SMOKE TESTING

PERFORMANCE SPECIFICATION GUIDELINE FOR SANITARY SEWER

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NASSCO

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PART 1 - GENERAL BACKGROUND

A. The nature of smoke testing inspections is to confirm system connectivity, identify gravity sewer system defects that allow inflow and infiltration (I&I), 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. Defects identified through smoke testing can be utilized to determine I&I flows by calculating the tributary area for surface runoff draining into a known defect. When combined with flow monitoring, manhole inspection, flow isolation, dye water flooding and closed-circuit television (CCTV) 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. For example, smoke exiting from a storm sewer catch basin (in a separate system) that was introduced into a separate sanitary gravity system may identify a potentially large source of inflow; however, smoke testing alone does not identify where the connection or problem is located. Indirect sources of smoke through storm pipes can be caused by poor pipe joints or defective lateral connections on the sanitary sewer and may require further investigation. Techniques such as dye flooding in combination with CCTV inspections can be helpful to pinpoint the source of the smoke. Further investigations are commonly required based on the initial smoke test findings to establish the cause, location, and assist with repair recommendations.

B. It is important to realize that smoke exiting through the surface above a mainline sewer may indicate a more significant problem, and it is advisable to perform further investigation of an entire line segment. A comprehensive PACP inspection of the sewer main will help to better define the extent of the problems. Caution should be taken when proceeding with system repairs based solely on findings from smoke testing activities. 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. For sanitary sewer investigations, attention should be given to smoke exiting storm sewer pipes and inlet structures. Smoke entering a storm sewer will tend to migrate throughout the system resulting in smoke exiting from multiple inlets. The possible cause for smoke exiting the storm sewer may be due to poor joints, in both the storm and sanitary sewer, a defective service lateral crossing the storm sewer, damage to the storm or sanitary sewer pipe caused by excavations or directional drilling, direct connection(s), etc. Additional investigation, which may include dye flooding and CCTV inspections, will be required to determine the exact location of the source, and assist with establishing cost effective repair methods.

D. Smoke testing can provide detailed information on wet weather I&I sources, cross-connections with storm sewers, odor complaints and service connection confirmation, etc. However, soils that are saturated or frozen will not allow smoke to migrate effectively and limit the accuracy 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 for optimal smoke testing conditions.

E. Field documentation of the defects is extremely important. One option to document defects that are located during smoke testing include a detailed sketch referencing the defect relative to the upstream manhole or by measurement from permanent objects (corner of house, power pole, etc.). Another more accurate option is to collect a GPS point for each defect. Defect data documentation should establish accurate locations of each defect and provide for easy identification in the future. Additional inspections may be required to pinpoint the source and determine the best repair method. Color photographs should be taken to document each defect during the smoke test. 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 further dye testing and/or internal CCTV inspection.

1.1 SCOPE

A. It is the intent of this guideline to provide smoke testing materials and procedures that will be needed to properly investigate the identified study area. All materials and procedures should be consistent with these guidelines, current industry standards, and as approved by the Asset Owner.

1.2 REQUIREMENTS

A. The utilization of high capacity smoke blower(s) is required to maximize the results of testing of the gravity sewer system. The smoke blower(s) will be specifically designed for smoke testing a sewer system and shall generate non-toxic smoke. The smoke testing crew personnel will visually identify and document each defect location. All crew members participating in the smoke testing activities shall utilize 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 in 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. Crews should also look at the topographic location of the defect and assign an estimated tributary area that could generate flows in the system during wet weather events. This estimate should be based on a rainfall event that is heavy enough to create sheeting across the ground. Inspections will be performed by introducing non-toxic smoke into the sanitary sewer pipes using high capacity blower(s) (or approved equal depending on the project goals), observing smoke exiting vent stacks on buildings 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 may include personnel for traffic control.

B. The employees performing the smoke testing under the provisions of these specifications should be properly trained and thoroughly experienced in the use of the equipment and procedures.

C. Each employee shall wear and display a photo ID identifying him/her by name, company name and contact information. Clothing and vehicles identifying the company are also preferred. All job supervisors should have business cards with contact information to provide to residents if requested.

Crews involved with the smoke testing activities should always treat the public with respect and be prepared to provide detailed information and assistance to property owners as needed. In most cases, the public is not familiar with smoke testing procedures and the possibility of smoke entering the building. Smoke entering a building can be concerning to the occupants, which may lead to panic with the fear that the building is on fire.

1.4 NOTIFICATION

Proper notification in conjunction with clear and concise communication with all stakeholders is the key to a successful smoke testing project. Educating the public prior to performing smoke testing will help to prepare property owners and provide a warning of the possibility of smoke entering the building. Providing a detailed door hanger and speaking with residents or businesses prior to testing can minimize disruptions throughout the project from both the public and emergency response personnel.

A. Smoke door hangers and notifications should be distributed at least 48 hours prior to smoke testing within a defined area. If more than seven days have elapsed since notifications were distributed, it is recommended that crews re-notify the property

owners prior to conducting smoke testing. All smoke notifications should include information about the project, ways to avoid smoke entering the building and at least one (1) phone number that residents can call with any questions or concerns. The demographics of the project area should be investigated, and depending on the area to be tested, it may be important to provide a multi-lingual version of the notice with a phone number to someone fluent in the language. Special attention should be given to sensitive locations such as hospitals, nursing homes, medical facilities, childcare facilities, schools or any other vulnerable locations that could be adversely impacted by smoke entering the building. When a sensitive facility is identified, it is recommended that a face-to-face meeting be scheduled with the buildings maintenance group (or other key personnel) to discuss the operation and address any special circumstances to minimize any detrimental impact the smoke testing might have. It is advisable to avoid the use of a door hanger or speaking to a front desk representative as the sole means of communicating the details and possible ramifications with the smoke testing process.

B. The use of “Smoke Testing in Progress” signs displayed throughout the project area will help to educate the public and minimize any unnecessary disruptions. The use of these signs can reduce the number of calls to emergency services by motorist or pedestrians in the area that are unaware of the testing that is being conducted.
C. Daily notifications identifying the project limitations for the day should be sent to the Asset Owner, Client(s), and emergency services. Crews should only work within the project limits as identified in the daily notification and shall not proceed outside of these areas unless all parties above are updated, and daily boundaries are expanded and re-sent. Smoke testing crews should check with all residents who expressed concerns or have special needs prior to commencing testing that might impact their property.
D. Detailed records should be maintained by the smoke testing crews of all notifications and any communication with property owners regarding special circumstances. Failure to comply with this requirement may be cause to suspend smoke testing operations until compliance is achieved.

PART 2 - EQUIPMENT

2.1 SMOKE BLOWERS

A. Portable blower(s) designed and built specifically for the use of smoke testing shall be used for all smoke testing activities. The blower shall be self-contained, portable, and capable of producing a minimum of 1,800 cubic feet of air per minute (cfm). 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 on buildings 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 or “seal” to the manhole without excessive loss of smoke.

C. Cameras are required to document each defect or observations found by the crew. It is recommended that a minimum of a 5 mega-pixel camera be used for taking photos, and that a flag or other means of identification be placed on/in the ground to help identify the defect or observation in the photograph.

D. If GPS equipment is utilized to document smoke testing defects, it should be capable of pinpointing the identified defect with an accuracy of one meter or less.

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 Safety Data Sheet (SDS) for the material utilized to generate the smoke to the Client(s), Owner(s) and emergency services prior to testing. A copy of the SDS should also be carried by field personnel for any residents that request a copy, or if a First Aid situation should occur.

2.3 OTHER EQUIPMENT

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

PART 3 - PROCEDURES

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 insurance, traffic control measures, and other terms of the permit shall be provided to the satisfaction of the Owner/ Client.
   2. The Owner/ Client 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 Owner/ Client review required submittals including, but not limited to, SDS sheets, public notification procedures, emergency response notification procedures, field inspection forms, defect identification methods and database deliverable. Work shall not proceed until Owner/ Client accepts all submittals.
4. A WORK SCHEDULE shall be submitted to the Owner/ Client for review and approval. No field testing or notification may proceed until the schedule has been approved by the Owner/Client. After approval of the WORK SCHEDULE, the Contractor shall not make any revisions or modifications to it without Owner/Client written approval.
5. Daily Notifications
    a. The Contractor shall notify, by hand delivery (or otherwise approved by the Owner/Client) of approved door hangers to each address, all residences, and businesses in the study area. All door hanger notification shall be approved by the Project Manager before printing and distribution. The Contractor shall place door hangers on all residences and businesses a minimum of 48 hours and no more than seven (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 distributed for testing areas more than seven (7) days prior to smoke testing. If smoke testing is delayed for more than seven (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 performed 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 that day’s testing. Owner/Client will identify and provide contact information for all individuals designated for daily notifications.
6. It shall be the Contractor's responsibility to keep adequate records of all notifications and to produce them upon request by the Project Manager. 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 Owner/Client for review and approval. The Work Schedule shall be in a digital format or 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 Owner/Client. 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 Owner/Clients' approval.
   2. Smoke testing shall not be performed on weekends or on holidays without the prior approval of the Owner/Client.

D. Contractor shall not perform smoke testing on days that, in the opinion of the Owner/Client, 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 have 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 atmospheric monitoring, fall protection, harnesses, ventilation equipment, safety toe boots, hard hats, eye protection, protective glove etc.
      d. Traffic Control. The area of work shall always 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. It is recommended to follow Manual on Uniform Traffic Control Devices (MUTCD) guidelines when conducting any traffic or pedestrian control.
      e. Any condition deemed to be unsafe by the Contractor shall be reported to the Owner/Client. It is further understood that the Contractor shall not be required

to work where, in the opinion of the Contractor, conditions are hazardous and cannot be modified to conduct the required activities in a safe manor to protect people and/ or equipment.

2. Confirm that adequate conditions exist which will allow for desired results. Examples; dry ground conditions, adequate access to structures to be tested, notifications have been distributed, residents or institutions that requested assistance or notification prior to testing have been addressed, and any other preliminary procedures that may be necessary prior to conducting smoke test.
3. Unless otherwise approved by the Owner/Client, 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)
4. Upon approval of the Owner/Client, longer sections of pipe may be tested provided good pressure is generated or smoke plume is produced. The walk through for locating defects will not begin until smoke is highly visible with a smoke plume emanating from the plumbing vents of buildings along the entire length of pipe being tested
5. Procedures for documenting identified defects shall be approved by the Owner/Client prior to commencing smoke testing activities. At a minimum, a locate flag, or other means of identification, will be placed at the location of the defect. Crew members shall traverse the entire perimeter of all structures looking for illicit connections such as uncapped/ damaged cleanouts, storm inlets, area drains, pool drains, roof drain connections, etc. Special attention should be given to any buildings where the vent stacks do not exhibit smoke and findings properly documented for further investigation. Typical methods to accurately re-locate defects in the future include:
    a. Triangulate the defect with respect to the distance from two fixed objects (house corners, power poles, fire hydrant, etc.) and document by recording the information and measurements with a location sketch.
    b. Survey with 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 these guidelines that the smoke testing be accomplished without the need for bypass pumping. The Contractor may need to provide temporary plugs, sandbags, or flow barriers as required to contain an adequate volume of smoke within the section of sewer being tested, or to avoid smoke entering an area that smoke is not intended. If flow control measures are utilized, the Contractor shall monitor the upstream sewer for surcharged conditions to prevent backups into buildings and overflow conditions.

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 recorded on field worksheets or on electronic devices in a manner that can be clearly understood and as approved by the Owner/Client.
9. Examples of possible defects identified during smoke testing:
    a. Roof gutters/ downspouts
    b. Sewer cleanouts
    c. Leakage in house laterals
    d. Patio or area drains
    e. Stairwell or driveway drains
    f. Foundation drains
    g. Storm drain cross connections
    h. Manholes
    i. Sewer building vents (lack of smoke)
    j. Any other source not stated above
10. Each smoke defect, as identified above, shall include at minimum, a site address, be referenced by sketch and/or GPS point, or dimensioned to permanent landmarks, along with the intensity of smoke.
11. All identified smoke defects shall be documented with a digital photograph that is adequately identified for future reference. It is recommended that all photographs be included and attached as a part of smoke testing field forms. Photographs of smoke defects shall include a defect flag, or other means of identification, where possible. All photographs shall be clearly cross-referenced to the typed and/or computer-generated form indicating the location of the smoke defect. Photographs should include sufficient field of view so that drainage patterns can be discerned.
12. The Owner/Client 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 format approved by the Owner/Client. Deliverables should include at a minimum:
    a. Maps of the 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. All database 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 Owner/Client for review. Following Owner/Client 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 deliverable to the Owner/Client.

END OF SECTION