

## **Section 2350**

### **Test and Seal**

#### **PART 1: General**

##### **1.1 *General Description of Work –***

- 1.1.1 Provide all labor, materials, tools, equipment and incidentals as shown, specified, and required for testing lateral tap connections to the sewer by hydraulically applying a positive pressure to the joints, monitoring the pressure in the void and monitoring the test medium flow rate. The test medium shall be air.
- 1.1.2 The intent of lateral tap testing is to identify those lateral taps that are not watertight and that can be successfully sealed by packer injection grouting.
- 1.1.3 Test tap connections to the sewer main.

##### **1.2 *Requirements –*** This Contract requires work in active sewers. Follow all federal, state and local requirements for safety in confined spaces.

##### **1.3 *Qualifications –***

- 1.3.1 Contractor shall have a history of at least five years of pressure testing and grouting sewers and shall have successfully pressure tested a minimum of 5,000 sewer pipeline joints and 250 lateral connections.
- 1.3.2 All Work shall be supervised by a foreman having previously performed pressure testing and chemical grout sealing of a minimum of 3,000 sewer pipeline joints and 250 lateral tap connections.

##### **1.4 *Submittals –***

- 1.4.1 Equipment operating procedures and systems.
- 1.4.2 Submit complete records collected during the joint testing activities, identifying the following:
  - 1.4.2.1 Location of the pipeline segment in which the testing is being done.
  - 1.4.2.2 Location of each lateral tap tested.
  - 1.4.2.3 Location of any lateral taps not tested and the reason for not testing.
  - 1.4.2.4 Test pressure achieved and the duration of test maintained for each lateral tap passing the air test.
  - 1.4.2.5 Retest test pressure for each lateral tap passing air test after the application of grout.
- 1.4.3 Documentation of Testing Observations.

- 1.5 *Reference Standards* – National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), Second Edition Reference Manual, 2001.

## **PART 2: Products**

### **2.1 *Equipment* –**

- 2.1.1 The basic equipment used for mainline pipe joints and for laterals connected to the mainline shall consist of a remotely operated television camera capable of pan and tilt, joint testing device such as a packer, and test monitoring equipment. 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 device and a means for continuously measuring the actual static pressure of the test medium within the void area only.
- 2.1.2 The device for testing lateral tap connections shall consist of inflatable mainline end elements and a lateral grouting plug that creates a void area extending beyond the tap connection. Whenever possible, use a lateral grouting plug sized to match the diameter of the lateral being grouted with an effective sealing length of no less than 3 feet. Where the Contractor elects to abandon a capped or inactive lateral shown on the Drawings using grout, utilize alternate lateral grouting plug or equipment sized appropriately for the capped/inactive lateral. If the lateral transitions from 6 inches to 4 inches in diameter, use a 4-inch lateral grouting plug, but no relief for excess residual grout will be provided. Maintain a variety of lengths of lateral grouting plugs and adjust length of lateral grout plug as required to grout capped/inactive laterals. The device shall provide a means for continuously measuring the static pressure of the test medium and chemical grout within the void area created by the inflation of the device. All pressure measurements shall be made within the void area.
- 2.1.3 Void pressure data shall be transmitted electronically from the void area to the monitoring equipment. All test monitoring shall be carried out in the TV studio.

## **PART 3: Execution**

### **3.1 *Preparation* –**

- 3.1.1 Testing will not be required on pipe exhibiting the following conditions or characteristics. Provide Engineer with digital image and intention not to grout any such defect.
- 3.1.1.1 Longitudinally fractured or broken pipe, as classified by PACP, or on sections of the pipe between joints.
- 3.1.1.2 Any section of pipe that is scheduled to receive a cured-in-place point repair.
- 3.1.1.3 Any section of pipe that is scheduled for replacement or other work involving excavation or new connections.
- 3.1.1.4 Engineer or Contractor determines that, significant structural damage of the pipe would occur as a result of the pressure test.

- 3.1.2 Clean sewer and remove all roots in mainline sewer except minor hair roots prior to testing.
- 3.1.3 Attempt to test and, if needed, grout any joint separated less than 1-inch. For joints separated by more than 1-inch, the Engineer may elect to install a cured in place point repair (CIPPR) by separate contract.
- 3.1.4 Attempt to test and, if needed, grout any small or medium offset joint as classified by PACP. For offset joints that are classified as large offset by PACP, the Engineer may elect to install a CIPPR by separate contract.
- 3.1.5 Clean lateral and remove roots from lateral when directed.
- 3.1.6 Confirm the inside diameter of the lateral pipe to be tested and apply the appropriate packer.
- 3.1.7 During testing and sealing, provide sewer flow control so as to provide unimpeded view of the packer.
- 3.1.8 Record the testing procedure. The recording shall show the location of the lateral tap connection and the test pressure in subtitles. Sealing of the failed lateral tap connection will be incorporated on the same recording.

### 3.2 *Documentation of Roots in Lateral Taps –*

- 3.2.1 During mainline sewer cleaning or testing, document all lateral taps containing roots that are either (a) greater than fine roots or (b) of a nature to prevent testing and sealing of tap connection. For each such tap connection, submit a screen shot image clearly showing the extent of roots. Submit images in electronic format, labeled and organized in a manner to easily retrieve the image for the lateral tap in question. The list of lateral taps with roots shall include upstream and downstream manhole numbers, station, property address served, plan sheet number where tap is located and photograph of outside cleanout, if present.
- 3.2.2 Engineer will review the list of lateral taps containing roots and direct Contractor as to which laterals are to be (a) cleaned and grouted, (b) grouted without cleaning - in which case such lateral tap would be excluded from warranty testing, or (c) removed from the scope of work - in which case no payment for such lateral will be made. Successful cleaning of lateral taps (i.e. such that no more than fine hair roots remain) will be paid per the applicable item on the Schedule of Prices. No payment will be made for unsuccessful attempts to clean lateral taps.

### 3.3 *Lateral Tap Testing Procedure –*

- 3.3.1 Lateral tap joint testing pressure shall be equal to 2 psi per vertical foot of pipe depth plus 2 psi; however, test pressure shall not exceed 10 psi without approval of the Engineer.
- 3.3.2 Air testing lateral taps shall be accomplished by isolating the area to be tested with the lateral tap packer and by applying positive pressure into the isolated void area. A pan and tilt camera shall be used to position the lateral packer for laterals directly connected to the mainline sewer. The lateral bladder shall be inverted from the mainline assembly into the lateral pipe and inflated. The mainline elements shall then be inflated to isolate the lateral

connection and the portion of the lateral to be tested. Direct visual observation and measured cable lengths shall be used to position the lateral packer for laterals directly connected to manholes. A sensing unit shall be located within the void area and will accurately transmit continuous pressure readout to the control panel.

- 3.3.3 The test procedure will consist of applying air pressure into each isolated void area. A sensing unit shall be located within the void area and will accurately transmit continuous pressure readout to the control panel. Air shall then be slowly introduced into the void area until a pressure equal to or greater than the required test pressure, but in no cases greater than 2 psi above the required test pressure, is observed on the pressure monitoring equipment. Once the designated pressure in the isolated void is displayed on the meter of the control panel, the application of air pressure will be stopped and a twenty-second waiting period will commence. The void pressure will be observed during this period. If the void pressure drop is greater than 1.0 psi, the lateral shall be considered to have failed the air test and shall be grouted and retested.
- 3.3.4 After completing the air test for each individual lateral specified herein, derate the lateral packer, with the void pressure meter continuing to display void pressure. If the void pressure does not drop to approximately zero, the equipment shall be adjusted to provide a zero void pressure reading at the monitor.

#### 3.4 Control Test –

- 3.4.1 Prior to starting the testing phase of the Work, demonstrate the acceptable performance of air test equipment in the presence of the Engineer by conducting demonstration tests daily, or more frequently as directed by the Engineer.
- 3.4.1.1 For pipe less than or equal to 18 inches in diameter, provide a straight pipe of appropriate diameters and sufficient length to test mainline packers and lateral push packers and a wye tap mockup of appropriate diameters and sufficient length to test the lateral tap connected to mainline packer. All of these test devices shall be fitted with a 1/8-inch diameter tap hole with a plug or screw that can be removed to test the packer under both sound and leaking conditions. For pipe greater than 18 inches in diameter, the below method shall be used.
- 3.4.1.2 After entering each pipeline segment with the test equipment, but prior to the commencement of testing, position the test equipment on a section of sound sewer pipe between pipe joints, and perform a test as specified. The equipment shall hold a 10 psi test pressure for a period of 60 seconds with a pressure drop of less than 1 psi. In the event of a failed test, repair any defective equipment and re-test to verify proper operation of all equipment at no additional compensation. Should it be found that the barrel of the sewer pipe will not meet the test requirements, then the performance testing shall be waived or modified as determined by the Engineer.
- 3.4.1.3 If air testing equipment cannot be performed successfully, repair or otherwise modify air test equipment and repeat the tests until the results are satisfactory to the Engineer. This test may be required at any other time during the performance of testing work if the Engineer suspects the testing equipment is not functioning properly.

## **PART 4: Packer Injection Grouting**

### **4.1 *General Description of Work* –**

- 4.1.1 *General* – Provide all labor, materials, tools, equipment and, incidentals as shown, specified, and required to grout lateral tap connections using a packer injection.
- 4.1.2 *Packer Injection Grouting* – Packer injection grouting is used to reduce the infiltration within the pipeline, seal lateral tap connections that have failed the test criteria and prevent further loss of pipe bedding into the pipe.
- 4.1.3 *Method* – Packer injection grouting shall be accomplished by pressure injection of chemical grout into the soils encompassing the pipe joint. Chemical grouts shall be designed to be injected into the soil surrounding the pipe, which stabilizes the soil and forms a permanent impermeable seal called a soil ring. Adequate volumes of grout must be injected to form an effective seal. This application will be through structurally sound joints and penetrations from within the pipe (packer method) in tandem with a closed circuit television inspection system.
- 4.1.4 *Plug Size* – Use a lateral grouting plug sized to match the diameter of the lateral being grouted with an effective sealing length of no less than 3 feet.
- 4.1.5 *Site Conditions* – The site is characterized by a water table that is seasonally above the joints, but does experience extended periods when the pipe bedding becomes dry.

### **4.2 *Requirements* –**

- 4.2.1 This Contract requires work in active sewers. Adhere to all federal, state and local requirements for safety in confined spaces.
- 4.2.2 Worker safety training should include reviewing the hazards associated with hoses, pumps, tanks, couplers, compressors, bottles, motors, and all other related application apparatus. Additional safety considerations including safely handling, mixing, and transporting of chemical grouts should be provided by the grout Manufacturer or supplier or both. Their safe operating practices and procedures should describe appropriate personal protective equipment (PPE) for the various grouting operations. Operations covered should include the proper storage, transportation, mixing, and disposal of grouts, additives, and their associated containers.

### **4.3 *Qualifications* –**

- 4.3.1 Contractor shall have a history of at least five years of pressure testing and grouting sewers and shall have successfully pressure tested and grouted a minimum of 5,000 sewer pipeline joints and 250 lateral connections.
- 4.3.2 All work shall be supervised by a foreman having previously performed pressure testing and chemical grout sealing of a minimum of 3,000 sewer pipeline joints and 250 lateral tap connections.

#### 4.4 Submittals –

##### 4.4.1 Grout Information:

- 4.4.1.1 Description of chemical grout.
  - 4.4.1.2 Grout mixture ratio (including additives). Include procedure for adjusting grout mixture for variations of ambient temperatures and changes of temperature of grout through hoses exposed to atmosphere.
  - 4.4.1.3 Curves of grout gel time versus temperature.
  - 4.4.1.4 Instructions for addition of agents.
  - 4.4.1.5 MSDS Sheets.
- 4.4.2 Equipment operating procedures and systems to be used, including Manufacturer's literature on grout pumps, operating pressures, packers, and lateral blockage clearing equipment.
- 4.4.3 Annular space between the packers and the host pipe.
- 4.4.4 Upon completion of grouting each reach, submit to Engineer a report showing the following data for each lateral tap connection tested, grouted or attempted to be grouted:
- 4.4.4.1 Pipe material and diameter.
  - 4.4.4.2 Stationing.
  - 4.4.4.3 Time, date, and temperature.
  - 4.4.4.4 Grout mixture formation, including additives and catalyst mixture formulation and proportion of each.
  - 4.4.4.5 Pumping pressure.
  - 4.4.4.6 Gel time.
  - 4.4.4.7 Quantity of grout used to seal the joint.
  - 4.4.4.8 Step grouting, if applicable.
  - 4.4.4.9 Post-grout pressure test results.
  - 4.4.4.10 Regrouting and retesting giving above data as required.
  - 4.4.4.11 Video recording cross-reference index.
- 4.4.5 Documentation of Post-construction Inspection and Warranty Inspection.

## **PART 5: Products**

### **5.1 General –**

#### **5.1.1 All grout materials must have the following characteristics:**

- 5.1.1.1 While being injected, the grout must be able to react/perform in the presence of water (groundwater).
- 5.1.1.2 The cured grout must withstand submergence in water without degradation.
- 5.1.1.3 The resultant grout formation must prevent the passage of water (infiltration) through the pipe joint.
- 5.1.1.4 The grout, after curing, must be flexible, under both dry and wet conditions.
- 5.1.1.5 The grout must not be biodegradable.
- 5.1.1.6 The cured grout should be chemically stable and resistant to acids, alkalis, and organics found in sewage.
- 5.1.1.7 Residual grout shall be easily removable from the sewer line to prevent blockage of the sewage flow.

5.1.2 Handle, formulate, and store grout in accordance with the Manufacturer's recommendations. The uncured grout shall be delivered to the Site in unopened containers with the date of manufacture clearly indicated. Do not utilize uncured grout manufactured more than six months prior to the date of application. Immediately remove from the Site any uncured grout compound determined to be more than six months old. Once a container of uncured grout has been opened it shall be used within 72 hours.

5.1.3 All material shall be clearly dated by the Manufacturer. Engineer shall be provided the opportunity to inspect the Contractor's storage facilities at any time. Any material found to have exceeded its shelf life or found to be stored under improper temperature and humidity conditions, as determined by Manufacturer's recommendation, shall be marked rejected, shall not be used, and shall be removed from the Site immediately.

5.1.4 Mix and handle the grout and the constituents producing it, which may be toxic on contact or inhalation, as recommended by the Manufacturer and to minimize hazard to personnel. Provide appropriate protective measures to ensure that the grout components and the chemicals produced in mixing are under the control of the Contractor at all times and are not available to unauthorized personnel or others. Dispose of excess grout resulting from sewer grouting operations in a safe manner. All equipment and material shall be subject to the review of Engineer.

5.1.5 All grout materials used shall meet the following minimum application requirements:

- 5.1.5.1 All component materials shall be easily transportable by common carriers.
- 5.1.5.2 Packing of component materials shall be compatible with field storage requirements.

- 5.1.5.3 Grout components shall be packed in such a fashion as to provide for maximum worker safety when handling the materials and minimize spillage when preparing for use.
  - 5.1.5.4 Mixing of the components shall be compatible with field applications and not require precise measurements.
  - 5.1.5.5 The concentration of the grout and additives shall be within the limits recommended by the Manufacturer.
  - 5.1.5.6 Catalyzation shall take place at the point of injection/repair.
  - 5.1.5.7 Cleanup shall be done without inordinate use of flammable or hazardous chemicals.
- 5.1.6 Do not use this method to attempt repair of longitudinally cracked pipe, structurally unsound pipe, flattened, or out-of-round-pipe.

## 5.2 *System Description –*

- 5.2.1 Grouting equipment shall consist of two separate pumping systems capable of supplying an uninterrupted flow of sealing materials to completely fill the voids. The gel side of the system shall be a closed system to minimize exposure to moisture. Pumps, fittings, and hoses shall be designed to transport a high viscosity material and shall not be affected by acetone or ketone solvents. The sizing of the system shall be such that the water side can transport materials at 1 to 1 or 8 to 10 times the ratio of the gel side. Pumps shall be sized to deliver a minimum of 3 GPM.
- 5.2.2 Grout shall pass from the pumping system through instant reading, controlled flow meters and then through a dual hose system into the sealing device. The device (referred to hereafter as a packer) shall be a cylindrical case of a size less than pipe size, with the cables at either end used to pull it through the line. The packer shall be constructed in such a manner as to allow a restricted amount of sewage to flow at all times.
- 5.2.3 Generally, the equipment shall be capable of performing the specified operations in sewers where flows do not exceed 25 percent of pipe diameter.
- 5.2.4 For mainline joint packers, air impervious inflatable sleeves shall be mounted over the cylinder with the ends of the sleeve sealed to the ends of the casing. The sleeves shall be so constructed that they can be pneumatically expanded from the center to both ends. The center portion of the sleeve shall be sealed to the casing by a broad confining band. When the packer is inflated, two widely spaced annular bladders shall be formed, each having an elongated shape and producing an annular void around the confined portion of the sleeve. The central portion of the packer (between the ends) shall be expandable in order to reduce the amount of wasted grout in the void area. No sealing device which is expanded mechanically nor where the expansion sleeve is not continuous will be allowed in order to prevent damage to the pipe from excessive amounts of sealing pressures or air leakage in the center area of such sealing device. Only low void packers with annular space less than 14 gallon shall be used.
- 5.2.5 Tap and lateral service sealing shall be accomplished using the lateral grouting plugs and push packers.



5.2.6 Provide back-up bladders for all packers on-site any time grouting work is being conducted. Equipment for cleaning lateral blockages shall be present on-site where any grouting work is being conducted.

5.3 *Grouts* –

5.3.1 Acrylamide base grout shall have the following characteristics:

- 5.3.1.1 A minimum of 12 percent acrylamide base material by weight in the total grout mix. A higher concentration of acrylamide base material may be used to increase strength or offset dilution during injection.
- 5.3.1.2 The ability to tolerate some dilution and react in moving water during injection.
- 5.3.1.3 A viscosity of approximately 2 centipoise, which can be increased with additives.
- 5.3.1.4 A constant viscosity during the reaction period.
- 5.3.1.5 A controllable reaction time from 10 seconds to 1 hour.
- 5.3.1.6 A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, firm, flexible gel.
- 5.3.1.7 The ability to increase mix viscosity, density and gel strength by the use of additives.
- 5.3.1.8 Product Manufacturer: Avanti AV-100; or equal.

<b>Approved Manufacturers</b>	
<b>Manufacturer</b>	<b>Model</b>
Avanti	AV-100
Or approved equal as determined by ECUA in writing	

5.3.2 Acrylic base grout shall have the following characteristics:

- 5.3.2.1 A minimum of 12 percent acrylic base material by weight in the total grout mix. A higher concentration of acrylic base material may be used to increase strength of set dilution during injection.
- 5.3.2.2 The ability to tolerate some dilution and react in moving water during injection.
- 5.3.2.3 A viscosity of approximately 2 centipoise, which can be increased with additives.
- 5.3.2.4 A constant viscosity during the reaction period.
- 5.3.2.5 A controllable reaction time from 5 seconds to 6 hours.
- 5.3.2.6 A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, flexible gel.
- 5.3.2.7 The ability to increase mix viscosity, density and gel strength by the use of additives.

<b>Approved Manufacturers</b>	
<b>Manufacturer</b>	<b>Model</b>
Avanti	AV-118
DeNeef Construction Chemicals	AC400
Or approved equal as determined by ECUA in writing	

5.3.3 Urethane base grout shall have the following characteristics:

- 5.3.3.1 One part urethane resin thoroughly mixed with 8 parts of water weight (11percent resin). When high flow rates from leaks are encountered, the ratio of water being pumped may be lowered to no less than 5 parts (17 percent resin).
- 5.3.3.2 A liquid having a solids content of 75 to 95percent, and a specific gravity of greater than 1.00.
- 5.3.3.3 Viscosity of between 100 and 1500 centipoise at 70°F that can be pumped through 500 feet of 1-inch hose with a 1000-psi head at a flow rate of 1 ounce per second.
- 5.3.3.4 The water used to react the resin should have a pH of 5 to 9.
- 5.3.3.5 A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, flexible gel.
- 5.3.3.6 The ability to increase mix viscosity, density and gel strength by the use of additives.

<b>Approved Manufacturers</b>	
<b>Manufacturer</b>	<b>Model</b>
Avanti	AV 254
	AV 350
DeNeef Construction Chemicals	Hydro Active Multigel NF
Or approved equal as determined by ECUA in writing	

5.4 *Additives* –

5.4.1 For lateral tap connection grouting, add latex additive (or equal) to strengthen the grout. The quantity of latex additive will be according to the Manufacturer recommendation. Adjust the grout admixture to meet specified viscosity and reaction time. Follow Manufacturer's recommendations for product handling and start. Latex additive shall have the following characteristics:

<b>Required Characteristics of Latex Additive</b>		
Solids Content	49% minimum	ASTM D-1010
pH	7.5-8.5	8.0 Average
Viscosity	130 cps @ 77°F	ASTM D-1638
Density	8.52 lbs./gal.	ASTM D-1564W
Solvent	Water	

- 5.4.1.1 Shall provide protection against shrinkage and improve the strength of the gel.
- 5.4.1.2 Shall not contain organic solvents.

- 5.4.2 Add a root deterrent chemical such as dichlobenil to the grout in proportions as recommended by the Manufacturer.
- 5.4.3 Use a shrink control agent that is a water-based emulsion with the grout. The shrink control agent shall reduce shrinkage and improve strength of the grout providing the resultant cured material with both improved hydrostatic pressure resistance and flexibility. The agent shall be added in proportions as recommended by the Manufacturer.
- 5.4.4 Add gel time extending agent in accordance with the Manufacturer's recommendations to extend gel time as necessary.

<b>Approved Manufacturers</b>	
<b>Manufacturer</b>	<b>Product</b>
Avanti	Potassium Ferricyanide (KFe)
Or approved equal as determined by ECUA in writing	

**PART 6: Execution**

6.1 *General* –

- 6.1.1 Remove roots and test laterals.
- 6.1.2 Grout all lateral tap connections and transitions that failed the pressure test by the injection method or equal. Generally, this shall be accomplished by forcing grout through a system of pumps and hoses into and through the joints of the sewer from the packer within the sewer pipe. Jetting or driving pipes from the surface that could damage or cause undermining of the pipelines, shall not be allowed. Except where specifically shown on the Drawings or called for in the Specifications, do not uncover the pipe by excavation.
- 6.1.3 Remove excess grout from pipe and laterals. Excess grout shall be defined as a thickness of grout greater than 1 inch thick at any point or an amount of grout that, given its location, size and geometry, in the judgment of the Engineer, could cause a blockage. Flush or push forward to the next downstream manhole, remove from the sewer system, and properly dispose of excess grout. In no case shall excess grout material be allowed to accumulate or flushed down the sewer.
- 6.1.4 All decisions regarding allowable roots or excess grout shall be made in the field during the work by the Engineer and shall be final. It is the Contractor's responsibility to either remove all grout and roots or obtain Engineer approval to leave them in place.
- 6.1.5 Any structurally undamaged joint that structurally fails (breaks) during testing and grouting under normal pressure conditions that are documented on video shall be the Owner's responsibility and cost to repair. Any structurally failed pipe or joint that is grouted at the Engineer's direction that further fails/breaks during testing and grouting under normal pressure conditions that are document on video shall be the Owners responsibility and cost to repair. Promptly repair any sewer damage resulting from the Contractor's operations at no additional compensation.

6.2 *Sewer Flow Control* – During grouting, provide sewer flow control so as to provide unimpeded view of the packer.

### 6.3 Grout Preparation –

- 6.3.1 Mix all grout at the Site in the presence of the Engineer. Do not use grout that has been mixed off-site and is in the Contractor's tank when the truck arrives on Site. Follow the Manufacturer's recommendations for the mixing and safety procedures to protect personnel from any adverse effects of the grouting compounds. Add and mix powder and additives at rates that will eliminate the formation of lumps within grout tanks solutions. Use accurate scale(s) to weigh the various non-water grout solution components. Thoroughly mix all additives in the grouting component tanks. Provide accurate thermometers to verify temperature of grouting components in tanks.
- 6.3.2 At the beginning of each day, prior to application of grout, perform a pump test to determine if proper ratios are being pumped from the grout component tanks at the proper rates and to measure pump rates. Use separate containers to capture the discharges from the grout component tanks. Take corrective action if unequal quantities are being pumped. Repeat the pump test until equal quantities are pumped from the grout tanks. Pump one gallon of grout and count the pump strokes to confirm the number of pump strokes required to achieve the delivery rate. Repeat the pump test until proper ratios and delivery rates are pumped from the grout tanks.
- 6.3.3 At the beginning of each day, when new batches of grout are mixed, when grout additives are modified to change gel times, at the beginning of any new pipe segment or manhole, and whenever the temperature in the tanks or ambient temperature have changed by more than 10°F from the previous gel test, perform a grout gel test in the presence of the Engineer to determine the grout mixture gel time by collecting a sample of grout from the packer discharge.
- 6.3.4 Add gel time extending agent, as necessary and in the presence of the Engineer, to compensate for changes in temperature in grout component tanks or hoses. The addition of dilution water to extend gel times is not acceptable unless resulting base material exceeds 12 percent by weight.
- 6.3.5 During the grouting process, the Contractor and Engineer shall monitor the grout component tanks to make sure that proper ratios are being pumped. If unequal levels are noted in the tanks, repeat the pump test as described above.
- 6.3.6 Gel times shall be within 5 seconds of the following unless otherwise approved by Engineer.

$$\text{Gel time} = \frac{(\text{volume of annular space (gal.)} + (\text{pipe diameter (in.)})/4 (60 \text{ sec./min.}) + 5 \text{ sec.})}{\text{Pumping Rate (gpm)}}$$

### 6.4 Lateral Tap Connection Sealing By Packer Injection Grouting –

- 6.4.1 Lateral tap sealing begins if the lateral tap does not pass the air test, shows evidence of leakage, has been successfully cleaned to remove roots, or where Contractor has been directed to grout a tap that contains visible roots. The lateral packer shall remain in position during the pressure test, thus maintaining the isolated void. Pressure inject grout through the lateral packer into the annular space between the lateral grouting plug and the lateral pipe. Pump the grout out into the soil through leaking joints and pipe defects.

- 6.4.2 Pump grout materials into this isolated area. Run the pump continuously until refusal. Refusal shall mean the mixed grout has flowed through any joint failure, through any annular space, and into the surrounding soil; gelled or filled the available void space; and formed a cohesive seal stopping further grout flow, and an 8 psi back pressure is achieved while pumping. If the grout pumped exceeds 1 gallon per foot of lateral bladder plus 3 gallons, it will be suspected that there are significant voids on the outside of the pipe or that the packer is not properly sealed. Check that the packer is sealed properly. If it is, modify grouting procedure to step grouting by pumping additional grout in 4 gallon increments, waiting 1 full minute, retesting; and, if needed, continuing with additional 4 gallon grout steps until successful test or until directed to stop by the Engineer. Record the amount of grout pumped on the sealing log.
- 6.4.3 Upon completion of the lateral tap sealing procedure, air test the lateral tap a second time to confirm the sealing of the connection. If the lateral tap fails this air test, repeat the grouting procedure at no additional cost to the Owner. Repeat this sequence of air testing, grouting and subsequent air testing until either the lateral tap is sealed or it is determined that the grout consumption is too high and may result in the blockage of the lateral pipe. The final determination to stop subsequent attempts to seal a lateral tap will be made jointly between the Engineer and the Contractor. Air tests after grouting laterals containing roots is not required.
- 6.4.4 Confirm lateral flow after sealing of each lateral tap. With the lateral packer in position, retract the inversion tube and inject air pressure into the lateral. Should a pressure build in the lateral and not drop to approximately zero in a few seconds, move the packer off the connection and view the connection with a television camera. With the camera viewing the connection point, attempt to obtain water flush by the occupant. If no water is viewed during this procedure, it will be assumed that the building sewer connection is substantially blocked with grout and the Contractor shall immediately clear the lateral at no additional cost to the Owner. Blockages in the lateral that are not the result of grouting operations shall not be the responsibility of the Contractor.

6.5 *Lateral Tap Connection Warranty Testing –*

- 6.5.1 Conduct warranty testing on 15 percent of the mainline lateral tap connections (excluding grouted taps that contained roots) 18 to 24 months after Conditional Acceptance. Engineer will select the lateral tap connections to be warranty tested. Actual period for testing shall be determined by the Engineer and will ideally be conducted during high groundwater conditions. Contractor will be provided with 60-day notice of the warranty testing. Conduct all warranty testing in the presence of the Engineer.
- 6.5.2 If more than 10 percent of the warranty tested lateral tap connections fail, test an additional 15 percent of the lateral tap connections. If more than 10 percent of the second group of warranty tested lateral tap connections fail, test 100 percent of the remaining, untested, lateral tap connections at no additional compensation.
- 6.5.3 Grout and retest all lateral tap connection joints failing warranty testing at no additional compensation.
- 6.5.4 Perform a Warranty Inspection of all lateral taps that are warranty tested.