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Standard Practice for Sealing of Sewers Using Chemical Grouting[1]

This standard is issued under the fixed designation F2304; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

~~ε^1 NOTE—Editorial changes were made throughout in May 2016.~~

1. Scope

1.1 This practice describes the procedures for testing and sealing individual sewer pipe joints with appropriate chemical grouts using the packer method. Sewer systems shall include sanitary, storm, and combined and their appurtenances. Chemical grouting is a soil sealing process, which seals the voids within the soil surrounding the exterior of the pipe at the point of leakage. Chemical grouting is not considered a structural repair.

1.2 This practice applies to sewers ~~6~~6 in. to 42 in. ~~(18~~(18 cm to 107 cm) in diameter. Larger diameter pipe may be grouted with specialized packers or man entry methods. Host pipe interior surfaces must be adequate to create an effective seal for the packer elements.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 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 chemical grout manufacturer or supplier or both. Their safe operating practices and procedures should describe in detail appropriate personal protective equipment (PPE) for the various grouting operations. Operations covered should include the proper storage, transportation, mixing, and disposal of chemical grouts, additives, and their associated containers.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standard:*[2]

C1920 Practice for Cleaning of Vitrified Clay Sanitary Sewer Pipelines

[1] This practice is under the jurisdiction of ASTM Committee F36 on Technology and Underground Utilities and is the direct responsibility of Subcommittee F36.20 on Inspection and Renewal of Water and Wastewater Infrastructure.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *NASSCO Standards:*[3]
NASSCO Specifications Guidelines Wastewater Collection Systems Maintenance and Rehabilitation
NASSCO Specifications Guideline—Sewer Line Cleaning Wastewater Collections Systems Maintenance and Rehab, Sewer Line Cleaning
NASSCO Specifications Guidelines—Television Inspection, Main Sewers Wastewater Collections Systems Maintenance and Rehab, Television Inspection, Main Sewers

3. Summary of Practice

3.1 The work required by this practice shall consist of furnishing all labor, materials, equipment and supervising and performing all work necessary to rehabilitate the designated sanitary or storm sewer lines or both, all in accordance with the procedures. The work shall consist of, but not necessarily be limited to, performing the following tasks where specified:

3.1.1 *Sewer Line Cleaning,* shall be performed with hydraulically propelled high-velocity jet or mechanically powered equipment. Selection of equipment shall be based on field conditions such as access to manholes, quantity of debris, size of sewer, depth of flow, and so forth. NASSCO Specifications Guideline—Sewer Line Cleaning section adequately addresses the sewer line cleaning process in the current edition.

3.1.2 *Sewer Flow Control,* shall be performed as required to comply with this practice.

3.1.3 *Television Inspection,* shall be required to reveal and document sewer line conditions and be performed in advance of or in conjunction with pipe joint testing and sealing sewer pipe joints. NASSCO Specifications Guidelines—Television Inspection, Main Sewers section adequately addresses sewer line television inspection processes in the current edition.

3.1.4 *Sewer Pipe Joint Testing,* shall be performed to identify defective (infiltrating/exfiltrating) pipe joints and shall be accomplished by applying a positive test pressure to each individual sewer pipe joint, monitoring the test pressure and any test pressure decay, or through visual observation of the leaking joint.

3.1.5 *Sewer Pipe Joint Sealing,* shall be accomplished by the pressure injection of chemical grout (chemical sealing material) into the soils encompassing the pipe joint. Chemical grouts are designed to be injected into the soil surrounding the pipe, which stabilizes the soil and forms a permanent impermeable seal called a soil ring. Because the chemical grout is placed outside the pipe, adequate volumes must be injected to form an effective seal. This application will be through structurally sound joints from within the pipe (packer method) in tandem with a ~~closed circuit~~ closed-circuit television inspection system.

4. Significance and Use

4.1 The inspection, testing, and repair of sewer pipe joints is a practice that can assist in maintaining and optimizing sewer performance. It is important to identify methods that use the most current compounds and technology to ensure the reduction of infiltration and exfiltration. The method selected should utilize environmentally safe grout and minimize the disruption of traffic.

4.2 This practice serves as a means to inspect, test, and seal sewer pipe joints, having selected the appropriate chemical grouts, using the packer method. Television inspection and joint testing are used to identify sewer line conditions, defective joints, and document the repairs undertaken. Instruction on joint sealing, if necessary, is then detailed, using pressure injection into the soils encompassing the pipe joint with a chemical grout (chemical sealing material).

4.3 This practice should not be used for longitudinally cracked pipe, severely corroded pipe, structurally unsound pipe, flattened, or out-of-roundpipe. In areas with high groundwater pressure, greater than 10 psi (68.9 ksi) at the test point, consult equipment manufacturers.

5. Contract Responsibilities

5.1 Sewer system sealing contracts should define or affix responsibility or make provisions for the following items:

5.1.1 *Notice of Client/Owner Requirements,* which are relevant to and within the scope of work to be performed under the contract.

[3] Available from National Association of Sewer Service Companies (NASSCO), ~~2470 Longstone Lane, Suite M, Marriottsville, MD 21104,~~5285 Westview Dr., Suite 202, Frederick, MD 21703, http://www.nassco.org.

5.1.2 *Municipal and Other Licenses and Permits,* and assistance in obtaining approvals or consent from utilities or carriers or other persons or organizations upon whose property or authority performance of work under the contract might impinge; or a written release from responsibility for the performance of work under the contract if and to the extent such work is precluded by the inability to obtain approvals or consent.

5.1.3 *Access to Site of Work,* to be provided to the extent that the owner is legally able to so provide or, if not so able, a written release from responsibility for the performance of work at sites where access cannot be made available.

5.1.4 *Clearances of Blockages or Obstructions,* in the sewer system, if any, if such clearance is required for performance of work under the contract and if such clearance is not otherwise provided for within the contract.

5.1.5 *Location and Exposure of All Manholes,* unless otherwise provided for in the contract.

5.1.6 *Manhole Numbering System,* for all areas of the project and accurate manhole invert elevations when required for performance of the work.

5.1.7 *Shutdown or Manual Operation of Certain Pump Stations,* if such becomes necessary for performance of the work.

5.1.8 *Water,* necessary for performance of work under the contract, from fire hydrants or other sources must be obtained in accordance with local ordinances.

5.1.9 *Disposal Area,* for all materials removed from the sewers during the performance of the work and the unencumbered right of the contractor to transport and expeditiously dispose of such materials at a location designated by the owner.

5.1.10 *Secure Storage Area,* of a size adequate to accommodate the required vehicles, equipment, and materials for the period of the contract.

5.1.11 *Notice to Third Parties,* (such as utilities and affected residents) of the contractor's intent to perform work in an area where such parties may have rights to underground property or facilities. Request for maps or other descriptive information as to the nature and location of such underground facilities or property and assurance of the ~~contractor's~~contractor's ability to enter upon any public or private lands to which access is required for performance of the work under the contract.

5.1.12 *Information Pertinent to the Site* of the project including reports prepared under previously accomplished studies or surveys and other data relative to the project, including maps, drawings, construction specifications sewer system records, and so forth.

5.1.13 *Authorization* to perform work that must be performed during nighttime hours, on weekends, or on holidays.

5.1.14 *Traffic Control,* as specified by the agency with jurisdiction over the roadway or by uniformed officers when the safety of workers or the public requires such protection.

5.1.15 The contractor shall certify that backup equipment is available and can be delivered to the site within 48 h.

5.1.16 Submit work schedule to the owner's representative for review and approval before commencement of the project.

5.1.17 Submit equipment operating procedures and systems to the owner's representative for review and approval before commencement of the project.

6. Chemical Grout (Chemical Sealing Materials)

6.1 The intent of this section is to define the properties that a chemical sealing material must have to perform effectively in the intended application and under expected field conditions. The intended application is remotely sealing sewer pipe joints with a sealing packer as specified in Section 12.

6.1.1 Generic chemical sealing materials currently in use along with the basic properties, performance standards, and mix ratios, which are known to give acceptable performance, are listed in 6.2.

6.1.2 It is recognized that new and improved chemical sealing materials will become available from time to time. Sources,

manufacturers, and product names of chemical sealing materials will thus change from time to time and therefore specific sources, manufacturers, and product names are not given.

6.1.3 In every case, mixing and handling of chemical sealing materials shall be in accordance with the ~~manufacturer's~~manufacturer's or ~~suppliers~~supplier's recommendations or both.

6.2 *General*—All chemical-sealing materials used in the performance of the work specified must have the following characteristics:

6.2.1 While being injected, the chemical sealant must be able to react/perform in the presence of water (groundwater).

6.2.2 The cured material must withstand submergence in water without degradation.

6.2.3 The resultant chemical grout formation must prevent the passage of water (infiltration) through the soil ring and sewer pipe joint.

6.2.4 The sealant material, after curing, must be flexible as opposed to brittle.

6.2.5 The sealant formation must not be biodegradable.

6.2.6 The cured sealant should be chemically stable and resistant to the concentrations of acids, alkalis, and organics found in normal wastewater and storm water.

6.2.7 Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.

6.2.8 Measurement of the component materials being mixed must be compatible with field operations.

6.2.9 Field cleanup must be done without inordinate use of flammable or hazardous chemicals.

6.2.10 Residual sealing materials must be easily removable from the sewer to prevent reduction or blockage of the flow.[4]

6.3 *Chemical Sealing Materials*—The following is a generic listing of chemical sealing materials currently in use and the basic requirements, properties, and characteristics of each.

6.3.1 *Acrylamide Base Gel Sealing Material:*

6.3.1.1 A minimum of 10 % acrylamide base material by weight in total sealant mix. A higher concentration of acrylamide base material may be used to increase strength or offset dilution during injection.

6.3.1.2 The ability to tolerate some dilution and react in moving water during injection.

6.3.1.3 A viscosity of approximately 2 centipoise, which can be increased with additives.

6.3.1.4 Maintains a constant viscosity during the reaction period.

6.3.1.5 A controllable reaction time from 10 s to 1 h.

6.3.1.6 A reaction (curing), which produces a homogeneous, chemically stable, nonbiodegradable, firm, flexible gel.

6.3.1.7 The ability to increase mix viscosity, density and gel strength by the use of additives.

6.3.2 *Acrylic Base Gel Chemical Sealing Material:*

6.3.2.1 A minimum of 10 % acrylic base material by weight in the total sealant mix. A higher concentration of acrylic base material may be used to increase strength or offset dilution during injection.

[4] EPA Grant No. R806567-01, Office of R&D, U.S. EPA, Cincinnati, OH 45268.

6.3.2.2 The ability to tolerate some dilution and react in moving water during injection.

6.3.2.3 A viscosity of approximately 2 centipoise, which can be increased with additives.

6.3.2.4 A constant viscosity during the reaction period.

6.3.2.5 A controllable reaction time from 10 s to 1 h.

6.3.2.6 A reaction (curing), which produces a homogenous, chemically stable, nonbiodegradable, flexible gel.

6.3.2.7 The ability to increase mix viscosity, density, and gel strength by the use of additives.

6.3.3 *Urethane Base Gel Chemical Sealing Material:*

6.3.3.1 ~~One part~~ One-part urethane prepolymer thoroughly mixed with between five and ten parts of water weight. The recommended mix ratio is one part urethane prepolymer to eight parts of water (11 % prepolymer). When high flow rates from leaks are encountered, the ratio of water being pumped may be lowered.

6.3.3.2 A liquid prepolymer having a solids content of ~~75~~75 % to 95 % and a specific gravity of greater than 1.00.

6.3.3.3 A liquid prepolymer having a viscosity of between ~~100~~100 centipoise and 1500 centipoise at ~~70°F (21.1°C)~~70 °F (21.1 °C) that can be pumped through 500 ft (152 m) of ½~~-in. (1.3-cm)~~ in. (1.3 cm) hose with a ~~1000-psi (6895-kPa)~~1000 psi (6895 kPa) head at a flow rate of 1 oz/s.

6.3.3.4 The water used to react the prepolymer should have a pH of 5 to 9.

6.3.3.5 A cure time appropriate for the conditions encountered.

6.3.3.6 A relatively rapid viscosity increase of the prepolymer/water mix. Viscosity should increase rapidly in the first minute for 1 to 8 prepolymer/water ration at ~~50°F (10°C).~~50 °F (10 °C).

6.3.3.7 A reaction (curing) that produces a chemically stable and nonbiodegradable, tough, flexible gel.

6.3.3.8 The ability to increase mix viscosity, density, gel strength, and resistance to shrinkage by the use of additives.

6.3.4 *Urethane Base Foam Chemical Sealing Material:*

6.3.4.1 Approximately one part of urethane prepolymer thoroughly mixed with one part of water by weight (50 % prepolymer).

6.3.4.2 A liquid prepolymer having a minimum solids content of between ~~75~~75 % and 95 % and a minimum specific gravity of 1.00.

6.3.4.3 A liquid prepolymer having a viscosity of ~~150~~150 centipoise to 1200 centipoise at ~~72°F (22.2°C)~~72 °F (22.2 °C) that can be pumped through 500 ft (152 m) of ½~~-in. (1.3-cm)~~ in. (1.3 cm) hose with a ~~500-psi (345-kPa)~~500 psi (345 kPa) head at a flow rate of 1 oz/s.

6.3.4.4 A cure time appropriate for the conditions encountered.

6.3.4.5 During injection foaming, expansion and viscosity increases occur.

7. Optional Additives

7.1 Additives enhance the performance of the chemical sealing materials and can be used for specific applications. Additives are used to strengthen grout, reduce grout shrinkage, protect against low temperatures, increase viscosity, help fill large voids, and inhibit root growth. Owner/operators representative should consult with grout manufacturers to determine appropriate additives.

8. Sewer Line Cleaning Procedure

8.1 *Intent*—The intent of sewer cleaning is to remove foreign materials and restore the sewer to obtain proper seating of the packer. The importance of this phase of the operation cannot be overemphasized. Refer to Practice C1920 or NASSCO Specifications ~~Guidelines.~~Guidelines, or both, as appropriate.

9. Sewer Flow Control Procedure

9.1 When sewer line depth of flow at the upstream manhole of the section being worked on is above the maximum allowable for television inspection and joint testing (Table 1), or sealing (Table 2), the flow shall be reduced to the level shown by operation of pump stations, plugging or blocking of the flow, or by pumping and bypassing.

9.2 *Plugging and Blocking*—A plug inserted into the sewer upstream of the section being worked on can be used to regulate the flow to the recommended limits. The plug shall be designed so that all or any portion of the flow can be released.

9.3 *Pumping and Bypassing*—When pumping and bypassing is required, the contractor shall supply the pumps, conduits, and other equipment to divert the flow around the manhole section in which work is to be performed. The bypass system shall be of sufficient capacity to handle existing flow plus additional flow that may occur during a rainstorm. It must be designed so that if the bypass fails, flow can be immediately restored through the pipe. The contractor will be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. If pumping is required on a ~~24-h~~24 h basis, engines shall be equipped in a manner to keep noise to a minimum.

9.4 *Flow Control Precautions*—When flow in a sewer is plugged, blocked, or bypassed, sufficient precautions must be taken to protect the sewer from damage that might result from sewer surcharging. Further, precautions must be taken to ~~insure~~ensure that flow control operations do not cause flooding or damage to public or private property being served by the sewers.

10. Television Inspection Procedure for Main Sewers

10.1 After cleaning, the sewer shall be remotely inspected by means of color closed-circuit television. The inspection for access will be done one manhole section at a time. The flow in the sewer being inspected will be suitably controlled as specified in Section 9. NASSCO Specifications Guidelines—Television Inspection, Main Sewers section adequately addresses sewer line television inspection processes in the current edition.

11. Method for Sewer Pipe Joint Testing

11.1 *Scope*—Pipe joint testing identifies those sewer pipe joints that are defective (allowing groundwater to enter the sewer system and sewage to exfiltrate the sewer system) and that can be successfully sealed by the internal pipe joint sealing process. Testing will be performed on all joints in a section, unless visibly leaking, as this is a positive leak indicator. Testing all nonvisibly leaking joints must be performed in each section. Testing each nonvisibly leaking joint ~~insures~~ensures that the entire section is sealed even if the water table is raised. All sewer line joint testing and grouting shall be conducted immediately following the cleaning and pressure testing of the reach.

11.2 *Significance and Use*—Sewer pipe joint testing is used to test the integrity of individual pipe joints. Testing should not be performed and will not be required on longitudinally cracked or broken pipe.

11.3 *Equipment:*

11.3.1 The basic equipment used shall consist of a television camera, a joint testing device (known as a packer) with inflatable bladders, and test monitoring equipment. The equipment shall provide a means for introducing a controlled test medium, under

TABLE 1 Maximum Depth of Flow—Television Inspection

~~6- to 10-in. pipe~~	~~20 % of pipe diameter~~
6 in. to 10 in. pipe	20 % of pipe diameter
~~12- to 24-in. pipe~~	~~25 % of pipe diameter~~
12 in. to 24 in. pipe	25 % of pipe diameter
27 in. and up pipe	30 % of pipe diameter

TABLE 2 Maximum Depth ~~Of~~ Flow—Joint Testing/Sealing	
~~6- to 10-in. pipe~~	~~25 % of pipe diameter~~
~~1-2 to 24-in. pipe~~	~~30 % of pipe diameter~~
~~27-in. and up pipe~~	~~35 % of pipe diameter~~

TABLE 2 Maximum Depth of Flow—Joint Testing/Sealing	
6 in. to 10 in. pipe	25 % of pipe diameter
1-2 in. to 24 in. pipe	30 % of pipe diameter
27 in. and up pipe	35 % of pipe diameter

pressure, into the void area created by the expanded ends of the joint testing device. The packer will simultaneously permit some flow to pass through its center annulus. The equipment will also provide a means for continuously measuring the actual static pressure of the test medium within the void area created by the inflation of the packer. All pressure measurements shall be made at the void area.

11.3.2 Void pressure data shall be transmitted from the void to the monitoring equipment or video picture of a pressure gauge mounted on the packer and connected to the void area. All test monitoring shall be above ground and in a location to allow for simultaneous and continuous observation of the television monitor and test monitoring equipment by the owner's representative.

11.4 *Procedure:*

11.4.1 *Control Testing*—Before starting the pipe joint testing phase of the works, a control test shall be performed as follows.

11.4.1.1 To ~~insure~~ensure the accuracy, integrity, and performance capabilities of the testing equipment, a demonstration test will be performed in an above-ground ~~8-in. (20-cm)~~8 in. (20 cm) nominal diameter test cylinder suitable to contain the full length of the packer and sustain the void test pressure. The test cylinder will be equipped with a pressure indicating device and can be calibrated to read similar test pressures. The cylinder will be equipped with a void release valve to exercise a controlled release of the test media with the associated pressure drop to be equally displayed on the cylinder gage and test monitoring equipment. The observed pressure shall be within ±½ psi (3 kPa) of the ~~7~~7 psi to 10 psi ~~(48~~(48 kPa to 69 kPa) pressure applied to the test gage to pass successfully. The void pressure should drop to within ±½ psi (3 kPa) of zero or to the value of the check valve not exceeding 3 psi (21 kPa), after the pressure is released to pass successfully.

11.4.1.2 If this controlled test cannot be performed successfully, the contractor shall be instructed to repair or otherwise modify this equipment and perform the test again until the results are satisfactory to the owner's representative. This test may be required at any other time during the joint testing work if requested by the owner's representative to verify the accuracy of the testing equipment.

11.4.2 *Intermediate Test*—~~After-~~After entering each manhole section and immediately before the commencement of the joint testing, an intermediate test will be conducted on the pipe between joints as follows (in Sewer Barrel Test):

11.4.2.1 The packer will be positioned on a section of sound and clean pipe between two consecutive joints. The procedure for packer inflation and test media introduction will be conducted, the system will be isolated, and the test media supply line vented to allow for the reading of a simulated void test. The test should read ~~positive,~~positive and hold a ~~7~~7 psi to 10 psi ~~(48~~(48 kPa to 69 kPa) test pressure for a period of 15 s with a pressure drop of less than 1 psi (7 kPa). This procedure will support the accuracy and performance of the testing equipment. Higher test pressures can be utilized for pipe at greater depths up to the practical limit of the packer end seals, approximately 10 psi (69 kPa).

11.4.2.2 Should it be found that the test equipment will not meet this intermediate joint test requirement, and assuming the barrel is sound and clean, the contractor shall be required to repair or otherwise modify the equipment and retest until the results are satisfactory to the engineer. Additionally, this test may be required any time the engineer or contractor wish to confirm correct operation of the equipment while in the pipe during the test and seal operation.

11.4.3 *Final Test Equipment Observation*—Upon completing each test, the packer shall be deflated. The operator should observe that the void pressure-monitoring meter will drop to within ±½ psi (3 kPa) of initial pressure reading. Should the void ~~pressure monitoring~~ pressure-monitoring meter fail to drop to ±½ psi (3 kPa) of the initial pressure reading, there may be a blockage in the void monitoring system. The operator shall be responsible for cleaning his equipment of residual grout material or make the necessary equipment repairs to provide for an accurate void pressure reading. This test observation of the pressure dropping to within ±½ psi (3 kPa) of the initial pressure reading should also be performed after each joint test.