANSI/AWWA C105/A21.5-10 – Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
  3. ANSI/AWWA C110/A21.10 – Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in., for Water and Other Liquids.
  4. ANSI/AWWA C111/A21.11 – Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
  5. AWWA C115 – Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
  6. AWWA C116 – Standard for Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron.
  7. ANSI/AWWA C151/A21.51 – Ductile-Iron Pipe, Centrifugally Cast.
  8. AWWA C153 – Ductile-Iron Compact Fittings for Water Service.
  9. AWWA C213 – Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
  10. AWWA C517 – Standard for Resilient-Seated Cast-Iron Eccentric Plug Valves.

11. ANSI/AWWA C905-10 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in.

E. Plastic Pipe Institute

1. TN 34 – Installation Guidelines For Electrofusion Couplings 14” and Larger.
2. TN 42 – Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Projects.
3. TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.
4. TR 41 – Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 – Submittals.
- B. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, catalog cut or other data as required to provide a complete description of piping, fittings and other appurtenances specified herein.
- C. Certificates:
1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
  2. Manufacturer's sworn certification that pipe will be manufactured in accordance with specified reference standards for each pipe type.

1.05 QUALITY ASSURANCE

- A. Design Criteria:
1. Use only one type and class of pipe in any continuous line of sewer between structures, unless otherwise indicated on the drawings.
  2. Use pipe and fittings designed to withstand imposed trench loadings and conditions at the various locations.
- B. Source Quality Control:
1. Perform hydrostatic and leakage shop tests on all pipe and fittings in accordance with applicable AWWA Standards.

2. Shop Tests: Each pipe manufacturer must have facilities to perform listed tests. The Engineer reserves the right to require the manufacturer to perform such additional number of tests as the Engineer may deem necessary to establish the quality of the material offered for use.

Material	Test Method	Number of Tests
a. Polyvinyl Chloride Pipe	ASTM D 3034	As specified in ASTM D 3034
	ASTM D 1693	As specified in ASTM D 1693
	ASTM D 2412	As specified in ASTM D 2412
b. Ductile Iron Pipe	ANSI A 21.51	As specified in ANSI A 21.51

3. Laboratory Tests: The Engineer reserves the right to require that laboratory tests also be conducted on materials that are shop tested. Furnish without compensation, labor, materials, and equipment necessary for collecting, packaging, and identifying representative samples of materials to be tested and the shipping of such samples to the Testing Laboratory. The Contractor will pay for these laboratory tests.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle piping and related products in accordance with Specifications, manufacturer's recommendations, and as supplemented herein.
- B. Pipe and related materials to be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances drop or skid such material against other products already on ground.
- C. Handle pipe and related materials at all times with care to avoid damage. Interior kept free from dirt and foreign matter. All pipe and appurtenances carefully lowered or raised into place, with suitable equipment in manner that will prevent damage to material. Do not drop or dump pipe or accessories under any circumstances.
- D. Thoroughly inspect pipe, pipe linings, fittings, valves, and all related materials for defects prior to being unloaded and again prior to being installed. Repair or replace any defective, damaged, or unsound material, as determined by Engineer, at no additional cost to Owner.
- E. All lumps, blisters, and excess coating removed from ends of each pipe. Joints wire brushed and wiped clean, dry and free from oil and grease before pipe is installed.

1.07 SITE CONDITIONS

A. Environmental Requirements:

1. Keep trenches dewatered until initial bedding has been placed, pipe joints have been made, and initial bedding and concrete cradle and encasement, if any, have cured.
2. Under no circumstances lay pipe in water or on bedding containing frost.
3. Do not lay pipe when weather conditions are unsuitable, as determined by the Engineer, for pipe laying work.

**PART 2 – PRODUCTS**

2.01 GENERAL

- A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.
- B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified in Paragraph 3.08.
- C. The drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

2.02 PIPE AND FITTINGS

A. Gravity Sewer Pipe and Fittings - Polyvinyl Chloride:

1. Polyvinyl chloride (PVC) pipe, used for sewer construction less than 15 feet in depth, shall equal or exceed the requirements of ASTM D 3034 for 4-inch through 15-inch pipe and ASTM F 679 for 18-inch through 27-inch pipe. The PVC sewer pipe shall have a minimum standard dimension ratio (SDR) of 35 and the minimum pipe stiffness, as tested in accordance with ASTM D 2412, shall be 46 psi when measured under 5 percent deflection at 73 degrees Fahrenheit. Pipe shall be manufactured with integral wall bell and spigot joints in standard lengths not exceeding 20 feet.
2. Polyvinyl chloride (PVC) pipe, used for sewer construction between 15 feet and 20 feet in depth, shall equal or exceed the requirements of ASTM D 3034 for 4-

inch through 15-inch pipe and ASTM F 679 for 18-inch through 27-inch pipe. The PVC sewer pipe shall have a minimum standard dimension ratio (SDR) of 26 and the minimum pipe stiffness, as tested in accordance with ASTM D 2412, shall be 115 psi when measured under 5 percent deflection at 73 degrees Fahrenheit. Pipe shall be manufactured with integral wall bell and spigot joints in standard lengths not exceeding 20 feet.

3. All polyvinyl chloride (PVC) pipe and fittings shall utilize elastomeric O-ring gasketed joints assembled in accordance with the manufacturer's recommendations. Gaskets shall have a minimum cross sectional area of 0.20 square inches and conform to ASTM F 477 specifications. Provide elastomeric gaskets that have been tested as suitable for continuous contact with domestic sewage.
4. Polyvinyl chloride wye branches, repair couplings, tees, pipe stoppers, and other fittings shall be manufactured in accordance with the same specifications and shall have the same thickness, depth of socket, and annular space as the pipe. PVC sewer fittings shall conform to ASTM D-3034 specifications with a minimum wall thickness of SDR 35. PVC material shall have a cell classification of 12454-B or C as defined in ASTM D 1784.

**B. Gravity Sewer Pipe and Fittings - Ductile Iron:**

1. Ductile iron pipe, used for sewer construction greater than 20 feet in depth or at locations as determined by the Engineer, shall be centrifugally cast with push-on joints, not less than 12 feet nor more than 20 feet in length. Ductile iron sewer pipe shall be Pressure Class 350 and meet the requirements of ANSI A21.51 and ANSI 21.50.
2. Fittings and specials for ductile iron pipe shall be made of cast iron in accordance with ANSI A21.10 and rated for 350-psi working pressure.
3. Buried Joints: Use rubber-gasketed joints for pipe and fittings installed underground. Push-on: Per ANSI/AWWA C111/A21.11 requirements.
4. Epoxy Lining: Refer to paragraph 2.05.
5. Pipe and Fittings Coating: Factory coated inside and out with bituminous material, minimum 1 mil dry thickness. Bituminous material and finished coat shall conform to seal coat requirements of ANSI A21.4 and AWWA C151.

**C. Force Main Pipe – PVC SDR 21:**

1. PVC SDR 21 pipe, for sanitary sewer force main, shall be made from quality PVC resin, compounded to provide physical and mechanical properties that equal or exceed cell class 12454-B as defined in ASTM D 2241.
2. All polyvinyl chloride (PVC) pipe and fittings shall utilize elastomeric O-ring gasketed joints assembled in accordance with the manufacturer's recommendations. Gaskets shall have a minimum cross sectional area of 0.20

square inches and conform to ASTM F477 specifications. Provide elastomeric gaskets that have been tested as suitable for continuous contact with domestic sewage.

D. Force Main Fittings – Ductile Iron:

1. Fittings shall be made of ductile iron in accordance with ANSI A21.10 and rated for 350-psi working pressure.
2. Mechanical joints: Shall conform to AWWA C111. Bolts shall be high-strength, low-alloy steel per AWWA C111. Unless otherwise specified, gasket material shall be standard styrene butadiene copolymer (SBR).
3. Flanged Joints: Shall conform to AWWA C110 and C115, Class 125. Gaskets shall be vulcanized natural or vulcanized synthetic rubber that is free of porous areas, foreign material, and visible defects. Gasket materials shall conform to AWWA C111. Factory cut gaskets shall be used. Bolts shall be black steel machine bolts with heavy hexagon heads conforming to ANSI B18.2.1. Nuts shall conform to ANSI B18.2.2. The bolts shall be tightened uniformly to distribute the bolt stress evenly and bring the pipe into alignment.
4. Epoxy Lining: Refer to paragraph 2.05.
5. Fittings Coating: Factory coated inside and out with bituminous material, minimum 1 mil dry thickness. Bituminous material and finished coat shall conform to seal coat requirements of ANSI A21.4 and AWWA C151.
6. All exposed force main ductile iron fittings shall have flanged joints.

E. Low Pressure Sewer Pipe – PVC SDR 21:

1. PVC Pipe, for low pressure sewer, shall be suitable for use as a pressure conduit, meeting or exceeding the requirements of ASTM D 2241. Pipe shall be manufactured with integral wall bell and spigot joints in standard lengths not exceeding 20 feet. All polyvinyl chloride (PVC) pipe shall utilize elastomeric O-ring gasketed joints assembled in accordance with the manufacturer's recommendations. Gaskets shall have a minimum cross sectional area of 0.20 square inches and conform to ASTM F 477 specifications. Provide elastomeric gaskets that have been tested as suitable for continuous contact with domestic sewage.

F. Low Pressure Sewer Fittings – PVC SDR 21:

1. Fitting design and material requirements shall conform to ASTM D 2241, SDR-21 for 200-psi pressure. PVC material shall conform to ASTM 1784 requirements for Cell Classification 12454-B.
2. Gaskets shall have a minimum cross sectional area of 0.20 square inches and conform to ASTM F 477 specifications. Provide elastomeric gaskets that have been tested as suitable for continuous contact with domestic sewage.

- G. Thrust Restraint for Force Main and Low Pressure Sewer Piping:
1. Contractor has option of any of the means specified below. Length of restraint as shown on the drawings. Restraint shall be provided at all fittings, bends, tees, changes in direction, etc.
    - b. Concrete Thrust Blocks and Tie Rods: Concrete shall be as specified in PennDOT Publication 408, Section 704 for Class A Concrete - 3,000 psi compressive strength (at 28 days). Tie rods shall be constructed of suitable metal. Metal harness of tie rods shall be galvanized or otherwise rust proofed and shall be painted with bituminous coating after installation. Contractor shall submit thrust block designs to Engineer for review.
    - c. Retainer Glands: Mechanical joint restraint consisting of follower gland which when actuated imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. ASTM A 536-80 ductile iron follower gland of dimensions such that it can be used with AWWA C153 mechanical joints. Restraining devices shall be of ductile iron, heat-treated to a minimum hardness of 370 BHN. Twist-off nuts shall be used to insure proper actuating of the restraint device. Restraint device shall have a 250-psi minimum working pressure with 2:1 minimum safety factor. Retainer Glands shall be installed in accordance with manufacturer's instructions and procedures.

## 2.03 FORCE MAIN VALVES AND APPURTENANCES

- A. General: All valves and appurtenances shown or listed on the drawings shall be installed as shown or detailed, or as directed by Engineer, and shall be as specified herein.
1. Painting: All surfaces of each valve body assembly shall be clean, dry and free from grease before painting. All unmachined surfaces of the valve body assembly shall be wire brushed down to clean metal. Two coats of an asphalt varnish shall be applied in accordance with AWWA C500. Finished painting for exposed valves shall have the surface prepared and painted in accordance with manufacturer's recommendations.
  2. Spare Parts and Tools: Repair or service parts for one of each type and size of valve used in this work shall be furnished and stored as directed by the Engineer. The equipment shall include, in general, the following items: special tools required for maintenance, including seat replacement, or operation of valves, gaskets, rings, seals, lubricants, bolts, washers, and miscellaneous accessories required to maintain valves in proper operating service.
  3. Flanges: All flanged valves shall be drilled and faced to the ASA 125 pound standard template, and in accordance with ANSA B16.1.

- B. Swing Check Valves (4" and larger):
1. Check valves larger than 3-inches shall be cushioned swing check valves rated for a minimum working pressure of 200 psi and shall be of the "Shockless Swing-Check" type as manufactured by G.A. Industries, Gulf/Tyco, or equal.
  2. Valve closure shall be controlled by an external weighted lever arm, the action of which is cushioned by a hydraulic oil or pneumatic cylinder. Counterweights and cushion cylinders shall be designed so that adjustments can be made in the field to minimize surge and to prevent backflow and hammering noises during actual service conditions. The pneumatic cushion system shall be completely self-contained.
  3. Valve bodies, cover discs, levers, and disc arms shall be constructed of heavy cast iron or cast steel fully conforming to the latest revision of ASTM A-126 Class B or Class WCB, respectively. Valve ends shall be Standard American 125 pound flat-faced flanged, in accordance with ANSI B16.1. Each valve disc shall be suspended from a noncorrosive shaft which shall pass through a stuffing box and be connected on the outside of the valve to the cushion and counterweight mechanism.
  4. Valve seating shall be rubber-to-metal designed for drop-tight shutoff. The body seat ring shall be made of bronze or stainless steel and the disc seat ring of 80 Durometer rubber. Body and disc seats shall be renewable.
  5. With the exception of the valve body and seat, all parts in contact with water shall be manufactured from noncorrosive materials. Internal corrosive surfaces shall be shop painted with two coats of epoxy for corrosion resistance. Exterior of valves shall be manufacturer's standard finish.
- C. Knife Gate Valves:
1. Knife gate valves shall be bonnetless, wafer type with a cast iron body, incorporating support ribs for a strong-flanged connection as manufactured by Red Valve Company, Inc., or equal.
  2. Valves shall be the size indicated on the Contract Drawings and shall be provided with thru-bolt flanges for connection to the force main piping. Flange drilling dimensions must meet M.S.S. SP-81 and ANSI B16.5, Class 125/150 requirements.
  3. Valves shall have all wetted parts constructed of 316 stainless steel.
  4. Valves shall have a fabricated stainless steel liner. The liner shall extend through the valve chest to the top of the packing gland. Both sides of the gate shall be finish ground.
  5. Valve stems shall be stainless steel and shall have double pitch threads. Yoke nuts shall be acid-resisting bronze.

6. The valve shall have a raised seat with a relieved area around the seat to prevent jamming. The valve gate shall be suitable for 125-psi pressure differential.
7. Packing glands shall have 3-layers of fiber packing with a 4<sup>th</sup> elastomer seal.
8. Valves shall have a round port with a replaceable resilient seat interlocked by a metal retaining ring. The retaining ring shall act as a wiper blade to clean the gate before it passes over the seat. The resilient seat shall be captured and locked into place on three sides, only exposing one surface for sealing to prevent blowout.

D. Plug Valves:

1. Plug valves shall be non-lubricated eccentric type with flanged or MJ ends. Eccentric plug valves shall be not less than 100% port in all sizes and meet AWWA C517. Flanges to be faced and drilled ANSI 125 pound standard. Mechanical Joint valves shall fully comply with ANSI/AWWA C111/A21.11. Eccentric Plug Valves shall be as manufactured by DeZurik, Valmatic, or equal.
2. Eccentric plug valves to be provided with grease fittings in body.
3. Valve bodies of ASTM A126 Class B cast iron. Bodies in 4 inch and larger valves furnished with 1/8 inch welded overlay seat of not less than 90 percent pure nickel. Seat area to be raised, with raised surface completely covered with weld to insure that plug face contacts only nickel. Screwed-in seats not acceptable.
4. Plugs of ASTM A536 ductile iron. Plug to have cylindrical seating surface eccentrically offset from center of plug shaft. Interference between plug face and body seat, with plug in closed position, to be externally adjustable in field with valve in line under pressure. Plug resilient faced with soft rubber.
5. Valves to have sleeve type metal bearings of sintered, oil impregnated permanently lubricated type 316 Grade CF-8M or Type 317L stainless steel in ½ inch to 36 inch sizes. Non-metallic bearings not acceptable.
6. Valve shaft seals of multiple V-ring type, externally adjustable and repackable without removing bonnet or actuator from valve under pressure. Valves utilizing O-ring seals or non-adjustable packing not acceptable.
7. Valve pressure ratings to be 175 psi through 12 inch and 150 psi for 14 inch through 72 inch. Each valve given hydrostatic and seat test with test results being certified.
8. Interior of valves to be fluidized bed epoxy coated. Exterior of valves shall be manufacturer's standard finish.
9. Plug valves to be manual handwheel or gear actuated. Valves to open left unless otherwise indicated on drawings.

- E. Wastewater Combination Air Valves – Force Main:
1. Acceptable Manufacturer: A.R.I., or equal.
  2. The wastewater combination air valve (CAV) shall be specifically designed for use in wastewater applications and have a working pressure range from 2.9 to 145 psi. Its design shall prevent contact between the wastewater and the sealing mechanism at pressure up to its rated working pressure and shall ensure drip tight sealing when back pressure at the seal is 3 psi and higher. The spring guided rod and the bottom float assembly shall be able to move freely while the valve is closed, and perform without jamming or allowing air escape under vibrations or bottom float bouncing related to the turbulence from pump starts and stops and/or flow fluctuations.
  3. The CAV shall automatically discharge air and gas from a filling system, shall admit air into the system at drainage and at water column separation, and shall continuously release accumulated air and gas when the system is pressurized and operational.
  4. The stainless steel body, shall be conical in shape for assuring a larger air pocket while maintaining a relatively short profile, assuring a larger chamber for non-restrictive movement of the float, and providing an outward slanting wall to deter accumulation of grime and grease.
  5. All springs, washers, and stems shall be constructed of ASTM 316 stainless steel.
  6. All O-rings shall be made of BUNA-N with pressure ratings equivalent to the overall working pressure required for the CAV.
  7. The air release mechanism and seal shall be constructed of stainless steel.
  8. Combination air valves shall have a full-size 2" BSP inlet.
  9. The valve shall be no more than 18 inches high.
- F. Ball Valves – 2 Inches and Smaller:
1. 3-piece full port design or 2-piece standard port design all stainless steel construction. The valve must have an adjustable stem packing, reinforced PTFE seats, PTFE stem packing, PTFE thrust washer and PTFE body seal.
  2. Provide valves with threaded connections to CAV as specified above.
- G. Valve Boxes:
1. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that

the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the drawings shall be provided around the valve box, sloped outwards.

2. All valve boxes shall be 2-piece cast iron, sliding type, 5-1/4" shaft, with heavy duty traffic weight collar and the lid marked with the appropriate carrier product (i.e.: SEWER). Boxes shall be as manufactured by East Jordan Iron Works, Inc., Tyler / Union, Charlotte Pipe and Foundry Company, or equal.

#### 2.04 LOW PRESSURE SEWER VALVES AND APPURTENANCES

A. General: All valves and appurtenances shown or listed on the drawings shall be installed as shown or detailed, or as directed by Engineer, and shall be as specified herein.

1. Painting: All surfaces of each valve body assembly shall be clean, dry and free from grease before painting. All unmachined surfaces of the valve body assembly shall be wire brushed down to clean metal. Two coats of an asphalt varnish shall be applied in accordance with AWWA C500. Finished painting for interior work shall have the surface prepared and painted in accordance with manufacturers recommendations.
2. Spare Parts and Tools: Repair or service parts for one of each type and size of valve used in this work shall be furnished and stored as directed by the Engineer. The equipment shall include, in general, the following items: special tools required for maintenance, including seat replacement, or operation of valves, gaskets, rings, seals, lubricants, bolts, washers, and miscellaneous accessories required to maintain valves in proper operating service.
3. Flanges: All flanged valves shall be drilled and faced to the ASA 125 pound standard template, and in accordance with ANSA B16.1.

B. Ball Valves 2 Inches and Smaller:

1. Ball Valves shall be of PVC body with PVC ball, PVC stem, PTFE seat, full port design, and shall be supplied with true union. Valves shall be supplied with end connectors suitable for use in connecting PVC Pipe. Valves shall have a pressure rating of at least 200 psi.
2. Valves shall be as manufactured by Spears Manufacturing Company, or equal.

C. Curb Stop Valves:

1. Curb Stop Valves shall be of heavy cast bronze body construction with molded Buna-N rubber seat, EPDM O-ring seals and full port design. Valves shall be supplied with pack joints suitable for use in connecting to PVC pipe. Valves shall have a pressure rating of at least 200 psi. Each valve shall also be supplied with a roadway type curb box and stationary rod. Valves shall be as manufactured by Ford Meter Box Co., Inc., or equal.

D. Check Valves:

1. Check Valves shall be of bronze construction horizontal use and full port design. The valves shall be designed for a pressure rating of 200 psi and shall be of the swing check type. Valves shall be suitable for direct burial. Valves shall be as manufactured by American Valve, Nibco, or equal.

E. Curb Boxes:

1. All curb boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the CMU and locking curb boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the curb box, sloped outwards.
2. All curb boxes shall be cast iron, with stationary rod and the lid marked with the appropriate carrier product (i.e.: SEWER). Boxes shall be as manufactured by Ford Meter Box Co., Inc., East Jordan Iron Works, Inc., Tyler / Union, Charlotte Pipe and Foundry Company, or equal.

F. Low Pressure Cleanout Piping:

1. Polyvinyl Chloride (PVC) Schedule 80 Pipe, 1/2 Through 16 Inch Diameter: Provide pipe which is permanently marked with manufacturer's trademark, size and ASTM conformance designation. Pipe design and material requirements shall conform to ASTM D 1785 for Schedule 80 pipe. PVC material shall conform to ASTM 1784 requirements for Cell Classification 12454-B.
2. All polyvinyl chloride (PVC) Schedule 80 pipe and fittings shall utilize solvent weld joints assembled in accordance with the manufacturer's recommendations.

G. Valve Boxes:

1. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the CMU and valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Contract Drawings shall be provided around the valve box, sloped outwards.
2. All valve boxes shall be 2-piece cast iron, sliding type 5-1/4" shaft, with heavy duty traffic collar and the lid marked with the appropriate carrier product (i.e.: SEWER). Boxes shall be as manufactured by East Jordan Iron Works, Inc., Tyler / Union, Charlotte Pipe and Foundry Company, or equal.

H. Wastewater Combination Air Valves – Low Pressure Sewer:

1. Acceptable Manufacturer: A.R.I., or equal.
2. The wastewater combination air valve (CAV) shall be specifically designed for use in wastewater applications and have a working pressure range from 2.9 to 145 psi. Its design shall prevent contact between the wastewater and the sealing mechanism at pressure up to its rated working pressure and shall ensure drip tight sealing when back pressure at the seal is 3 psi and higher. The spring guided rod and the bottom float assembly shall be able to move freely while the valve is closed, and perform without jamming or allowing air escape under vibrations or bottom float bouncing related to the turbulence from pump starts and stops and/or flow fluctuations.
3. The CAV shall automatically discharge air and gas from a filling system, shall admit air into the system at drainage and at water column separation, and shall continuously release accumulated air and gas when the system is pressurized and operational.
4. The reinforced nylon body, shall be conical in shape for assuring a larger air pocket while maintaining a relatively short profile, assuring a larger chamber for non-restrictive movement of the float, and providing an outward slanting wall to deter accumulation of grime and grease.
5. All springs, washers, and stems shall be constructed of ASTM 316 stainless steel.
6. All O-rings shall be made of BUNA-N with pressure ratings equivalent to the overall working pressure required for the CAV.
7. The air release mechanism and seal shall be constructed of stainless steel.
8. Combination air valves shall have a full-size 2" BSP inlet.
9. The valve shall be no more than 18 inches high.
10. The valves shall not weigh more than 9 pounds.

2.05 DUCTILE IRON PIPE AND FITTINGS LINING

A. Condition of Ductile Iron Pipe Prior to Surface Preparation:

1. All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this Section is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

B. Lining Material

1. Pipes and fittings shall be lined with Protecto 401™ Ceramic Epoxy, or equal. The material shall be an amine cured novolac epoxy containing at least 20% by volume of ceramic quartz pigment.
  - a. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
  - b. The following test must be run on coupons from factory lined ductile iron pipe:
    - 1) ASTM B117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.
    - 2) ASTM G95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5 mm undercutting after 30 days.
    - 3) Immersion testing rated using ASTM D714-87.
      - 20% Sulfuric acid - No effect after two years.
      - 140°F 25% Sodium Hydroxide - No effect after two years.
      - 160°F Distilled Water—No effect after two years.
      - 120°F Tap Water (scribed panel)—0.0 undercutting after two years with no effect.
  - c. An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

C. Application

1. Applicator
  - a. The lining shall be applied by a certified firm with a successful history of applying linings to the interior of ductile iron pipe and fittings. All applicators must be independently inspected at least two times per year to insure compliance with the requirements of this specification. This inspection must be coordinated and reviewed by the manufacturer of the lining material and any deviation from the application and/or quality requirements shall be corrected by the applicator. All inspections shall be in writing and a permanent record maintained.
2. Surface Preparation
  - a. Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance that can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the

surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be re-blasted.

3. Lining

- a. After surface preparation and within 12 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness. No lining shall take place when the substrate or ambient temperature is below 40°F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

4. Coating of Bell Sockets and Spigot Ends

- a. Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401™ Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

5. Number of Coats

- a. The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely re-coatable with itself without roughening of the surface.

6. Touch-Up and Repair

- a. Protecto 401™ Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

D. Inspection and Certification

1. Inspection

- a. All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC PA-2 Film Thickness Rating.
- b. The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Any defects found shall be repaired prior to shipment.

- c. Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

2. Certification

- a. The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

- E. Handling

1. Lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling.
2. Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

## 2.06 PIPELINE DETECTION AND MARKING

- A. Pipeline detection tape:

1. Minimum 3 inches wide, green in color, imprinted with the words "CAUTION – SEWER LINE BELOW", and capable of being detected with inductive methods.
2. Install detection tape two (2) feet below final grade on main line and service laterals.

## 2.07 PIPING SPECIALTIES

- A. Flexible Type Pipe Transition Coupling:

1. Flexible type pipe transition couplings shall be provided where PVC pipe is to be connected to DIP pipe. Flexible type pipe transition couplings shall be constructed of an elastomeric compound meeting the requirements of ASTM C1173 and D5926 and manufactured by Fernco Inc., or equal.
2. Coupling shall be provided with a 316 stainless steel clamp band. 6" and larger couplings shall have two nut and bolt take-up points per band. Coupling shall have a .012" thick, 300 Series stainless steel shear ring. Length manufactured shall be according manufacturer based on coupling diameter. Width manufactured according to coupling width. Clamps shall be welded on to the shear ring in place.

- B. Solid Sleeve Type Pipe Coupling:
1. Solid sleeve type pipe couplings shall be used where PVC and non-PVC, such as VCP or cast iron piping is to be interconnected. Solid sleeve type pipe couplings shall also be used to transition from 6" to 4" diameter lateral piping. The couplings shall consist of a sleeve, gaskets, follower flanges, and the necessary hardware to complete the coupling.
  2. The sleeve shall be Ductile Iron meeting the requirements of ASTM-A536. Ends shall have a smooth inside taper for uniform gasket seating.
  3. Gaskets shall be standard, nitrile rubber of new material. The gaskets shall provide a permanent seal and be suitable for a temperature range of -20 deg F to 180 deg F.
  4. Follower flanges shall be Ductile Iron meeting ASTM-A536. The flanges shall be designed with a high strength/weight ratio. The flange thickness shall be as recommended by the manufacturer for coupler size. Bolts shall be stainless steel.
  5. The coupling shall be finished with a fusion bonded epoxy coating.
  6. Solid sleeve type pipe couplings shall be 441 Omni Cast Transition Couplings and R441 Reducing Couplings as manufactured by Smith-Blair, or Equal.
- C. Concrete Cradle, Encasement, and Anchors: 3000 PSI 28-day compressive strength as specified for Class A Concrete in PennDOT Publication 408, Section 704.

### **PART 3 – EXECUTION**

#### **3.01 EXAMINATION**

- A. Carefully examine each section of pipe and each pipe fitting before laying on conformance with the inspection requirements of the appropriate referenced standard.
- B. Remove rejected pipe from the project.

#### **3.02 PREPARATION**

- A. Clean piping interior and mating surfaces of bell, spigot and gasket before laying. Maintain clean until completed work is accepted.
- B. Perform trenching for sewer pipe and place pipe bedding as specified in Section 31 23 33 "Trenching and Backfilling for Utilities."
- C. Dig bell holes sufficiently large to permit proper joint making and to insure pipe is firmly bedded full length of its barrel.

3.03 LAYING PIPE

A. General Requirements for Open Cut Pipe Installation:

1. Lay pipe proceeding upgrade true to line and grades given. Lay bell and spigot pipe with bell end upgrade unless shown otherwise on the drawings or directed by the Engineer. Lay all pressure piping with the bell end toward pump discharge.
2. Contractor's attention is called to the fact that a portion of the construction involved in this project is being conducted at minimum allowable grade. The Contractor shall use care in setting lasers or the other means that he plans to utilize for construction of the sewers. If not constructed at the required grade, the Engineer shall have the option of directing the Contractor to relay the pipe to the required grade at no additional cost to the Owner.
3. Exercise care to insure that each length abuts against the next in such manner that no shoulder or unevenness of any kind occurs along inside bottom half of pipeline.
4. Center spigot end in bell or socket end of previously laid pipe, shove tight and secure.
5. No wedging or blocking permitted in laying pipe unless by written order of Engineer.
6. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Do not bring succeeding pipe into position until the preceding length is embedded and securely in place.
7. Walking or working on completed pipe line, except as necessary in tamping and backfilling, not permitted until trench is backfilled one-foot deep over top of pipes.
8. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints after laying.
9. Take up and replace with new, such in-place pipe sections found to be defective. Replace at Contractor's expense.
10. Take necessary precautions to prevent newly laid pipe from floating as a result of water accumulation in the trench; or the collapse of the pipe line from any cause. Restore or replace pipe as necessary at Contractor's expense.
11. Bed pipe using materials specified in Section 31 23 33 "Trenching and Backfilling for Utilities."
12. At the close of each day's work, and at such other times when pipe is not being laid, protect open end of pipe with a close fitting stopper.

13. Cut pipe using only equipment specifically designed for that purpose such as an abrasive wheel, rotary wheel cutter, a guillotine pipe saw or a milling wheel saw. The use of chisels or hand saws will not be permitted. Grind smooth cut ends and rough edges. Bevel slightly, cut end for push-on connections.
14. Where cutting of pipe is necessary, minimum laying length shall be five (5) feet.

B. Specific Requirements:

1. Install plastic pipe and fittings, and assemble joints according to ASTM D2321 for Class 1 bedding material.
2. Ductile Iron Pipe and Fittings – Install per AWWA 600. Pipe cutting, where necessary to field cut pipe use an approved pipe cutter, milling cutter or abrasive wheel. Pipe sections must have a minimum laying length of five (5) feet.
3. Refer to Section 31 23 33 – Trenching and Backfilling for Utilities, for backfilling requirements.
4. Pipeline detectable tape shall be installed continuously along all gravity and low pressure sewer lines. The tape shall be installed directly above each pipeline and two (2) feet from the ground surface. Tracer wire shall be installed continuously along all force main sewer lines.
5. Service Connection Fittings:
  - a. Make connections to sewer using fittings of same material and joint configuration as the sewer at the planned point of branch connection.
  - b. Use commercially manufactured wye fittings and one-eighth bends.
  - c. Set wye branches at proper vertical angles as required to bring service connections to the proper depth.
  - d. Fitting locations shall be determined in the field by the Engineer.

C. Joints:

1. Make pipe and fittings joints according to pipe manufacturer's specifications and to specifications previously specified for pipe.
2. Make joints watertight. Immediately repair detected leaks and defects. Methods of repair subject to Engineer's approval.

D. Alignment and Grade:

1. Lay and maintain all pipe at the required lines and grades as shown on the Contract Drawings. Place fittings and valves at the required locations with joints centered, spigots forced home, and all valve stems plumb. Do not deviate from the required line and grade, except with the approval of the Engineer.

2. Deflect pipe joints where indicated on the drawings. Deflections shall not exceed pipe manufacturer's recommended maximum allowable deflection.
3. Do not change grade or alignment without Engineer's approval.

E. Drop Connections:

1. Make drop connections where indicated on the Drawings, where drop in invert is two feet or more or as required by the Engineer. Construct drop connection in accordance with design shown on the Detail Drawing.

3.04 BORING AND JACKING

- A. Refer to Section 33 05 24 – Utility Pipe Boring and Jacking, for trenchless installation of pipe.

3.05 THRUST RESTRAINTS

- A. Temporary Thrust Restraint: Provide temporary thrust restraint at temporary caps or plugs. Submit details of temporary restraint to the Engineer for review.
- B. Permanent Thrust Restraint: Provide as previously specified.

3.06 FIELD QUALITY CONTROL

A. General Requirements:

1. Conduct tests specified herein so that each pipe line installed in the project is tested to the Authority's/Engineer's satisfaction.
  - a. Sanitary sewers installed in Township roadway to property line is tested by the Authority.
  - b. Sanitary sewers installed between building and proper line is tested by SEDA-COG, County Codes Inspector.

1. Provide tools, materials (including water), apparatus and instruments necessary for pipe line testing.
2. Conduct tests in the presence of and to the satisfaction of the Engineer.

- B. Alignment: After the gravity mains have been laid and backfilled, a light will be flashed between manholes or manhole locations to determine whether the alignment of the sewer is true and whether any pipe has been displaced, broken or otherwise damaged subsequent to laying. This test will again be conducted before final acceptance of the sewer.

1. Horizontal Alignment: Each section (manhole to manhole) of sewer shall show no less than a three-quarter (3/4) light circle throughout its length and any and all

defects shall be corrected by the Contractor, to the satisfaction of the Engineer, before the work shall proceed and before acceptance of and/or payment shall be made.

2. Vertical Alignment: No vertical displacement or misalignment will be accepted. The Contractor, to the satisfaction of the Engineer, shall correct all defects before the work shall proceed and before acceptance of and/or payment shall be made.

C. Initial Section Test:

To demonstrate acceptability of installed pipe materials and workmanship, construct and air test one sewer section from manhole to manhole using the pipe provided in the Contract. Pre-testing such section prior to actual Initial Section Test not permitted.

1. Conduct Initial Section Test in same manner as Line Acceptance Test specified in a following paragraph.
2. Conduct said Initial Section Test for each size and type pipe material used in the Project prior to continued installation of same pipe.
3. Provide pipe manufacturer's representation during laying, backfilling and testing of Initial Sections Tests.
4. Failure of an Initial Section Test will be sufficient cause for the Engineer to reject manufacturer and supplier of pipe regardless of cause of failure.
5. Sewer sections successfully tested as Initial Section Test will be retested under Line Acceptance Test.
6. Include costs for above stated tests in unit or lump sum price or prices bid for the Work as no separate payment will be allowed for Initial Section Test.

D. Line Acceptance Test for Gravity Lines: (Leakage tests)

1. After a section of sewer is constructed between adjacent manholes, backfilled and successfully cleaned, perform a low pressure air Line Acceptance Test in accordance with ASTM C828 and the following:
  - a. Seal and brace sewer piping at upstream and downstream manholes and at all laterals. Test plug seal before actual use by testing plugs outside the trench in one length of pipe pressurized to maximum anticipated testing pressure. Plugs shall hold without bracing and show no movement. After plug is placed in pipe and sealed, brace or protect as insurance against blow out. Protect workers from potential of plug blow out.
  - b. Introduce low pressure air slowly into sealed sewer section until the internal air pressure is four psig greater than the average ground water pressure acting on the pipe, but in no case higher than 10 psig.

- c. To determine the internal air pressure for the test, add 3.5 psig to the height in feet of the ground water above the invert of the pipe divided by 2.3. However, the test pressure should not exceed 10 psig.
  - 1) For example, if ground water height is 6.9':  $3.5 + (6.9/2.3) = 6.5$  psig.
- d. Allow no less than 3 minutes for air temperature and pressure to stabilize. Add air only to maintain required test pressure.
- e. After the stabilization period, adjust the test pressure to the required test pressure, and disconnect the air supply. Then measure the time that is required to achieve a 1.0 psig pressure drop.
- f. The line passes if the time required for a 1-psig pressure drop exceeds the value listed in Table 1 included at the end of this Section. Interpolate values for intermediate distances from those shown. If the time for 1 psig pressure loss is less than that reported in the table, then the line fails and shall be repaired prior to re-test.
- g. For conditions not reflected in the Table, utilize the following equation:

$$T=0.085 * (D^K) / Q$$

Where: T=shortest time, in seconds, allowed for the air pressure to drop 1.0 psig.  
K=0.000419D\*L, but not less than 1.0  
Q=0.0015 cubic feet/minute/square feet of internal surface  
D=nominal pipe diameter in inches  
L=Length of pipe being tested in feet

- 2. After laterals are installed, re-test line in accordance with the above procedure if line is initially tested before the installation of laterals.
- 3. Where lines are live and carry flow, perform Joint Acceptance Test by testing one joint at a time as described in paragraph E, below.

E. Joint Acceptance Test for Gravity Lines (Leakage Tests)

- 1. Joint Testing Equipment Control Test: A two-part control test shall be performed to insure the accuracy, integrity, and performance capabilities of the testing equipment; testing as follows:
  - a. Demonstration Test: Prior to starting the air testing work, perform a demonstration test in the presence of the Engineer using a test cylinder, furnished by the Contractor, constructed so that a leak can be simulated. The demonstration test shall use the procedures specified in this Section.
    - 1) The purpose of the demonstration test is to establish that the air testing system is capable of meeting the specified test criteria.

- 2) If this test cannot be performed successfully, the Contractor shall repair or otherwise modify his equipment and repeat the test until the results are satisfactory to the Engineer.
  - 3) The Engineer may require that this test be repeated at any time during the joint testing work when, in the Engineer's opinion, the testing results are suspect.
- b. Readiness Test: Prior to commencing joint testing in each section of sewer main piping, perform a readiness test in the presence of the Engineer. Position the air testing packer on a section of sound sewer pipe between pipe joints and perform a test as specified in Paragraph 3.03 of this Section.
- 1) The purpose of the test is to check that the piping is properly cleaned for air testing and the air testing equipment system is operating in accordance with the requirements of the Specifications.
  - 2) If this test cannot be performed successfully, the Contractor shall remove the air testing packer from the sewer section and repair or otherwise modify his equipment and repeat the test until the results are satisfactory to the Engineer.
2. Air Testing Equipment: Provide a complete air testing system specifically designed and constructed for internal air pressure tightness integrity testing of sewer piping joints. The equipment shall be constructed in such a way as to provide means for introducing air, under pressure, into the void area created by the expanded ends of the joint-testing packer and a means for continuously measuring the actual static pressure of the air within the void area only. The system shall include, but not be limited to, the following items and features:
- a. Closed Circuit Television System per requirements of Section 33 01 31.
  - b. Packer: Open end, cylindrical casing of a size less than the pipe diameter, remote controlled for forward and backward movement within the sewer mains.
    - 1) Air-inflatable sleeves (or diaphragms) mounted at each end of the casing exterior with the ends of sleeves fastened to the casing. Devices that have sleeves which may require extreme pressures to "seat" against the inside periphery of the sewer main pipe are not permitted.
    - 2) Regulate expansion of air-inflatable sleeves by precise pressure gauges and controls. Under no conditions will hydraulically or mechanically expanded devices be allowed.
    - 3) Pass conduits leading from the surface through one end of the packer casing adapted to supply air, under pressure, to the space at the center of the casing.

- c. Compressed Air System: compressed air system shall include compressed air source, piping, valves and pressure gauges to control the rate of air flow to the packer sleeves and test section.
  - 1) To prevent loading the test section with the full pressure of the compressor, the test equipment shall be provided with an approved pressure regulating device.
- d. Test Monitoring Equipment: Provide test monitoring equipment to transmit the value of the void air pressure to a remote test pressure monitoring gauge or readout.
  - 1) Test pressure monitoring gauge or readout shall be located to allow for simultaneous and continuous observation of the television monitor and test monitoring equipment by the Engineer.
- 3. Use internal televising to observe each joint and fault and to accurately position air testing equipment in sewer piping. Televising conducted in conjunction with air testing will be considered a part of the work of air testing.
- 4. The air testing packer end elements shall be expanded so as to isolate the joint from the remainder of the line and create a void area between the packer end elements and the pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient inflation pressure to contain the air within the void without leakage past the expanded ends.
- 5. Contractor shall then introduce pressurized air into the isolated void created by testing device. Pressure shall be applied until it is determined that the pressure cannot be built in the void or until the test pressure of  $\frac{1}{2}$  psi per foot of depth plus four (4) psi to a maximum of 10 psi is reached as recorded by the void pressure monitor. When either of these conditions is reached, Contractor shall shut off the air supply.
- 6. If the required pressure cannot be developed, joint shall have failed the test. If the required test pressure in the void was increased to  $\frac{1}{2}$  psi per foot of depth plus four (4) psi, rate of decay of this pressure shall not exceed one (1) psi in 30 seconds. The joint being tested will also have failed if the pressure drops more than one (1) psi in 30 seconds. The line shall then be repaired prior to the retest.
- 7. Test Records:
  - a. During joint acceptance testing, records shall be kept which include identification of the sewer section tested, test pressure used, location (footage) of each joint tested, a statement indicating test results (passed or failed) for each joint tested, test pressure achieved and maintained for each joint passing air test, weekly equipment pressure test results, sewer section barrel test results, and air temperature at time of testing joints.

F. Hydrostatic Testing for Pressure Lines (Force Main and Low Pressure Sewers):

1. Leakage Test Requirements

- a. After the pipe has been installed as specified, all newly laid pipe, or any valved section thereof, shall be subjected to a pressure of 150 pounds per square inch, or 50% in excess of the normal working pressure. Engineer will provide working pressures.
- b. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
- c. All piping inside chambers, valve pits, etc. shall show no leakage.
- d. Leakage in PVC and DIP pipelines shall be acceptable when the leakage is less than the number of gallons per hour as determined by the formula,

$$L = \frac{ND \times P^{1/2}}{7400}$$

in which "L" equals the allowable leakage in gallons per hour; "N" is the number of joints in the length of pipelines tested; "D" is the nominal diameter of the pipe, in inches, and "P" is the average test pressure during the leakage test, in pounds per square inch gauge. (the allowable leakage according to the formula is equivalent to 11.6 gallons per 24 hours per mile of pipe per inch nominal diameter, for pipe in 18' lengths evaluated on a pressure basis of 150 psi.).

- e. Duration of Test: The duration of the test under pressure shall be two hours.
- f. Procedure: Each valved section shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to Engineer. The pump, pipe connections, and all necessary apparatus, including gauges, shall be furnished by Contractor and approved by Engineer. Contractor will make all taps into the pipe, and furnish all necessary assistance for conducting the tests.
- g. Expelling Air Before Test: Before applying the specified test pressure, all air shall be expelled from the pipe. If hydrants or blowoffs are not available at high places, Contractor shall make the necessary taps at points of highest elevation before the test is made and insert the plugs after the test has been completed.

- h. Should any test of pipe laid disclose leakage greater than that specified above, Contractor shall, locate, repair and replace the defective joints, pipe or fittings until the leakage is within the specified allowance.

G. Time for Making Test:

- 1. Where any section of a main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction backing was installed. If high early strength cement is used in the concrete reaction backing, the hydrostatic pressure test shall not be made until at least two days have elapsed.
- 2. Engineer shall be present during the operating of valves required to fill mains for pressure and leakage test.
- 3. Contractor shall advise Authority/Engineer of any pressure test and leakage test at least 72 hours in advance. No testing will be authorized unless ambient air temperature is 35 $\pm$  F or higher.
- 4. The pressure and leakage tests shall be witnessed by Engineer.
- 5. Contractor shall furnish laboratory calibrated test gauges and measuring devices for the leakage test.
- 6. The section under test shall be brought back to test pressure at one-half hour intervals during the testing. Engineer will record both the makeup water amount and pressure at each one-half hour re-pressurization.

H. Alignment Test for Pressure Lines:

- 1. Prior to backfilling of pressure lines, the joint alignment shall be inspected to assure the maximum deflection present in each joint does not exceed the manufacturer's recommendations.
- 2. Pressure lines that are a portion of a pump discharge system shall be inspected to assure the line is installed at a constant or increasing grade so as to eliminate the possibility for air accumulation at an intermediate high point.
- 3. Contractor shall correct any and all defects to the satisfaction of Engineer prior to backfilling. This shall be completed before the work shall proceed and before acceptance of and/or payment shall be made.

I. Gravity Sewer Deflection Test

- 1. Test all gravity sewer main installed not less than 30 days following backfill.
- 2. Mandrel shall be cylindrical in shape, 95 percent of nominal pipe diameter and 4' long. Mandrel diameter achieved with no less than 8" arms evenly spaced at each end and in the middle of the mandrel.

3. Pull mandrel through pipe section manually. Powered pulling devices are not permitted.
  4. Pipe fails test if mandrel cannot be pulled through pipe. Note location of failure, excavate, replace pipe section that failed, and re-test.
- J. Acceptance: Observation of successful testing of manholes, gravity sewers, force mains, or low pressure piping by the Engineer does not constitute acceptance of the system or any portion thereof. Upon completion of any determined portion of a total system, and successful testing thereof, the Engineer may recommend final acceptance to the Authority. Only upon final inspection by the Authority or Engineer, and upon written acceptance for same, will the system or portion thereof be considered substantially completed. Upon such acceptance, the warranty period as specified for the manholes, sewers or force main will commence in accordance with the Authority's standards.
1. If, during this final inspection, any irregularities are observed, the condition must be corrected at the Contractor's expense prior to acceptance.

TABLE 1

**MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP  
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015**

1 Pipe Diameter (in.)	2 Minimum Time (min: sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	SPECIFICATION TIME FOR LENGTH (L) SHOWN (MIN:SEC)								
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.	
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24	
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31	
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33	
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48	
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15	
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53	
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46	

END OF SECTION