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## **07210 GENERAL**

### **A. DESIGN REQUIREMENTS**

1. These specifications apply to all force mains that are to be owned, operated, and maintained by the Town of Cary. Design of private pump stations and force mains and associated facilities is not covered by these specifications or otherwise herein, and the applicant should look for guidance from other appropriate agencies (NCDENR, NC Plumbing Code, etc.).
2. All aspects of the design of wastewater force mains, and associated facilities shall, at a minimum, meet the requirements of the latest version of the NCDENR "Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains". Requirements presented in the Town of Cary Standard Specifications hereunder that are more restrictive or go above and beyond the requirements of the Minimum Design Criteria are required by the Town of Cary.
3. All aspects of the design of pump stations, force mains, and associated facilities shall be submitted for review and approval to the Town of Cary Engineering Department.
4. Wastewater force main interconnections shall be prohibited, unless authorized by the Director of Engineering. All wastewater force mains shall extend to the nearest gravity sewer or pump station wet well that has sufficient long term capacity.

## **07220 WASTEWATER FORCE MAINS**

### **A. DESIGN**

1. Force mains shall be installed with a minimum cover of 4 feet measured from the top of the pipe to the finished grade.
2. Force mains shall be installed in dedicated public right of way or in dedicated utility easements as follows. When wastewater force mains are constructed adjacent to gravity sewer mains or for construction of parallel wastewater force mains, the minimum horizontal clearance shall be at minimum 7-ft from pipe edge to pipe edge when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft up to installation depth of 10-ft. Clearances for pipelines greater than 10-ft depth shall be designed by Engineer of Record and approved by the Town of Cary Engineering Dept. Easement widths outlined below shall be widened by at least the clearance between the pipelines when constructing a shared gravity sewer and wastewater force main corridor.

Standard Easement Width for Sewer Force Mains

<u>Pipe Size</u> (diameter)	<u>Pipe Depth</u> (feet)	<u>Easement Width</u> (feet)
8-inch to 12-inch	10-ft or less	20-ft
8-inch to 12-inch	10-ft – 12.5-ft	25-ft
8-inch to 12-inch	12.5-ft – 15-ft	30-ft
8-inch to 12-inch	15-ft to 17.5-ft	35-ft
8-inch to 12-inch	17.5-ft to 20-ft	40-ft
12-inch to 24-inch	15-ft or less	30-ft
12-inch to 24-inch	15-ft – 17.5-ft	35-ft
12-inch to 24-inch	17.5-ft – 20-ft	40-ft
Greater than 24-inch	Any Depth	Specified by Director of Engineering
Any Size	Deeper than 20-ft	Specified by Director of Engineering

3. Dedicated easements for force mains and appurtenances shall be recorded as “Town of Cary Utility Easement”. Town of Cary force main easements shall contain only Town of Cary utilities unless otherwise approved by an encroachment agreement.
4. Wastewater force main discharge manholes and intermediate air release locations that require odor control shall be provided with sufficient easement area to accommodate the odor control systems as designed by the Engineer of Record, whether utilizing passive, forced-air or chemical treatment for odor control. The maintenance easement for odor control systems shall be sized based on site specific conditions and shall provide sufficient area for routine maintenance operations, such as refilling media, chemicals, replacing equipment, etc.
5. Force mains shall discharge at the invert of the receiving manhole and shall be as close as possible to 180 degrees from the outlet pipe.
6. Force main minimum design velocity shall not be less than 2-ft per second throughout the length of the force main. As a design preference, force main systems when operating at higher flows shall reach velocities of 3 to 5 ft/s to resuspend any settled solids.
7. Force main systems shall be of adequate sizing and design to effectively convey the ultimate peak flows as applied by the connected pump station to the discharge point.

8. The force main route shall be such that the number of high points requiring combination air valves is minimized to the extent possible. Combination Air Valves rated for use with raw wastewater shall be installed at all the high points or runs exceeding 3000-ft on all force mains in accordance with the Standard Details. A high point shall be determined as any location where the vertical separation between the adjacent low point and high point in the force main is greater than or equal to 10 vertical feet.
9. A plug valve shall be installed at least every 3000 feet of force main length, unless otherwise approved by the Director of Engineering.
10. All air release valves, plug valves, or other fittings or appurtenances that have moving or operating parts and require maintenance and routine access shall have a manhole placed over them or over the operating portion of the device.
11. Refer to Section 07000 of the Town of Cary Standard Specifications for more details bedding and installation requirements.
12. Separation Requirements

**Separation Between Sewer Force Main and Storm Water Pipes:**

Sewer force mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or minimum 500-psi, quick setting, non-excavatable flowable fill that meets or exceeds NCDOT specifications.

**Separation Between Sanitary Sewer and Sewer Force Main:**

There shall be a minimum 7 foot horizontal separation between parallel gravity and/or force mains in outfall locations when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft in outfalls.

**Separation Between Sewer Force Main and Water Main**

**Parallel Installations:** 10-ft lateral separation (pipe edge to pipe edge) or minimum 3-ft lateral separation, and water line at least 18-inches above sewer force main measured vertically from top of sewer pipeline to bottom edge of water main. In unique cases where the sewer force main and the water main are installed with at least 3-ft of lateral separation but less than 10-ft of horizontal separation, and less than 18-inches of vertical separation, both the water main and sewer force main shall be constructed of ductile iron pipe with joints in full compliance with water main standards.

Crossings (Water Main Over Sewer Force Main): All water main crossings of sewer sewer force mains shall be constructed over the sewer force main in conformance with Town of Cary specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer force main. If 18-inches of clearance is not maintained, the water main and sewer force main shall both be constructed of ductile iron pipe with joints in conformance with water main construction standards. The ductile iron sewer force main shall extend 10-ft on both sides of the crossing. When the separation between pipelines is 18-inches or less, the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending 3-ft on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for sewer force main crossings of potable water mains.

Crossings (Water Main Under Sewer Force Main: Allowed only as approved by Town of Cary, when it is not possible to cross the water main above the sewer force main. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and both the water main and sewer force main shall be constructed of ductile iron in conformance with water main construction standards to a minimum of 10-ft on both sides of the crossing. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

#### Separation Between Sewer Force Main and Reclaimed Water

Sewer force mains and reclaimed water mains shall be laid with at least 10 feet of horizontal separation, measured laterally edge to edge unless the elevation of the bottom of the reclaimed water main is at least 18 inches above the top edge of the sewer force main, with a horizontal separation of at least 3 feet.

Where a reclaimed water main and a sewer force main cross, the crossing shall be constructed at a 90-degree angle and the sewer force main shall cross at least 18-inches below the reclaimed water line. Because all reclaimed water mains in the Cary municipal system are constructed to fully comply with water system testing and integrity standards as described by 15A NCAC 18C, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained, the sewer force main shall be provided in ductile iron pipe in full compliance with water main standard joints, and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

If the sewer force main crosses above the reclaimed water line, the clearance shall be at least 18-inches. Because all reclaimed water mains in the Cary municipal system are constructed to fully comply with water system testing and integrity standards as described by 15A NCAC 18C, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained,

the sewer force main shall be provided in ductile iron pipe in full compliance with water main standard joints, and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

#### Sanitary Sewer Force Main and Stream Crossings

The top of the sewer force main shall be at least one foot below the stream bed. Concrete encasement and ductile iron pipe shall be required when the cover between the top of the pipe and the stream bed is less than 3 feet.

Sewer force mains shall not be installed under any part of water impoundments.

The following minimum horizontal separations shall be maintained:

- i. 100 feet from any private or public water supply source, including wells, WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water (except as noted below)
- ii. 50 feet from any waters (from normal high water) classified WS-II, WS-III, B, SA, ORW, HQW or SB (except as noted below)
- iii. 10 feet from any other stream, lake, or impoundment (except as noted below)
- iv. 25 feet from private wells (with no exceptions)
- v. 50 feet from sources of public water supply (with no exceptions)

Where the required minimum separations cannot be obtained, ductile iron sewer force main pipe with joints equivalent to water main standards shall be used.

## **B. MATERIALS**

### **1. Pipe Materials**

- a) The minimum wastewater force main size shall be 4-inches in diameter, unless otherwise approved by the Town of Cary Engineering Dept.
- b) All wastewater force mains shall be constructed with ductile iron pipe provided with interior corrosion protection coatings as specified herein, unless otherwise directed by the Town of Cary Engineering Department. All ductile iron wastewater force mains and fittings for sewer construction shall receive an interior ceramic epoxy coating, consisting of an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, such as manufactured by Protecto 401. The interior coating shall be applied at a nominal dry film interior thickness of 40-mils. All DIP bells and spigots shall be lined with 8-mils of joint compound by Protecto 401 or

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approved equal applied by brush to ensure full coverage. All pipe supplied with Protecto 401 interior lining shall be provided free of holidays. Pipe installed with defects in the lining will be rejected. Patching of Protecto 401 coating defects after installation shall not be approved.

- c) Ductile Iron Pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum requirements for ductile iron pipe and required laying conditions are tabulated below, unless otherwise approved by the Town of Cary Engineering Department. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table.

Pressure Class, Max. Depth and Laying Condition for DI Wastewater Force Mains

<b>Pipe Diameter</b>	<b>AWWA C-150, Laying Condition</b>	<b>Pressure Class</b>	<b>Maximum Depth of Cover</b>
4-8 -inch	type 1	350 psi	3-16 feet
4-8 -inch	type 4	350 psi	16-20 feet
10-12 -inch	type 1	350 psi	3-10 feet
10-12 -inch	type 4	350 psi	10-20 feet
14-20 -inch	type 4	350 psi	3-28 feet
24 -inch	type 4	350 psi	3-25 feet

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

- d) All buried DIP and fittings shall have bituminous coating on the exterior surface in accordance with AWWA C151. Pipe fittings shall be made of ductile iron designed and manufactured per AWWA C110. All fittings up to and including 24 inches in diameter shall be designed for a minimum internal pressure of 350 psi, unless otherwise approved by the Town of Cary. Joints for fittings shall be mechanical joint and shall be interior coated with Protecto 401 as specified herein for ductile iron pipe.

All ductile iron pipe shall be marked in conformance with ASTM A-746.

## 2. Material Identification

- a) Force mains shall be appropriately identified upon installation so they will not be confused with potable water lines or other utility lines.
- b) Identification Tape: Green detector tape 3 inches in width and clearly labeled "Caution Buried Sewer Force Main" shall be laid a maximum of 2 to 2.5-feet below the finished grade. The identification tape differentiating wastewater force mains from other utility lines shall be consistent throughout the service area.
- c) Marker Balls: Marker balls approved by the Town of Cary shall be installed along wastewater force mains at a maximum spacing of 100-ft and depth not to exceed 2-ft. Additionally, marker balls shall be provided at all bends, fittings and reducers. The electronic marker balls shall be provided in green color for wastewater and shall be designed to reflect a specific signal back to the electronic locator. The electronic marker balls shall be installed during pipe laying and provisions shall be made to assure they are not damaged during backfill operations. Electronic marker balls shall be tested at the completion of backfill operations to assure they are all working properly. Any defective units shall be replaced. All marker ball locations shall be provided on the as-built drawings and the field locations provided for recording to the Cary GIS system.
- d) Force main plug valves or ball valves shall have valve box covers with the word "Sewer" cast into the cover.

## 3. Manhole Materials

- a) All sewer force main manholes shall be installed according to Section 07000 of the Town of Cary Standard Specifications when design and installation criteria are not otherwise covered herein.
- b) All manholes for wastewater force mains and force main discharge locations shall be epoxy coated at minimum 80-mils thickness.
- c) Force Main Manhole Epoxy Coating: Sewer force main receiver manholes, sewer force main combination air valve manholes and other concrete structures subject to high levels of hydrogen sulfide gas shall be provided with an approved monolithic epoxy coating system consisting of a 100% solids, solvent-free, two-component epoxy resin that meets the following specifications for up to 100 mils of coating with a manufacturer approved set time of 6-hours or less. The epoxy coating system shall be installed in no more than 2 applications with no runs and no holidays. High voltage holiday testing shall be utilized to verify there are no voids in the coating.

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Epoxy coatings shall only be applied to adequately cured concrete structures that have been sufficiently washed and prepared for epoxy coating installation. Properly applied coating shall provide a smooth finish at 80-mils or greater and fill all pores in concrete substrate.

- d) Force Main Receiver Manholes: Sewer force mains shall not discharge directly into existing gravity sewer lines unless otherwise approved by the Director of Engineering. Sewer force mains shall typically discharge into a receiver manhole that has been epoxy coated as specified herein. The receiver manhole shall be provided in the typical eccentric tapered design at minimum 5-ft diameter. The bench shall be sloped up to 8-inches from the invert channel to the manhole wall. The invert shall be provided with a gradual upsloping alignment from the force main entry to the gravity transition point. Sufficient grade shall be placed on the invert such that wastewater falls back into the force main when the pumps are not in operation creating a vapor lock between the force main and the manhole. Drop connections into force main receiver manholes shall be prohibited.
- e) Combination Air Valve Manholes: Manholes for combination air valve installation shall be provided in flat top configuration to accommodate the excess length of wastewater combination air valves. In cases where the combination air valve assembly shall be located in a paved area, provide typical eccentric, tapered manhole design with typical manhole frame and cover for paved areas. The minimum manhole diameter for combination air valve assemblies shall be 5-ft diameter. Any manholes located in NCDOT or street right-of-way shall be provided flush with finished grade.

### **C. INSTALLATION**

1. Restraint: All wastewater force mains in the Town of Cary sewer system shall be restrained. The standard joint restraint shall consist of stainless steel rodding and blocking as specified herein. Reaction blocking for all fittings or components subject to hydrostatic thrust shall be typically securely anchored with 3000-psi concrete thrust blocks poured in place. The reaction areas are shown in the Standard Details. No concrete shall interfere with the removal of fittings. A plastic film shall be applied to the pipe to prevent concrete from bonding to the pipe material.
2. All valves shall be restrained in a manner consistent with operation as a dead end, which includes restraining the valve to the pipe and restraining a sufficient number of pipe joints on both sides of the valve to accommodate dead end valve restraint. The specifications allow for several options to achieve required pipeline restraint, such as wedge action retainer glands, rods, blocking, manufacturer provided restrained joint pipe, concentric ring fittings, etc. All joint restraint products that include the sole means of restraint within the joint gasket shall be prohibited for use with Town of Cary wastewater force mains.

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3. All plans submitted shall include the pipe restraining plan including the number of joints restrained at fittings, valves, etc. Project designers shall include sufficient detail on the plan and profile drawings that make it clear to contractors what is required to meet the engineered restraining system specified. The pipe restraint plan shall be included under the design responsibility of the NC Professional Engineer sealing the plan drawings. Restraining systems not included within this specification shall require approval from the Town of Cary prior to utilization.

#### **D. VALVES AND APPURTENANCES**

1. Check Valve: Check valves shall be iron bodied, fully bronze mounted with bronze clapper disc and bronze seat ring, and shall have a spring loaded lever arm capable of being mounted on either side of the valve.
2. Plug Valve: Plug valves shall be non-lubricating, eccentric action and resilient plug facing with heavy duty Type 316 stainless steel bearings. Plug valves shall be designed for a working pressure of 175 psi for valves 12" and smaller, 150 psi for valves 14" and larger. Valves shall provide tight shut-off at rated pressure. The plug valve body shall be cast iron ASTM A126 Class B with welded-in overlay of 90% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable. All plug valves 12" and smaller shall have round port design that provides a minimum 80% port area. The valve plug shall be ductile iron ASTM A536 Grade 65-45-12, with EPDM, Buna N, or Neoprene resilient seating surface to mate with the body seat. Larger force main plug valves with rectangular plugs shall provide clean passage for a solid sphere of at least 67% of the adjoining pipe diameter to facilitate pigging of the forcemain. Force main plug valves with rectangular port shall be "full-port" cross-sectional area perpendicular to the flow of at least 100% of the adjoining pipe. All buried plug valves shall be provided with worm and gear actuators with 2-inch operator nut. Plug valves shall be provided with typical mechanical joint end connections and restrained with wedge action retainer glands on both ends of the valve assembly.
3. Rubber Seated Ball Valve: For larger diameter force mains, rubber seated ball valves shall be of the tight-closing, shaft-mounted type that fully comply with AWWA Standard C507 to provide a full port unobstructed waterway with no additional pressure drop. Design pressure ratings shall be 150 psi or greater and provide tight shutoff against flow. With the valve in the closed position, the rubber seated valve shall be bubble tight at rated pressure. All buried ball valves shall be provided with worm and gear actuators with 2-inch operator nut.

4. Combination air valves shall be provided to purge air from the system at startup, vent small pockets of air while the system is being pressurized and running, and prevent critical vacuum conditions during draining. Combination air valves shall be designed to prevent failure caused by grease and debris in the wastewater. Combination air valves approved for use in wastewater force main installations shall be installed at all high points of wastewater force mains 6 inches in diameter or larger and at other locations, such as major changes in slope, as directed by the Town. A high point shall be determined as any high location where the difference between the high elevation and adjacent low elevation exceeds 10-ft unless otherwise determined by the Director of Engineering based on special circumstances. The combination air valve shall automatically exhaust large volumes of air from the system when it is being filled and allow air to re-enter the pipe when the system is being drained. The wastewater force main shall be installed at a grade which will allow the air to migrate to a high point where the air can be released through an air valve. A minimum pipe slope of 1 foot in 500 feet should be maintained. The valve shall have a minimum two (2) inch NPT inlet and 145-PSI working pressure rating unless the pipeline design requires a higher pressure rating. Combination air valves shall be sized by the Engineer and approved by the Town.
  - a) Combination air valves shall be of the single housing style with Type 304 or 316 stainless steel body that combines the operation of both an air/vacuum and air release valve. The valve must meet the requirements of AWWA C512 and be installed in accordance with the Details.
  - b) The valve shall have a minimum two (2) inch NPT inlet for a 2-inch valve assembly. Combination air valves sized from 3-inches to 8-inches shall be provided with studded inlet connectors or flanged connections. The combination air valve shall be provided with cylindrical shaped floats and anti-shock orifice made of high density polyethylene. Combination air valves with spherical floats shall not be accepted. All combination air valves shall be installed in accordance with the Details.
  - c) The combination air valve shall be installed in standard flat top manhole as shown in the detail drawings. The Engineer of Record shall provide ample depth of installation to accommodate the extended design combination air valve as required for wastewater force mains.
  - d) The combination air valve shall be provided with a tap in the same sizing as the combination air valve assembly and isolated with a ball valve of the same size. All taps for combination air valves shall be provided with service saddles. The isolation ball valve shall be provided with NPT threads and connected with brass or bronze piping. The isolation ball valve shall be rated for 200-psi service or greater. For larger sizes, a standard plug valve and tapping sleeve with flange connections may be

required for connection with larger combination air valve assemblies provided with flange connections.

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#### Bypass Connection Assembly

All wastewater force mains shall be provided with an above ground blind flange connection to the force main that facilitates bypassing the pump station during emergency operations when the pump station is not functional. The bypass assembly shall include either a ball valve or plug valve assembly for isolation from the primary wastewater force main. Additionally, the primary force main shall be provided with a main line plug valve or ball valve on the upstream side of the bypass assembly to prevent bypass flow from draining back to the pump station. The bypass assembly shall be brought to the final graded surface with a visible blind flange assembly for connection by an outside pumping contractor. The bypass assembly shall be sized by the Engineer of Record and located within the pump station secured area in general close proximity to the wet well.

Force Main Odor Control Systems: Force main odor control shall be included in the design plans for any proposed force main at discharge locations, intermediate air release locations and otherwise as directed by the Town of Cary Engineering Department. For small force mains, this requirement may be waived contingent upon a written request and consideration of such exemption provided by the Engineer of Record. Factors included in the waiver request would be the number of residents in close proximity, type of development, size of force main, estimated flows, number of cycles, wastewater characterization, long term service conditions, etc. The suggested odor control technology shall be designed by the Engineer of Record to achieve 95% or greater hydrogen sulfide removal. For forced air systems, the design shall include provisions for power to the odor control system. For all odor control systems, the Engineer of Record shall provide sufficient easement area for long term maintenance of the system.

## **07560      INSPECTIONS, TESTING, AND TRAINING**

### **A. INSPECTIONS**

1. All materials and equipment used in the construction of the wastewater pumping system must be verified for compliance with the specifications (or other approval granted by the Town) by the Inspector prior to installation. Non-conforming materials or equipment shall be immediately removed from the job site.
2. Compliance with plans and specifications shall be verified on a regular basis by the Inspector.

## **B. TESTING**

### 1. General

- a) The Contractor shall furnish all materials, labor, and equipment to perform all testing. Water for testing purposes may be obtained from the Town of Cary. The Contractor shall reimburse the Town for all water used at Inside Utility Rates.
- b) All water or wastewater used during testing of the pump station, force main, or any of the systems described in this section, must be returned to the Town of Cary sanitary sewer system after proper coordination with the Town of Cary Department of Public Works and Utilities.
- c) All on-site testing and/or installation verification shall be performed in the presence of the Inspector or other representative authorized by the Town.

### 2. Force main Testing

- a) The force main shall be completely filled with water, all air shall be expelled from the pipe, and the discharge end of the pipeline shall be plugged and adequately blocked before the hydrostatic test begins.
- b) The force main shall be tested to a pressure of 150 psi or three times the rated Total Dynamic Head of the pumps in psi, whichever is larger, as measured at the lowest elevation of the pipeline, for a duration of 2 hours. The pressure gauge used in the hydrostatic test shall be calibrated in increments of 5 psi or less. At the end of the test period, the leakage shall be measured with an accurate water meter.
- c) All leaks shall be located and repaired regardless of the amount of leakage. If the force main does not pass the leakage test requirements, the cause of the failure shall be identified and repaired. Testing shall be repeated until the force main passes.

$$\text{Allowable Leakage (L)} = \frac{S \times D \times \text{SqRt}(P)}{133,200}$$

Where: L = leakage (gph)  
S = length of pipe (feet)  
D = nominal diameter of pipe segment tested (inches)  
P = test pressure (pounds per square inch)

END OF SECTION 07500

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