

# SMOKE TESTING

## PERFORMANCE SPECIFICATION GUIDELINE FOR SANITARY SEWER

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## **PART 1 - GENERAL BACKGROUND**

- A. The nature of the smoke testing inspections is to confirm system connectivity, identify gravity sewer system defects, assist in locating cross-connections between storm and sanitary sewer, locate the source(s) for odor complaints and to provide a permanent record of the defects including type, location, and severity. Smoke testing is one of the tools available for evaluating sanitary sewers and should not be considered the only test necessary to evaluate a collection system nor is it intended to be used for quantification of sources. When combined with flow monitoring, manhole inspection, flow isolation, dye water flooding and closed circuit television inspection a complete condition assessment of the collection system can be made. Smoke testing is very effective in identifying sources of inflow and restrictive conditions in sewers. Smoke exiting from a storm sewer catch basin (in a separate system) identifies a potentially large source of inflow; however, smoke testing alone does not identify where the connection or problem is located. It will be necessary to dye flood and CCTV various sewers to identify the connection, poor joints or service lateral that is the source for the smoke entering the storm sewer. Further investigations are commonly required based on the initial smoke test findings to establish the cause, location and repair method(s).
- B. It is important to realize that smoke exiting a mainline sewer may be a symptom of more significant problems and caution should be made in making one point repair without investigating the entire segment. It is common to find only a few smoke defects on entire lengths of sewer that when internally CCTV inspected are in very poor structural condition. Keep in mind that smoke will travel through the soil in a path of least resistance and may surface a considerable distance away from the actual defect source.
- C. Caution should also be taken in assessing storm drainage connections. Once smoke enters a storm sewer, many inlet structures may exhibit smoke exiting. The possible cause for smoke exiting the storm sewer may be due to poor joints, in both the storm and sanitary sewer, broken service lateral crossing the storm sewer, directional drilling that damaged storm or sewer pipe, direct connection, etc. Additional investigation, which may include dye flooding and CCTV, will be required to determine the exact location of the source and establish the repair method.
- D. (Note: During the planning stages of the smoke testing program, verification of the use of "catchment hoods" should be made. If hoods are being utilized, smoke may not exit from those catch basins connected to the sanitary sewer. It may be necessary to clean and/or drain the sumps below the level of the hood if testing is to be successful.)
- E. Smoke testing can provide detailed information on wet weather inflow sources, cross-connections with storm sewers, odor complaints and service connection confirmation, etc. However, soils that are saturated will not allow smoke to exit and limit the

usefulness of the testing. Therefore, it is recommended that smoke testing be scheduled during the dry season(s) to optimize the effectiveness of the test. Local conditions will dictate the time required after a rainfall event that will allow for smoke testing to be optimally effective. Establishing a test section of sewer, with previously identified defects, can provide a means of checking if soils are sufficiently dry. If the same defects are observed with similar intensity of smoke, then it is presumed that soils are sufficiently dry.

- F. Field documentation of the defects is extremely important and will include sketches of each system defect along with pertinent information for prioritizing the defects. Data documentation should be sufficient to establish the location of each defect. Additional inspections pinpoint the source and determine the best repair method. Color photographs will be taken to document each defect during the smoke test. The location of the defect will be determined by referencing the defect relative to the upstream manhole or by measurement from permanent objects (corner of house, power pole, etc.). The data collected in the field may be computerized using an industry standard database format so that the defects identified can be readily listed by priority for subsequent repair. Note that it may be feasible on small projects to collect all data on paper forms and manually perform analysis. Additionally, smoke testing information may be used to generate a list of line segments that require dye testing and internal TV inspection.

## 1.1 SCOPE

- A. It is the intent of this specification to provide for the smoke testing materials and procedures to be used in the investigation of the sanitary sewer facilities as shown on the project study area maps. All materials and procedures shall be consistent with these specifications, current industry standards, and as approved by the Utilities Department Project Manager.

## 1.2 REQUIREMENTS

- A. The Contractor shall test the gravity sanitary sewer system using high capacity blower(s). The smoke blower will be suitable for the anticipated testing and generate non-toxic smoke. The contractor personnel will visually identify and document each defect location. Contractor shall provide safety equipment suitable for the anticipated field and traffic conditions. Digital camera(s) will be used for documentation of observations. All inspections shall be recorded on standard smoke testing paper forms or entered into an electronic database.
- B. The nature of the smoke testing inspections shall be to confirm system connectivity, identify gravity sewer system defects, cross-connections between storm and sanitary sewer, location of potential building traps visualized by sewer vents with no smoke and to provide a permanent record of the defects including type, location, and severity.

Inspections will be performed by introducing non-toxic smoke into the sanitary sewer pipes using a high capacity blower (or approved equal depending on the project goals), observing smoke exiting vent stacks and at defect locations, and documenting the defects.

### 1.3 PERSONNEL QUALIFICATIONS

- A. The field crew will be of sufficient size to properly operate the smoke generation machine and provide full coverage of the area to visually locate smoke discharged from defects. This must include personnel for traffic control.
- B. The employees performing the smoke testing under the provisions of these specifications shall be properly trained and thoroughly experienced in the use of the equipment and procedures.
- C. Each employee shall wear or have on them a photo ID identifying him/her by name, company name and contact information. Clothing and vehicles identifying the company is also preferred. All job supervisors will have business cards with contact information to provide to residents if requested.
- D. The Contractor shall take appropriate action to ensure that his/her employees are polite to the public in all aspects of the work and that immediate assistance is provided to property owners if needed.

### 1.4 NOTIFICATION

- A. Contractor shall notify the project manager a minimum of 48 hours prior to the startup of smoke testing work or re-startup following delays due to weather. Contractor will provide the project manager the location for the next days work at the end of each day, if requested. No payment will be made for work performed without proper notification. Refer to section 3.1.A.5 for daily notification requirements.

## **PART 2 - EQUIPMENT**

### 2.1 BLOWERS

- A. The Contractor shall provide a portable blower designed and built specifically for the use of smoke testing. The blower shall be self contained and capable of producing a minimum of 4,500 cubic feet of air per minute. Blowers with less cfm may be approved by the project manager provided it is demonstrated that sufficient pressure is generated for the testing. If inadequate pressure is being generated, then additional blowers (dual blowers) or larger blowers may be required. Adequate pressure is being provided when smoke is exiting the vent stacks as a plume or, where no vent stacks are present, smoke is exiting the upstream/downstream manhole casting/vent

hole/pick hole, etc. In general, the larger the pipeline diameter being tested, the higher the smoke blower capacity (cfm) required.

- B. The base of the blower shall have appropriate adapters and seals to make a good connection to the manhole without excessive loss of smoke.

## 2.2 SMOKE PRODUCTION

- A. Smoke fluid, smoke candles, or approved equal, shall produce continuous smoke that can be controlled by the testing crew for the duration of the test. The smoke generated shall be white to gray in color, leave no residue, and shall be non-toxic and non-explosive.
- B. The Contractor shall supply the smoke MSDS sheet to the Project Manager.

## 2.3 OTHER EQUIPMENT

- A. In addition to the blower, the Contractor shall provide all other equipment, tools, and incidentals required to perform smoke testing as required by these specifications including, but not limited to, sewer line stoppers, sand bags, cameras, confined space entry equipment, and traffic control equipment.

# **PART 3 - INSTALLATION**

## 3.1 WORK PROGRESS

- A. The work shall generally progress as follows:
  1. The Contractor shall apply for and obtain work permits for all work to be performed in State and/or County Highways if applicable. All required insurances, traffic control measures, and other terms of the permit shall be provided to the satisfaction of the Project Manager.
  2. The Project Manager will provide the contractor with the procedure that should be followed regarding notification of fire department, police department, emergency personnel, etc.
  3. The Contractor shall have the Project Manager review required submittals including, but not limited to, the field inspection forms and database deliverable. Work shall not proceed until Project Manager accepts all submittals.
  4. A WORK SCHEDULE shall be submitted to the Project Manager for review and approval. No field testing or notification may proceed until the schedule has been approved by the Project Manager. After approval of the WORK SCHEDULE, the Contractor shall not make any revisions or modifications to it without the Project Manager's written approval.
  5. Daily Notifications
    - a. The Contractor shall notify, by hand delivery of approved door hangers to each address, all residences and businesses in the study area. All notification door

hangers shall be approved by the Project Manager before printing and distribution. The Contractor shall place door hangers on all residences and business 2-7 days prior to smoke testing at those specific addresses. Notification shall be an ongoing process throughout the project and shall be limited to the area provided in the look ahead schedule. Door hangers shall not be placed for areas which will not be tested within 7 days. If smoke testing is delayed for more than 7 days due to rain, etc., the area shall be re-notified. Logs will be maintained to document notification of hospitals, nursing homes, schools, high rise buildings, etc. The logs will include the facility name, notification date, time and individual notified. Notification of sensitive locations such as hospitals, nursing homes, day care, schools and the like must be done again immediately prior to testing.

- b. The Contractor shall check with all residents who expressed special concerns or special needs/notification prior to testing.
  - c. Notification of Emergency Services and dispatch centers will be completed each morning prior to testing that day. Project Manager will provide the required contact information for notifications by the contractor.
6. It shall be the Contractor's responsibility to keep adequate records of all notifications and to produce them upon Project Manager's request. Failure to comply with this requirement may be cause to suspend the Contractor's operations until compliance is achieved.
  7. Perform the smoke testing (Refer to Section 3.3).
  8. Prepare and provide the smoke testing data documents.

### 3.2 WORK SCHEDULE

- A. Upon award of the Contract, and prior to commencing any work, the Contractor shall provide a complete WORK SCHEDULE to the Project Manager for review and approval. The Work Schedule shall be typed and indicate the planned progress for the proposed work.
- B. The WORK SCHEDULE shall consist of a study area map showing the anticipated area(s) to be tested each day, week or month (depending on project size and duration).
- C. Acceptable Periods of Work
  1. Work hours must be approved by the Project Manager. However, the Contractor shall not typically commence testing before 8:00 a.m. local time and shall terminate testing no later than 5:00 p.m. each day. If the Contractor wishes to test before 8:00 a.m. or after 5:00 p.m. local time in commercial areas or high traffic areas, such testing shall be shown on the submitted WORK SCHEDULE and is subject to the Project Manager's approval.
  2. Smoke testing shall not be performed on weekends or on holidays without the prior approval of the Project Manager.



- D. Contractor shall not perform smoke testing on days that, in the opinion of the Project Manager, will hinder the results of the test. (For example, when heavy rains, or excessively saturated soil conditions would interfere with the effectiveness of the testing). Contractor may provide soil moisture or segment re-testing data as evidence that soil conditions are favorable for smoke testing.

### 3.3 PERFORMING THE TESTS

#### A. PROCEDURES:

##### 1. Safety

- a. The Contractor and his personnel shall be aware of and follow all Federal, State, and Local safety laws and regulations.
  - b. No entry into any part of the collection system shall be permitted until the Contractor has demonstrated that on-site personnel has been trained in applicable confined space safety procedures and has the equipment on-site to allow those procedures to be followed.
  - c. The Contractor shall minimize the physical entry of personnel into the sanitary sewer facilities. If required, manhole entry shall be in accordance with Federal, State, and local regulations for confined space entry and other regulations that may apply. The Contractor shall provide all safety equipment required for manhole entry operations, including harnesses, ventilation equipment, etc.
  - d. Traffic Control. The area of work shall, at all times, be protected by means of an adequate number of cones, barricades, flags, or by other means necessary to properly and safely protect both vehicular and pedestrian traffic.
  - e. Any condition deemed to be an unsafe by the Contractor shall be reported to the Project Manager. It is further understood that the Contractor shall not be required to work where, in the opinion of the Contractor, conditions would not be safe for the public, company personnel, equipment and/or other.
2. Confirm that adequate conditions (soil moisture, existence of catchment hoods, proper notifications, residents requiring assistance or notification, any preliminary procedures that may be necessary prior to conducting test, etc.) exist which will allow for desired results
3. Unless otherwise approved by the Project Manager, the sections of sewer subject to testing shall typically:
- a. Consist of a central manhole, where the blower will be positioned, and an upstream and downstream manhole and the sewer pipe between them. With three (3) manholes and two pipe sections, lengths should not exceed 1000 feet. The blower capacity and/or number of blowers necessary will be determined by the adequacy of pressure as observed at the vent stack or downstream/upstream manholes. (Refer to Section 2.1)
  - b. Upon approval of the Project Manager, longer sections may be tested provided good pressure, as evidenced by smoke plume, is observed at the vent stacks.
4. The walk through for locating defects will not begin until smoke is highly visible with a smoke plume emanating from the plumbing vents of houses at the end of

the setup location (maximum 500 ft radius) from the smoke testing machine. A locate flag will be placed at the location of the defect. Walkers shall traverse not only the sidewalk but between all homes and in back yards looking for illegal connections including patio, pool drains, roof drain connections and buildings where vent stacks do not exhibit smoke.

5. Defects must be located and documented as approved by the Project Manager. Typical methods to locate and re-locate defects in order of accuracy include:
  - a. Triangulate the defect with respect to the distance from two fixed objects (house corners, power poles, fire hydrant, etc.) and record on a location sketch
  - b. Sub-meter GPS coordinates
  - c. The distance from the upstream manhole to a point perpendicular to the defect is measured and the distance left/right to the defect is then measured.
6. Flow Control - It is the intent of this specification that the smoke testing be accomplished without the need for bypass pumping. The Contractor shall provide temporary plugs, sandbags, or flow barriers as required to contain an adequate volume of smoke within the section of sewer being tested. The Contractor shall monitor the resulting surcharged sewer at the manhole upstream of the tested section of sewer and prevent overflow conditions from occurring by removing the flow barriers or removing sewage by vacuum trucks.
7. All smoke testing information shall conform to the most recent version of the NASSCO smoke testing codes and database structure.
8. Data will be accurately and neatly recorded on field worksheets as provided by the Project Manager.
9. For each sewer main tested, the Contractor shall prepare a field log identifying each point of smoke exfiltration from:
  - a. Roof gutters
  - b. Sewer cleanouts
  - c. Leakage in house laterals
  - d. Patio or area drains
  - e. Storm drain cross connections
  - f. Manholes
  - g. Sewer vents (lack of smoke)
  - h. Any other source not stated above
10. Each smoke defect, as identified above, shall include an address, be referenced by sketch, and dimensioned to permanent landmarks.
11. A photograph of all leaks using a digital camera shall be included in the field log. Photographs of smoke evidence shall have a location indicated in the photograph using a defect flag where possible. All photographs shall be clearly cross-referenced to the typed and/or computer generated log indicating the location of the leak. Once the defect has been flagged the Smoke Testing Contractor will snap a digital picture (delivered in minimum 640x480 resolution) showing the smoke exiting from the defect, flag and physical features at or near the defect. Photographs should include sufficient field of view so that drainage patterns can be discerned.

12. The Project Manager may authorize QA/QC testing of specific line segments previously tested to determine the quality of testing performed and/or establish if soil conditions are sufficiently dry to continue smoke testing into new areas. Any re-testing will follow the same procedures.
13. The Contractor shall deliver project data in the NASSCO format approved by the Project Manager. Deliverables will include:
  - a. Maps of study area with corrections noted.
  - b. Summary of work quantities completed.
  - c. Summary of defect findings.
  - d. Completed field forms and sketches that document the testing and findings using the NASSCO smoke testing codes.
  - e. NASSCO database. All data codes and definitions shall conform to the NASSCO smoke testing requirements.
  - f. Submit one (1) complete copy of the field data and the electronic database to the Project Manager for review. Upon receiving the Project Manager's review and comments, the Contractor shall edit or revise the data delivery and/or electronic report as necessary and resubmit a copy of the final report (one hard copy and the electronic database) to the Project Manager.

**\*\*END OF SECTION\*\***