

**STANDARD SPECIFICATIONS
SECTION 02959
SEWER MAIN AND LATERAL CONNECTION SEALING BY CHEMICAL GROUT**

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for rehabilitation of defective mainline joints, circumferential mainline cracks, other small mainline defects and defective lateral-mainline interfaces by application of chemical grout material.

1.2 DEFINITIONS

- A. Mainline: Sewer Main.
- B. Lateral: Service pipe from property line to mainline.
- C. Lateral-Mainline Interface: Lateral connection to mainline.
- D. Lateral-Mainline Interface Seal: Watertight seal between lateral and mainline.

1.3 QUALITY ASSURANCE

- A. Follow ASTM F2304 and F2454-05.
- B. Commercially Proven Products:
 - 1. Minimum 12,000 mainline joints and 1,000 lateral-mainline interfaces successfully grouted and documented in the United States and Internationally.
 - 2. Translate international installations into English to Engineers approval.
- C. Personnel involved in sealing of joints and lateral connections: Certified by grout manufacturer they have successfully completed training in handling, mixing and application of grout for sanitary sewer line and joint and lateral connection sealing.
- D. Third-Party Inspector: Minimum of 5 years experience in Chemical grouting applications and have no financial or directorial link to grout manufacturer or Contractor.
- E. Engineer may inspect and test grout at factory, before delivery to site, while in storage, or prior to use.
- F. Internally CCTV inspect host pipe prior to grouting, during grouting and post grouting.

1.4 SUBMITTALS

A. Submit following Section 01330.

1. Catalog data showing manufacturer's clarifications and updates, ASTM references, material composition, specifications, and physical and chemical properties of grout.
2. Calculations of expected volumes of annular space between packer and pipe wall, to be used in calculating required gel times.
3. Manufacturer's recommended procedures for handling, storing, mixing and injecting grout.
4. Method of Construction.
 - a. Access manholes and site locations.
 - b. Work dimensions.
 - c. Size of working area.
 - d. Impacted portions of existing sewer.
 - e. Site access points.
 - f. Bypass pumping plan: Following Section 02960.
5. Emergency plan detailing procedures to be followed in event of health and safety emergency, pump failures, sewer overflows, service backups, and sewage spillage. Maintain copy on site for duration of project.
 - a. Address dangers associated with sewer rehabilitation work.
 - b. Identify Health and Safety officer. (i.e. crew chief)
 - c. Designated Health and Safety officer:
 - 1) Responsible for providing health and safety oversight of personnel participating on project team.
 - 2) Perform and document routine work area inspections, conduct safety meetings, and provide safety orientations for team members.
 - 3) Have in easily accessible location, the following contact information
 - a) Non emergency number.
 - b) Contractor's health and safety representative name and number.
 - c) Occupational health clinic number(s).
 - d. Submit for review the following;
 - 1) List of critical rehabilitation equipment, to be inspected on daily basis.
 - 2) Recently completed (previous month) monthly maintenance log.

B. Submit following Section 01450.

1. Grout manufacturer's certification that Contractor is approved installer of their system. Certificates of training in handling, mixing, and application of grout for sanitary sewer line and joint and lateral connection sealing for grout truck operator and at least one crewmember involved in sealing process.
2. Third party lab test results for field installations in United States of same grout system as proposed for actual installation.
 - a. Test results must verify grout physical and chemical properties specified herein have been achieved in previous field applications.

3. CCTV inspection reports and electronic downloads following 02956, before and following sewer joint sealing. Furnish original copies of CCTV inspections color DVDs to Engineer within 10 days.
4. Documentation for Products and Installers: Engineer's approval required before acceptance or injection of grout.
5. Proof of grout manufacturer's product liability insurance, if requested by Engineer.
6. Pump calibration information.
7. Field sealing records.
8. Certification of accuracy and calibration of pressure sensing/monitoring equipment by independent testing firm within one month before use of equipment.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect, store, and handle grout or other material during transportation and delivery, while stored on-site, and during installation following manufacturer's recommendations.
- B. Grout Material found defective or damaged due to manufacture or shipment:
 1. Remove from Contract site and replace, following Engineer's direction, at no cost to the Commission.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Grouting.
 1. Properties and Characteristics.
 - a. Will perform in presence of infiltrating water, during injection.
 - b. Packaged for field storage, handling requirements with minimum spillage and worker safety.
 2. Cured grout:
 - a. Submergible in water without degrading.
 - b. Not biodegradable.
 - 1) Additives may be used to meet this requirement, without effecting long-term strength.
 - c. Chemically stable and resistant to concentrations of acids, alkalis, and organic materials found in normal sewage.
 3. Composition.
 - a. Acrylamide gel:
 - 1) Minimum of 10 percent acrylamide base material by weight in total grout mix.
 - 2) Higher concentration percent of acrylamide base material (maximum 20%) may be used to increase strength or offset dilution during injection.
 - 3) Able to tolerate some dilution and react in moving water during injection.

- 4) Approximately 2 centipoise viscosity. Can be increased with additives.
 - 5) Constant viscosity during reaction period.
 - 6) Controlled reaction time from 10 seconds to 1 hour.
 - 7) Curing reaction producing a homogenous, chemically stable, non-biodegradable, firm, flexible gel.
 - 8) Able to prevent dehydration and increase-mix viscosity, density and gel strength by use of additives.
 - a) Diatomaceous earth (Celite 209 or equal) can be added to concentration of five percent.
 - b) Use of other additives following manufacturer's recommendation and Engineer's approval.
 - 9) Root control additive 2, 6-Dichlorobenzonitrile, may be added following manufacturer's recommendation and Engineer's direction.
- b. Urethane gel:
- 1) Ratio: One part urethane prepolymer mixed with 5 to 10 parts water by volume.
 - a) Recommended mix ratio: 1 part urethane prepolymer to 8 parts of water (11 percent prepolymer).
 - 2) Liquid prepolymer:
 - a) Solids content: 77 to 83 percent.
 - b) Specific Gravity: 1.04 (8.65 pounds per gallon)
 - c) Flash Point: 20 degrees F.
 - d) Viscosity: 600 to 1,200 centipoises water at 70 degrees F.
 - 3) Water for reacting prepolymer: pH of 6.5 to 8.
 - 4) Curing reaction:
 - a) Produces chemically stable, non-biodegradable, tough, flexible gel.
 - b) Able to increase mix viscosity, density, gel strength and resistance to shrinkage by using additives in water component of grout.
 - c) Minimum 15 percent shrink control agent supplied by the same manufacturer.
- c. Acrylate gel:
- 1) Minimum 10 percent acrylate base material by weight or as specified by the manufacturer.
 - a) In total grout mix, a higher concentration (percent) of acrylate base material may be used to increase strength or offset dilution during injection.
 - b) If acrylate base material is in 40 percent solution 27.5 percent by weight of total grout mix: 11 percent base material.
 - 2) Able to tolerate some dilution and react in moving water during injection.
 - 3) Viscosity: Approximately 2 centipoises.
 - a) Can be increased with additives.
 - 4) Constant viscosity during reaction period.
 - 5) Controlled reaction time: 10 seconds to 1 hour.
 - 6) Curing reaction producing homogeneous, chemically stable, non-biodegradable, flexible gel.

- 7) Able to prevent dehydration and to increase-mix viscosity, density and gel strength by use of additives.
 - a) Diatomaceous earth (Celite 209 or equal) can be added to concentration of five percent, by volume.
 - b) Use of other additives following manufacturer's recommendations and Engineer's approval.
- 8) Root control additive 2, 6-Dichlorobenzonitrile, may be added following manufacturer's recommendation and Engineer's direction.

2.2 EQUIPMENT

- A. General.
 1. CCTV system, necessary chemical grout containers, pumps, regulators, valves, hoses, joint sealing packers for various sizes of sewer pipes, and lateral bladders.
 2. Air pressure monitoring system:
 - a. Configured with no valves on air line between measuring point and pressure sensing device.
 - b. Digital readouts located at control panel in grouting truck.
- B. Grouting packer:
 1. Diameter less than pipe size, with cables attached at each end to pull it through the line.
 2. Designed to allow restricted amount of sewage to flow through device, in mainlines where sewage flows do not exceed maximum depth for joint testing/sealing following manufacturer's recommendation and following ASTM F2304 and ASTM F2454-05.
 3. Approved Manufacturers:
 - a. Logiball, Inc.
 - b. Cues, Inc.
 - c. Or Equal.

PART 3 EXECUTION

3.1 PUBLIC NOTIFICATION

- A. Follow Section 02950.
 1. Deliver written notices to each home or business immediately after sealing operation.

3.2 PREPARATION

- A. Access.
 1. Chemical grout sealing of mainline sewers: Through existing manholes.
 2. Chemical grout sealing of lateral-mainline connections: Through mainline sewers.
- B. Sewer Cleaning and Surface Preparation.

1. Cleaning of Main Line Sewers and Laterals.
 - a. Hydraulic high pressure jetting of reaches is permitted.
 - b. Before sealing work, lightly clean each line section.
 - c. Remove sludge, dirt, sand, grease, root, and other materials from pipe and collect and remove resulting debris from downstream manhole of sewer section being cleaned.
 - d. Collect debris and remove from site. Following jurisdictional requirements and Engineers' approval.
 - e. Sewers damaged as result of improper use of cleaning equipment: Promptly repaired at no additional cost to the Commission.
 - f. Clean sewer main within 72 hours before chemical grouting of sewer lateral connections.

C. Pre-sealing CCTV Inspection.

1. After cleaning, perform CCTV inspection to ensure main is sufficiently clean to perform sealing operations. Document protruding taps and structural defects found during the CCTV inspection.
 - a. If Engineer finds main is not sufficiently cleaned, remove CCTV and sealing equipment and re-clean at no additional cost to the Commission.
 - b. If light cleaning is not sufficient, heavy clean sewer following Section 02956.

D. Pre-sealing Reaming.

1. Ream or trim protruding taps following Section 02955.

E. Structural Defects.

1. Repair defects that would interfere with sealing operation following Section 02530 to Engineers acceptance prior to grout injection.
2. If possible, perform a reverse set up for sealing operation from opposite manhole instead of performing a point repair.

F. Bypass Pumping: Before pre-sealing CCTV inspection, and joint testing and sealing can be performed, depth of flow should be at or below levels shown in table.

1. If necessary, bypass pump to bring flow levels down to acceptable levels.

Pipe Diameter (inches)	Maximum Depth of Flow (as % of Pipe Diameter)
6 to 10	20
12 to 24	25
27 or greater	30

3.3 TESTING

A. Performance Test Demonstrations.

1. Before start of work, verify accuracy and repeatability of void pressure meter and fluid pumping equipment.

2. If test demonstrations fail to show accuracy of +/-0.5 psi for void pressure repeatability and +/- 0.1 gallon of chemical pumped into measured container or bucket, make required repairs or adjustments to equipment and gauges and retest until results meet Engineers satisfaction.
3. Test may be required at commencement of each work shift during sealing operations.

B. Mainline Joint Pressure Air Testing.

1. Before testing, perform control tests at ground surface to verify accuracy, integrity, and reliability of testing equipment following ASTM F2304.
2. After entering each pipe segment through manhole, and immediately before joint pressure air testing, perform an intermediate test on pipe between joints following ASTM F2454-05.
3. Maintain joint testing air pressure of 3 psi higher than groundwater pressure outside the pipe, up to maximum of 10 psi. If groundwater pressure data is not available, use joint testing pressure of 0.5 psi per vertical foot of pipe depth or 10 psi, whichever is greater.
4. Perform testing following ASTM F2304. Seal joints that do not maintain void pressure drop of less than 1 psi in 15 seconds.

C. Lateral Connection Pressure Air Testing.

1. Before lateral connection testing, perform control tests at ground surface to verify accuracy, integrity and reliability of testing equipment following ASTM F2454-05.
2. Maintain joint testing air pressure of 3 psi higher than groundwater pressure outside the pipe, up to maximum 6 psi. If groundwater pressure data is not available, use joint testing pressure of 0.5 psi per vertical foot of pipe depth or 6 psi whichever is greater.
3. Perform lateral connection testing following ASTM F2454-05. Seal joints that do not maintain void pressure with pressure drop of less than 2 psi in 15 seconds.

3.4 BASIC REQUIREMENTS

A. General.

1. Seal joints, defects or leaking lateral connections that failed air testing or show sign of visible leaks, by internal chemical methods, as directed by Engineer.
2. After sealing of joint, defect or connection, perform post air test per ASTM F2304 or ASTM F2454-05 for mainline sewer sealing and lateral sealing, respectively.
3. Sewer that Engineer deems damaged as a result of Contractor's operations, will be promptly repaired to Engineer's satisfaction at no cost to the Commission.
4. Grouting materials that set to a hard, rigid product capable of intrusion into sewer lines are not acceptable unless specifically approved by Engineer on a case by case basis.
5. Provide qualified, independent third party inspector to observe grouting mixing process, chemical grouting injections process and post grouting pressure testing. Report findings to Engineer.

B. Application Procedures for Joint Sealing and Lateral Connection Sealing.

1. Force chemical grouting material into or through faulty joints, defects or lateral connection by system of pumps, hoses, and sealing packers.
 - a. Position packer over faulty joint or lateral connection by means of measuring device and CCTV camera in line.
 - b. For mainline sewers, expand packer end bladders using controlled pressure. For lateral connections use lateral packer equipped with lateral bladder and rotating mechanism.
 - 1) Obtain a tight seal. If a tight seal is not obtained, remove equipment and make adjustments.
 - 2) Pump grout material through hose system at controlled pressures high enough to overcome external pressures such as groundwater pressures.
2. Design pumping unit, metering equipment, and packer devices so proportions and quantities of materials can be regulated following type and size of leak being sealed.
3. Set chemical pumping rates and mixing ratios as specified herein, following manufacturer's recommendations and Engineer's adjustments.
4. Determine appropriate gel set times.
 - a. To estimate gel set times, divide estimated volume of annular space (in gallons) by grout pumping rate (in gallons per minute), then add between 15 to 25 seconds. Adjust estimate by taking into account temperature of grout tanks, temperature of hoses, temperature of groundwater, amount of groundwater present and other field conditions.
 - b. The gel set time is typically between 20 and 40 seconds. Gel set times of less than 20 seconds may be required in presence of high filtration.
 - c. Monitor induction periods and gel characteristics through daily gel time tests for each sealing vehicle. Check each new batch once. If only one batch is used, check at least twice per day.
 - d. Perform new gel time test when grout additives are modified to change gel times, at beginning of new setup with new starting manhole, or when temperature in tanks and hoses changes by more than 10 degrees F from previous gel time test.
 - e. Use water with known and controlled pH that will be used during actual grouting operations.
 - f. Allow grout mixture to settle to remove entrained oxygen, before testing gel time.
 - g. Use plastic or stainless steel tanks. Do not use tanks that contain iron or copper.
5. During seal operations, operate void pressure monitoring equipment, described herein.
6. Integrate CCTV, grout pumping, and air pressure monitoring equipment so proportions, quantities, and void pressure for materials and sealing can be instantly monitored and regulated following type and size of joint, break, or leak.
7. Amount of chemical being pumped: Based on number of pumped strokes delivered for each sealed sewer main joint, defect or leaking connection.

- a. Record and provide results to Engineer.
8. If large voids are encountered on outside of sewer, including the possibility of "piping" holes to ground surface, which could cause excessive use of grout material, at Engineer's direction change operating pressures and pumping rates as follows.
 - a. Reduce pressures and pumping rates, such that intervals between pump strokes are shorter than gel time.
 - b. Pump first stage of grout, and then stop pumping until temporary gel of the grout is obtained on outside of pipe.
 - c. Increase pressure and pumping rate to pump the second stage and form a second layer.
 - d. Repeat this cycle until refusal conditions are reached, or until the inspector judges the grout consumption to be excessive.
 - e. Avoid sealing inner surface of pipe from inside before building up layers on the outside.
9. Grout injection complete: When chemical grout is pumped to refusal as defined in ASTM F2304.
 - a. If chemical grout cannot be pumped to refusal, within a volume less than or equal to 0.5 gallons per inch of pipe diameter due to latent physical conditions, do not perform additional work until Engineer grants authorization.
 - b. Lateral connections: When back pressure of grout in void at mainline level drops from 8 psi to 6 psi in greater than 20 seconds after cessation of grout pumping, following ASTM F2454-05.
 - 1) If using stage grouting, grout injection is complete when refusal pressure of 8 psi is achieved.
10. Sealed Defects.
 - a. Remove excess grout gel ring if obtrusive and impedes air testing and CCTV inspection of work as required. If excess grout gel ring cannot be removed by use of packer, jet clean pipe prior to testing seal.
 - b. Air test each sealed joint.
 - 1) If defect or connection fails air test after grout injection, reseal failed joints and air test again.
 - 2) After lateral connection has been sealed successfully as confirmed by post air test, break lateral packer seal and test service to assure grout has not blocked lateral connection further upstream.
 - a) In the event sewage back-up occurs and enters a dwelling, respond within 2 hours of being notified and be responsible for cleanup, repair, property damage costs and claims.
 - c. After all pipe joints and lateral connections have been grouted, retest all previously unsealed pipe joints and lateral connections. Seal any pipe joints and lateral connections that do not pass the air pressure test.
11. Flush or push forward excess grouting material to next downstream manhole, and remove from sewer system.
 - a. Dispose of debris following grout manufacturer's recommendation, and jurisdictional regulations.

- b. Excess grout material from upstream section(s) will not be allowed to accumulate in sewer.
- 12. Provide approved plug and/or by-pass pumping if grouting operations restrict or prevent simultaneous sewage flow passage.
 - a. Manage Sanitary Sewer Overflow following Section 02530.

C. Joint, Defect or Lateral Connection Sealing Verification.

- 1. Mainline joints and defects.
 - a. Deflate packer bladders after completing each seal until zero void pressure (± 0.5 psi) is shown on the monitoring equipment.
 - b. If zero void pressure (± 0.5 psi) is not achieved, clear residual grout material from packer or make needed equipment adjustments allowing true pressure reading.
- 2. Re-test joint, defect or lateral connection as described herein.
 - a. Re-seal joints, defects, or connections that do not meet specified test criteria and re-test until test criteria are met, or Engineer determines that joint defect, or lateral connection cannot be sufficiently sealed.
 - b. Additional testing and sealing will be at no additional cost to the Commission.

D. Residual Sealing Material.

- 1. Leave no residual grout material capable of reducing pipe diameter or restricting flow greater than 5 percent pipe capacity.

E. Obstructions.

- 1. During course of sealing operations obstructions may be encountered preventing travel of packer and camera.
 - a. Should obstruction not be passable, begin sealing operations from opposite end of sewer reach.
- 2. If additional obstructions are encountered after re-employment and no means are available for passing obstructions without damage to equipment, remaining sections of sewer main not sealed may be temporarily excluded from work requirements of Contract, until point repair is completed.

3.5 FIELD DOCUMENTATION

A. Records.

- 1. Keep complete, accurate, and legible records of operation for each joint, defect or connection sealed.
 - a. Include on Record of Operation for each joint or lateral mainline interface tested and/or routed or attempted to be grouted:
 - 1) Identification of work site, complete component, address, county page & grid, 200 foot sheet.
 - 2) Date and time.
 - 3) Station of each seal measured from upstream manhole.
 - 4) Location of any joints not tested and reason for not testing.

- 5) Grout mixture formation, including additives and catalyst mixture.
 - 6) Test pressures and durations of tests maintained for each joint passing the air test.
 - 7) Ambient outside air temperature at time of grout injection.
 - 8) Grout tank temperatures.
 - 9) Gel time and time last verified.
 - 10) Verified address of lateral.
 - 11) Estimated visible leakage (gpm) from joint/defect connection or lateral.
 - 12) Number of pump strokes and amount of grout in place.
 - 13) Beginning, ending, pressure losses, re-test pressures.
 - 14) Verification lateral is clear after sealing process.
 - 15) Remaining leakage and location after seal (gpm).
2. Work site will not be accepted until Engineer receives original record.
 - a. Failure to fill out logs completely will result in non-payment for the questioned mainline joint, defect or connection.

3.6 WARRANTY

- A. Provide twelve month performance and workmanship warranty for the seals from date of acceptance of the Commission.
- B. Perform CCTV inspections during the first wet weather season after initial sealing, to evaluate quality of the initial sealing.
- C. CCTV inspect initial retest area consisting of 10 percent of grouted joints and 10 percent of grouted lateral connections following Section 02956.
- D. Provide qualified, independent third party inspector to review CCTV inspection videos to verify integrity of seals.
- E. Reseal all joints sealed under this Contract that inspector finds defective within warranty period, at no additional cost to the Commission.
 1. Defective seals include, but not limited to those with root penetration, signs of infiltration, and cracks in pipe or grouting material.
- F. If failure rate of retested joints and lateral connections is 5 percent or less of joints and lateral connections retested, work shall be considered satisfactory and no further retesting will be required. If the failure rate of retested joints and lateral connections is greater than 5 percent, the Engineer shall randomly select another retest area consisting of another 10 percent of the initially sealed joints and lateral connections. Continue this additional retesting and resealing until a failure rate of less than 5 percent is met.

3.7 ACCEPTANCE

- A. When sealed joint, defect, and lateral connections pass the post air test.

PART 4 MEASUREMENT AND PAYMENT

4.1 TEST AND SEAL MAINLINE JOINT OR DEFECT

- A. Measurement: By each joint or defect sealed and air tested includes up to two gallons of grout per joint or defect.
- B. Payment: At unit price for each size listed in Bid Schedule.
 - 1. Payment includes plugging or by-pass pumping, traffic control, CCTV inspections, pre-sealing cleaning, reaming intruding taps, removal of extraneous materials from sewer main, labor and equipment necessary to seal joints, defects, and post sealing air test.

4.2 TEST AND SEAL LATERAL CONNECTION

- A. Measurement: By each lateral connection sealed and air tested, which includes up to two gallons of grout per joint or defect.
- B. Payment: At unit price for each size listed in Bid Schedule.
 - 1. Payment includes plugging or by-pass pumping, traffic control, CCTV inspections, pre-sealing cleaning, removal of extraneous materials from sewer main and lateral, labor and equipment necessary to seal connection, post sealing air test, and test to ensure that lateral is clear.

4.3 SEALING MATERIAL

- A. Measurement: By gallon of grout used, over initial two gallons per joint or lateral connection.
- B. Payment: At unit price listed in Bid Schedule.
 - 1. Payment includes materials, additives, storage, calculations, mixing, testing for in-place percentage and gel time tests.

4.4 RETESTING SEALED JOINTS UNDER WARRANTY

- A. Measurement: By unit price for each required item of work.
- B. Payment: At contingent price listed in Bid Schedule.
 - 1. Payment includes work related to retesting of sealed joints including cleaning, CCTV inspection, and air testing in the initial retest area only.
 - a. No compensation will be provided for resealing joint that fails air testing or any additional testing beyond initial retest area.

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