

SECTION 02709

GRAVITY PIPELINES AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish, install and test pipelines and appurtenances to gravity pipeline systems
- B. Additional Requirements Specified Elsewhere
 - 1. Section 01340: Shop Drawings, Product Data, and Samples
 - 2. Section 01400: Quality Control
 - 3. Section 01600: Material and Equipment
- C. Related Requirements Specified Elsewhere
 - 1. Section 02200: Earthwork
 - 2. Section 02612: Reinforced Concrete Pipe
 - 3. Section 02615: Ductile Iron Pipe
 - 4. Section 02617: Steel Pipe
 - 5. Section 02622: Plastic Pipe
 - 6. Section 02641: Valves and Accessories
 - 7. Section 02708: Pressure Pipelines and Appurtenances
 - 8. Section 03300: Cast-in-Place Concrete
 - 9. Section 07900: Joint Sealants

1.2 QUALITY ASSURANCE

- A. Allowable Tolerances
 - 1. Horizontal alignment: $\pm 0.5'$
 - 2. Maintain invert elevations at structures as indicated on the Drawings and uniformly grade between structures
- B. Manhole Depth
 - 1. Distance measured from invert of lowest pipe to top of ring and cover

1.3 SUBMITTALS

- A. Shop drawing and product data in accordance with Section 01340
 - 1. Material specification data
 - 2. General piping layout and laying schedule including all appurtenances
 - 3. Installation instructions
- B. Test reports: Reports of field tests

C. Certification of Compliance

1. Manufacturer's affidavit of compliance certifying
 - a. All materials comply with applicable standards
 - b. All materials comply with these Specifications

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Carefully handle, store and protect all pipe, fittings, valves and appurtenances to protect materials and protective coatings and linings
- B. Remove any damaged or defective materials from the construction site and replace at no additional expense to the Owner
- C. Under no circumstances shall materials be dumped or dropped into the trench

1.5 JOB CONDITIONS

A. Protection

1. Prevent foreign materials from entering pipe, fittings and appurtenances during installation
 - a. Do not place debris, tools, clothing or other materials in pipe
2. Coordinate material delivery closely with installation
3. Whenever pipe installation is stopped, seal open end of pipe with watertight plug to prevent trench water, debris or other material from entering the pipe
 - a. Take adequate measures to prevent flotation

B. Unsuitable Conditions

1. No pipe shall be installed when, in the opinion of the Engineer, trench or weather conditions are unsuitable

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe and Fittings

1. Reinforced concrete pipe: Refer to Section 02612
2. Ductile iron pipe: Refer to Section 02615
3. Steel pipe: Refer to Section 02617
4. Plastic pipe: Section 02622

B. Manholes

1. Bases: 3,000 psi compressive strength as specified in Section 03300 - Cast-in-Place Concrete
 - a. Precast base materials and manufacturing conforming to ASTM C478
2. Risers, cones and tops
 - a. Material: Precast concrete as specified in ASTM C478
 - b. Conformance: ASTM C478
 - c. Joints: Flexible plastic gaskets

3. Ring and cover
 - a. Material
 - 1) Fiber reinforced vinylester
 - b. Conformance: Composite, non-metallic
 - c. Cover pattern: Non-slip surface with "LF Sewer" cast in top
 - d. Bearing surface: Machined to ensure good seating between the ring and cover
 - e. Size
 - 1) Cover: 24" nominal diameter
 - 2) Ring: 4" minimum height and 22" minimum diameter clear opening
 - f. Color: Sewer green
 - g. Refer to Drawings for special manway covers
4. Steps
 - a. No steps are to be furnished and installed or unless shown on Drawings for special installations
5. Cement mortar
 - a. Conformance: ASTM C270, Type M
6. Gaskets
 - a. Type: Preformed flexible plastic
 - b. Conformance: Fed. Spec. SS-S-00210 (GSA-FSS)
 - c. Classification: Type 1 - Rope Form
 - d. Diameter
 - 1) 1½" for all manholes
7. Pipe penetration waterstop
 - a. Pipe penetration waterstop is required for all material type gravity flow piping entering and exiting a cast-in-place manhole or manhole base, except for concrete pipe
 - b. Bell gasket of same type as for pipe entering manhole such that when placed on the outside of the pipe a water tight seal will be formed when encased in concrete
 - c. Kor-N-Seal boot as manufactured by Dukor, to be used only when a smooth circular knockout is cast or cored in the concrete
 - d. Equivalent products for pipe penetration waterstop will be considered for use by the Engineer in accordance with the provisions of Specification Section 01340 as applicable
8. External manhole joint dampproofing and waterproofing
 - a. External concrete joint wrap
 - b. Elastomeric protective film wrap
 - c. 12-inch wide strip centered on all manhole joints
 - d. Design basis: Henry Company Sealants Division, "RUB'R NECK External Concrete Joint Wrap" or approved equivalent
9. Protective lining material
 - a. Application
 - 1) Manholes downstream of the disinfection facility require no protective lining material
 - 2) Manholes upstream of the disinfection facility require a protective lining material
 - b. PVC cast-in-place membrane lining system
 - 1) Application: All wastewater manhole barrel and cone or flat top sections

- 2) Composed of thermoplastic polyvinyl chloride resins
 - 3) Permanently flexible
 - 4) Suitable for sewage applications
 - a) Suitable for continuous exposure to hydrogen sulfide gas and resulting low pH moisture and saturation conditions
 - 5) Minimum elongation: 200%, ASTM D412
 - 6) Shore Durometer D: Not less than 50, ASTM D2240
 - 7) Liner sheets a minimum of 0.065" thickness
 - 8) Locked physically into structure on 2½" centers by casting plastic cover
 - 9) Design basis: Ameron "T-Lock Amer-Plate" or equivalent
- c. Epoxy coating system
- 1) Application: To be utilized on all manhole base decks and inverts after completion of PVC membrane lining system upstream of the disinfection facility
 - 2) Solventless, two-component, 100% solids epoxy resin
 - 3) Thixotropic in nature
 - 4) Filled with select fillers to minimize permeability and provide sag resistance up to 200 mils in a single coat
 - 5) Product type: Amine cured epoxy
 - 6) Color: Manufacturer's standard
 - 7) Mix ratio: Manufacturer's recommendation
 - 8) Compressive strength, psi: 12,870 per ASTM D695
 - 9) Tensile strength, psi: 6,640 per ASTM D638
 - 10) Tensile elongation, %: 1.53 per ASTM D630
 - 11) Hardness, shore D: 80 per ASTM 80
 - 12) Bond strength-concrete: Greater than tensile strength of concrete
 - 13) Chemical resistance to
 - a) Sulfuric acid, 10%: Immersion service
 - b) Sodium hydroxide, 20%: Immersion service
 - c) MEK: Incidental contact
 - 14) Thickness: 120 to 150 mils WFT
 - 15) Design basis
 - a) Raven Lining Systems, Inc. "Raven 405"
 - b) Or equal
10. Manhole adjusting rings
- a. Injection molded, high density polyethylene (HDPE) rings
 - b. Conformance: ASTM D4976
 - c. Sealant between rings: Butyl sealant
 - 1) Refer to Section 07900
 - d. Design basis: LADTECH, Inc. or approved equal

C. Concrete

1. Concrete encasement: Minimum 3,000 psi compressive strength at 28 days
2. Refer to Section 03300 - Cast-in-Place Concrete

D. Valves and Accessories

1. Refer to Section 02641 - Valves and Accessories for product requirements

E. Valve Boxes

1. Refer to Section 02708

PART 3 - EXECUTION

3.1 PREPARATION

A. Verification

1. Verify dimensions and class of proposed pipe, valves, fittings and equipment prior to installation to ensure the piping system will fit together properly

B. Cleaning and Inspection

1. All pipe, fittings, valves and appurtenances shall be thoroughly cleaned of all foreign material and inspected for cracks, flaws or other defects prior to installation
2. Keep clean until work is accepted
3. Keep joint contact surfaces clean until joint is completed
4. Mark defective, damaged or unsound materials with bright marking crayons or paint and remove from jobsite

C. Site Preparation and Excavation

1. Refer to Section 02200 - Earthwork for requirements

3.2 INSTALLATION

A. Pipe Laying

1. Begin pipe laying at the lowest end and install pipe with the spigot ends pointing in the direction of flow unless otherwise authorized by Engineer
2. Lay all pipe straight between changes in alignment and at uniform grade between changes in grade or slope
3. As each length of pipe is placed in the trench, the joint shall be completed in accordance with the applicable portions of the pipe material specifications and the pipe brought to the correct line and grade.
4. Secure pipe in place with the specified embedment material placed and tamped under and around the pipe
5. Do not walk on small diameter pipe or otherwise disturb any conduit after jointing has been completed
6. Do not lay pipe
 - a. In water
 - b. Under unsuitable weather conditions
 - c. Under unsuitable trench conditions
7. Pipe laid true to line and grade and joined in such a manner that the offset of the inside of the pipe at any joint is held to a minimum at the invert
 - a. Maximum offset at the invert shall be the smaller of 0.8% of the inside diameter of the pipe or 1/4"

B. Water Line Crossings

1. Where sewer pipe crosses above potable water piping or less than 18" clear distance vertically below the potable water piping, provide special pipe material and/or treatment
2. Construct crossing by installing one full length (18' minimum) of ductile iron or PVC AWWA C900 pipe centered on the intersection with the potable water piping
 - a. Use approved adapters for joints
 - b. Other AWWA standard water main material may be used subject to review by Engineer
3. Provide suitable backfill or other structural support or protection to preclude settling and/or failure of the higher pipe

3.3 INSTALLATION OF PIPELINE APPURTENANCES

A. General

1. Install all valves, manholes and appurtenances at locations indicated on the Drawings or as otherwise designated by the Engineer to accommodate field conditions
2. Record "as-built" measurements prior to backfill to reference all appurtenances to the nearest permanent surface improvements

B. Installation of Valves

1. Install valves in the pipeline in the same manner specified for laying and jointing the pipe
2. Install in accordance with details on Drawings

C. Installation of Valve Boxes

1. Install valve boxes on all buried valves except where specified otherwise
1. Install such that no stress is transmitted from valve box to the valve
2. Set boxes plumb and directly over valve
3. Place top of box flush with finished grade
 - a. 6" below finished grade in gravel surfaced roadways
4. Backfill and compact around each box
5. Provide extended stems on valves where required such that the operating nut is not lower than 4' below finished grade

D. Construction of Manholes

1. Base
 - a. Set stubs and mains before concrete is placed and recheck for alignment and grade before concrete has set
 - b. Where grade and alignment permit, lay pipe continuously through manholes and split the pipe after construction of the base

- c. Where grade and alignment do not permit, terminate pipe flush with interior manhole wall and construct transitions smooth and of proper radius for uninterrupted flow
 - d. Install pipe penetration waterstop
 - 1) For bell type gasket, lubricate gasket and position in the center of the concrete wall
 - 2) For Kor-N-Seal, form smooth circular knockout of appropriate size, after placing concrete, install boot per manufacturer's recommendations and grout inner annulus with non-shrink grout
 - e. Shape base with wood float and finish with steel trowel
 - f. Allow base to set a minimum of 24 hours before continuing construction
2. Risers
- a. Set each manhole section plumb and neatly point inside of joints
 - b. Use sections of various heights to bring ring and cover to established elevation
 - c. Fill all lifting holes and other imperfections in the interior manhole wall with cement mortar
 - d. Join manhole sections with preformed flexible plastic gaskets or grout
 - e. Install gaskets in accordance with manufacturer's recommendation and in such a manner that all surfaces are clean, dry and warm
 - f. Where mortar joints are used, set each section in a bed of mortar with a minimum thickness of 1"
3. Rings and covers
- a. Install cover rings on a minimum of one and a maximum of three 2" thick adjusting rings above the top or cone of the manhole
 - b. Set cover rings by sealing between each ring with butyl sealant or Sikaflex-1a
 - c. Install per manufacturer's recommendations
 - d. Anchoring to manhole cone
 - 1) Drill anchoring hole through manhole ring, adjustment rings and minimum 6" into manhole cone section to accommodate ½" stainless steel threaded carriage bolt, 4 anchor bolts/manhole
 - 2) Inject Hilti HIT-RE 500 epoxy adhesive into anchoring hole
 - 3) Insert ½" stainless steel threaded carriage bolt so head of bolt is flush/tight to manhole ring
 - e. Set top of ring
 - 1) ¼" below finished grade in paved roadways
 - 2) 3" above grade in all other areas
4. External concrete joint wrap
- a. Apply to clean, dry surface
 - b. Install in accordance with manufacturer's recommendations
5. Refer to details on Drawings for additional requirements

E. Installation of Flexible PVC Sheet Liner for Corrosion Control

- 1. General
 - a. Installation of the lining, including preheating of sheets in cold weather and the welding of all joints, shall be done in accordance with the recommendations of the lining manufacturer

- b. All interior surfaces of precast concrete manhole sections shall be lined including top or cover section
 - c. The lining shall be installed with the locking extensions running parallel with the longitudinal axis of the manhole section. Locking extensions shall terminate not more than 1½" from the end of the inside surface of the pipe section. Joint flaps when used shall extend approximately 4" beyond the end of the inside surface
 - d. The lining shall be snugly in place against inner forms and the concrete placed against lining vibrated, spaded or compacted in a careful manner so as to protect the lining and produce a dense, homogenous concrete, securing anchoring the locking extension into the concrete
 - e. Protect the lining from damage when removing forms and handling manhole sections. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the lining shall be pulled, without tearing the lining, and the resulting holes clearly marked
 - f. All nail and tie holes and all cut, torn and seriously abraded areas in the lining shall be patched. Patches made entirely with welding strip shall be fused on the liner over the entire patch area. All edges must be covered with welding strip fused to the patch and the sound lining adjoining the damaged area
 - g. Hot compounds shall not be poured or applied to the lining
 - h. The Contractor shall take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the work
2. Application to concrete pipe manhole sections
- a. The lining shall be set flush with the inner edge of the bell or spigot end of a manhole section and shall extend to the opposite end or to approximately 4" beyond the opposite end depending upon the type of lining joint to be made with the adjoining concrete section
 - b. Lined concrete manhole sections may be cured by standard curing methods
 - c. Care shall be exercised in handling, transporting and placing lined sections to prevent damage to the lining. No interior hooks or slings shall be used in lifting the sections. All handling operations shall be done with an exterior sling or with a suitable forklift
 - d. The liner sheet shall be placed around the entire circumference of each section. The longitudinal edges of the sheet shall be butt welded
 - e. No manhole section with damaged lining will be accepted until the damage has been repaired to the satisfaction of the Engineer and Owner
 - f. All surfaces in the manhole cone or flat top which may be exposed to corrosive conditions shall be constructed with the specified PVC lining. Extend the lining to the top extension surface of the manhole top to seal against the grade adjusting rings
3. Field joints in lining
- a. The joint between sections of lined pipe shall be prepared for installation of a joint cover strip of liner material after the sections have been set in place with the specified sealant between sections. Fill and carefully point the inside joint with cement mortar in such a manner that the mortar shall not, at any point, extend beyond the straight line connecting the surfaces of the

- adjacent manhole sections. Section joints must be dry before lining joints are made
- b. All mortar and other foreign material shall be removed from lining surfaces adjacent to the joint, leaving the surface clean and dry
 - c. Field joints in the lining at section joints may be either of the following described types
 - 1) Type P-1: The joint shall be made with a separate 4" joint strip and 2 welding strips. The 4" joint strip shall be centered over the joint, heat-sealed to the lining, then welded along each edge to adjacent liner sheets with a 1" weld strip. The 4" joint strip shall lap over each sheet a minimum of ½"
 - 2) Type P-2: The joint shall be made with a joint flap with locking extensions removed and extending approximately 4" beyond the pipe end. The joint flap shall overlap the lining in the adjacent pipe section a minimum ½" and be heat-sealed in place prior to welding. The field joint shall be completed by welding the flap to the lining of the adjacent pipe section using 1" welding strip. The upper manhole section lining shall extend and overlap the lower manhole section
 - 3) Care shall be to protect the flap from damage. Excessive tension and distortion in bending back the flap to expose the manhole section during installation and joint mortaring shall be avoided. At temperatures below 50°F, heating of the liner may be required to avoid damage
 - d. All welding of joints is to be in strict conformance with the specifications and instructions of the lining manufacturer
 - 1) Welding shall fuse both sheets and weld strip together to provide continuous joint equal in corrosion resistance and impermeability to the liner
 - 2) Hot-air welding tools shall provide effluent air to the sheets to be joined at a temperature between 500° and 600°F. Welding tools shall be held approximately ½" from and moved back and forth over the junction of the two materials to be joined. The welding tool shall be moved slowly enough as the weld progresses to cause a small bead of molten material to be visible along both edges and in front of the weld strip

F. Application of Protective Lining on Manhole Base Decks and Inverts

1. All standard Portland cement and/or new concrete to be well cured prior to application of protective coatings
 - a. Minimum 28-day cure time for standard Portland cement concrete
 - b. If quick setting, high strength cements are utilized, provide documentation from manufacturer relative to required cure time and curing conditions
 - c. Conduct Elcometer pull tests to verify suitability of concrete for coating application in accordance with the coating system manufacturer's recommendations
2. Surface preparation
 - a. Applicator is to inspect all surfaces specified to receive protective coatings prior to surface preparation

- 1) Notify Engineer of any disparity in the surfaces which may interfere with proper surface preparation or application of repair materials and/or protective coatings
 - b. All contaminants including oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed
 - c. All surfaces to be repaired and/or rebuilt to provide a thickness equal to that of new construction
 - d. Surfaces to receive protective coatings to be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and substrate
 - 1) Generally, this can be achieved with high pressure water cleaning using equipment capable of 5,000 psi at 4 gpm
 - 2) Other methods such as high pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shotblasting, grinding, scarifying or acid etching may also be used
 - 3) Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete
 - 4) Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound clean neutralized surface that is not excessively damaged
 - e. A mild chlorine solution may be used to neutralize the surface to diminish microbiological bacteria growth prior to final rinse and coating
 - f. Test prepared surfaces after cleaning but prior to application of the protective coating to determine if a specific pH or moisture content of the concrete is required according to manufacturer's recommendations
 - g. The area between the manhole and the manhole ring and any other area that might exhibit movement or cracking due to expansion and contraction, shall be grouted with a flexible or elastomeric grout or gel
3. Application of protective coating
- a. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment
 - b. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order
 - c. The protective coating must be spray applied by a Certified Applicator of the protective coating manufacturer
 - d. Specified surfaces shall be coated by spray application of a moisture-tolerant, solventless, 100% solids, self-priming epoxy protective coating specified. Spray application will be allowed to minimum and average wet film thicknesses of 120 and 150 mils respectively
 - e. Airless spray application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating to avoid any potential contamination from compressed air oil which may encourage inter-coat delamination
 - f. Apply protective coating to all surfaces of the manhole deck and invert
 - g. The protective coating should overlap the PVC cast-in-place membrane lining a minimum of 4"

4. Testing and inspection
 - a. During application a wet film thickness gage meeting ASTM D4414, Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness
 - b. After the protective coating has set hard to the touch, it shall be inspected with high-voltage holiday detection equipment. An induced holiday shall be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hard tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations
 - c. Measurement of bond strength of the protective coating to the substrate shall be measured in accordance with ASTM D4541. Any areas detected to have inadequate bond strength shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Applicator in strict accordance with manufacturer's recommendations
 - d. A final visual inspection shall be made by the Owner, Engineer and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator
 - e. The system may be put back into non-severe operational service as soon as the final inspection has taken place

G. Cleanouts

1. Construct cleanouts in accordance with details on drawings

3.4 FIELD QUALITY CONTROL

A. Alignment Tests

1. Engineer may lamp each section of pipeline between manholes and/or structures to determine if any displacement of the pipe has occurred
2. Contractor shall provide suitable assistance to the Engineer
3. Repair any poor alignment, displaced pipe or other defects discovered as directed by Engineer

B. Flushing and Cleaning

1. To be performed by the Contractor
2. Flushing must be completed and accepted by the Owner and Engineer prior to other testing
3. Pipeline must be clean of all construction debris and dirt

C. Leakage Tests

1. General
 - a. Furnish all equipment, labor and incidentals necessary
 - b. Conduct tests in the presence of and to the satisfaction of the Engineer
 - c. Complete all tests prior to placement of permanent surfacing
 - d. When leakage or infiltration exceeds the allowable amount
 - 1) Locate the source of infiltration or leakage
 - 2) Make necessary repairs or replacements to reduce leakage or infiltration to specified limits
 - e. Repair any individually detectable leaks regardless of the test results
2. Infiltration tests
 - a. Conducted on any section of the system where, in the Engineer's opinion, infiltration appears to exceed specified limits
 - b. Procedure of test
 - 1) Place an approved, calibrated V-notch weir in the line just above the next lower manhole
 - 2) Plug the line just above the next higher manhole
 - 3) Allow sufficient time for the water level behind the weir to stabilize before reading
 - 4) Dislodge any foreign material hanging on the weir before reading
 - 5) Take successive readings until consistent results are obtained
 - c. Maximum allowable infiltration: 50 gallons per day per inch of pipe diameter per mile
 - d. When the rate of infiltration exceeds the maximum
 - 1) Stop construction on pipeline
 - 2) Provide electronic or photographic visual inspection of the interior of the pipeline at no additional cost to Owner
 - 3) Make appropriate repairs by approved methods
 - 4) Continue to test the conduit until it is proven satisfactory prior to proceeding with further construction on the pipeline
3. Air tests
 - a. Conduct on gravity pipelines wherever the ground water table is below the elevation of the conduit at any point along the section to be tested unless otherwise specified in the pipe material specification sections
 - 1) Where the ground water table is above the conduit
 - a) Water pressure test or
 - b) Air test conduit and increase test pressure to compensate for the water pressure on the conduit caused by the ground water
 - b. Preparation for tests
 - 1) Flush and clean pipeline to wet the pipe surfaces and produce more consistent results
 - 1) Plug and brace all openings
 - 2) Check all pipe plugs with soap solution to detect any air leakage
 - 3) If leaks are found, release the air pressure, eliminate the leaks and start the procedure over again
 - c. Procedure of tests
 - 1) Add air until the internal pressure of the pipeline is raised to approximately 4.0 psig

- a) For cases where the pipe is entirely or partially submerged by groundwater, increase pressure by the average vertical height of the groundwater over the length being tested from the centerline of the pipe in feet divided by 2.31
- 2) Reduce flow of air and maintain pressure for a sufficient time to allow the air temperature to come to equilibrium with the temperature of the pipe
- 3) After temperature has stabilized, permit pressure to drop to 3.5 psig
 - a) For cases where the pipe is entirely or partially submerged by groundwater, increase pressure by the average vertical height of the groundwater over the length being tested from the centerline of the pipe in feet divided by 2.31
- 4) Shut off air and with a stop watch or a watch sweep second hand, determine the time lapse required for the air pressure to drop by 0.5 psig
- 5) The following air test table shall be used to determine the minimum air test holding time for a 0.5 psig pressure drop for the actual pipe length being tested. Minimum times shall be:
 - a) For lengths less than "Length for Minimum Time" use "Minimum Time"
 - b) For lengths greater than "Length for Minimum Time" interpolate time from incremental lengths shown or add "Time for Longer Length" to "Minimum Time"
- 6) If the time lapse equals or exceeds that determined from the table, the pipe shall be presumed to be within acceptable limits for leakage
- 7) If the time lapse is less than that determined from the table, make necessary corrections to reduce the leakage to acceptable limits and retest. Repeat procedure until results are within acceptable limits

AIR TEST TABLE

MINIMUM HOLDING TIME REQUIRED FOR PRESSURE TO DROP 0.5 PSIG

Pipe Dia. (in.)	Minimum Time (min:sec)	Length For Minimum Time (ft.)	Time for Longer Length (L, ft.) (sec)	LENGTH (ft.)			
				100	200	300	400
4	1:53	597	0.190L	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:51
8	3:47	298	0.760L	3:47	3:47	3:48	5:04
10	4:43	239	1.187L	4:43	4:43	5:56	7:54
12	5:40	199	1.709L	5:40	5:42	8:33	11:24
15	7:05	159	2.671L	7:05	8:54	13:21	17:48
18	8:30	133	3.846L	8:30	12:49	19:14	25:38
21	9:55	114	5.235L	9:55	17:27	26:11	34:54
24	11:20	99	6.837L	11:24	22:48	34:11	45:35
27	12:45	88	8.653L	14:25	28:51	43:16	57:42

4. Water exfiltration tests
 - a. Water exfiltration test used in lieu of air test

- 1) Contractor must request written approval from engineer
- 2) Method only acceptable in dry areas or when the pipe is sufficiently deep and the groundwater level above the pipe is suitably low, as determined by the engineer
- b. Test procedures
 - 1) Plug the pipe segment being tested on the upstream end of each manhole such that the upstream manhole will hold water for the test
 - 2) Fill the upper manhole to a minimum level of 4 feet above the top of the pipe or a minimum of 4 feet above the ground water level, whichever is greater
 - 3) The maximum internal pipe pressure at the lowest end of the pipe shall not exceed 25 feet or 10.8 psi
 - 4) Determine the leakage over the test duration by measuring the drop in water level in the manhole and computing the volume loss
- c. Minimum duration of test: 24 hours
- d. Allowable leakage: 50 gallons per inch of internal pipe diameter per mile per day. This includes manhole leakage
5. Where service lines are connected to the main line being tested, services shall be plugged and adjustments to the test criteria shall be made to accommodate the diameters and lengths of the service lines
6. Pressure pipeline tests
 - a. Refer to Section 02708 - Pressure Pipelines and Appurtenances for requirements

END OF SECTION