Wet Weather Leak Investigations

A Publication for AGA Members

Prepared by the AGA Customer Field
Services & Measurement (CFSM)
Committee
400 North Capitol St., N.W., Suite 450
Washington, DC 20001
U.S.A.
Phone: (202) 824-7000
Fax: (202) 824-7082
Web site: www.aga.org

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Definitions[1]

Bar Holing: A leak detection method for measuring subsurface gas readings in which a plunger bar is used to make a series of holes in the ground in a region of interest (e.g., near a gas line). Then a probe connected to a gas detection device is inserted in each hole to determine the presence of gas.

Combustible Gas Indicator (CGI): A device that can detect the presence of various combustible gases. They may employ either catalytic style sensors or IR sensors to passively (catalytic) or actively (IR) detect the gas.

Remote Methane Laser Detector (RMLD): A device that detects the presence (and concentration) of methane by projecting a laser light beam onto a target and interpreting the light that is reflected back to the sensor.

Wet Weather: For the purposes of this whitepaper, wet weather conditions include precipitation and situations where the ground near the gas facilities is saturated and/or covered with significant water, snow, ice, or sleet.

[1] These definitions are highlighted where they first appear in the whitepaper.

1. Introduction

Leak investigation is a complex process that requires an operator to balance variables like regulatory compliance timeframes, detection technology and methods, the limitations of those technologies and methods, gas migration pathways, and many other variables while protecting both the public and its employees.

Utilities must locate the source of the leak, classify its severity, and implement mitigation measures, often by a stipulated deadline. Locating the leak may be complicated because the gas can migrate away from the actual source. Moreover, the migration path of a natural gas leak will likely vary depending on the surrounding medium (i.e., asphalt, concrete, various types of soil). Full classification of a leak may require that the operator determine the gas concentration being leaked, the pipeline pressure, potential spread, proximity to other underground facilities and aboveground structures, and potential sources of ignition.

The results of the leak investigation will help determine the appropriate response, which can include performing an immediate repair, continuous monitoring, scheduling future repair for non-hazardous leaks, or even shutting down the system and evacuating multiple buildings for severe leaks. Once all of this is done, the results of the leak investigation, as well as any remedial action taken, should be documented in the leak investigation report.

Wet weather can further complicate this process as gas may be more difficult to detect in these conditions. Wet weather (i.e., rain, snow, sleet) can also limit the use of typical investigation equipment and methods, even to the point of rendering them unusable. Water accumulation can affect soil conditions, which may make locating the source of the leak more difficult than during dry conditions. An operator should adjust their leak investigation practices for suitability in wet weather and may need to recalibrate their response accordingly. All decisions made during these wet weather investigations must be done with public safety as the number one priority. Understanding the obstacles that can arise during wet weather leak investigations ahead of time may help an operator be better prepared to appropriately respond to the situation should it happen.

2. Investigation Methods and Devices

There are two types of leak investigations: (1) compliance driven leak surveys and (2) responding to leak/odor complaints. Compliance driven leak surveys should be postponed when conditions warrant until weather and soil conditions are acceptable. This is not an option for investigation responding to leak/odor complaints, where the leak source needs to be detected as soon as possible regardless of weather and soil conditions.

A leak investigation typically includes the following basic elements (although the order of steps can vary):

1. Arrive at the location of the leak/odor complaint in a timely manner.
2. Take gas readings near the location of the reported odor including structures as applicable.
3. Identify all gas facilities; where warranted, utilize maps.
4. If possible, make contact with the person who reported the odor of natural gas for further information.
5. Evaluate whether the potential leak could be indoors, outdoors, or both.
6. Check for existing underground facilities (e.g., fuel lines, electric lines, telephone wiring, television cables, water lines and sewer lines, cross bores, etc.).
7. Determine the source(s) of the leak taking into consideration potential gas migration pathways[2].
8. Identify and document extent of leak including migration.
9. Initiate appropriate mitigation and/or response measures.
10. Document results.

There are several types of leak investigation technologies and methods available to operators to help identify the source of the leak. Though the technologies used in wet weather do not differ significantly from those used in dry weather conditions, special considerations, noted below, should be taken for investigation methods used during wet weather conditions. The section below summarizes some potential advantages and disadvantages of different technologies. This section is not intended to be a comprehensive list of all commercially available technologies but is rather intended to provide an overview of some of the most common technologies and offer some considerations an operator may take into account. AGA does not endorse any specific technology, or technology provider.

- **Remote Methane Laser Detector (RMLD).** RMLDs employ an infrared laser beam to detect presence of gas from distances up to 50 – 330 feet away. An RMLD can be used to inspect large areas in the shortest amount of time and can be used through glass windows if no one is home. Unlike pump-driving surface sampling detectors where one must walk over the facilities to take ground surface gas readings, an RMLD is not susceptible to water being pulled into the tool. See **Figures 1 and 2**.

[2] See existing guidance in ANSI Z380.1, *Guide for Transmission, Distribution and Gathering Piping Systems*, Appendix G-192-11, Section 5: Leak Investigation and Classification.

Figure 1: *Heath RMLD-CS*
[Courtesy of Heath Consultants]

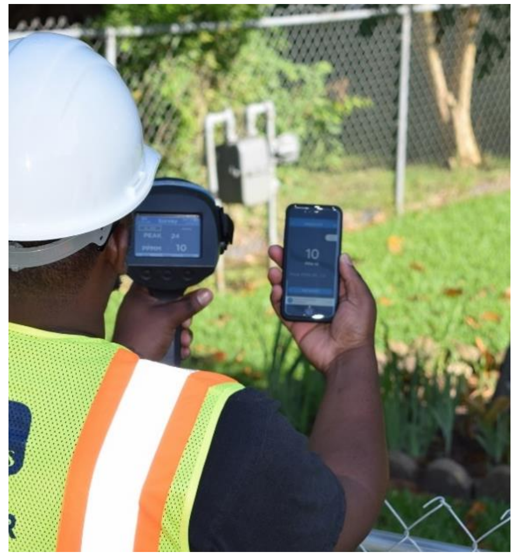

Figure 2: *Heath RMLD-CS*
[Courtesy of Heath Consultants]

- **Pump-Driven Surface Sampling Detectors.** These devices detect ppm levels of gas at the surface. Examples include infrared and flame ionization detectors. However, drawing moisture into the unit can negatively affect and/or damage the device. Ensure that all filters and water traps are in place to avoid damaging the detector. Frequent monitoring and/or changing of the filters may be necessary as well due to the high moisture concentration. See **Figure 3**.

Figure 3: *Sensit Portable Methane Detector (pump-driven surface sampling detector)*

[Courtesy of Sensit]

- **Bar-Holing and Combustible Gas Indicator (CGI).** This process entails using a plunger bar to place a series of holes in the ground and using a CGI to sample each hole to detect the presence of gas in percentage gas-to-air ratio. This is currently the most accurate method of determining the location of a leak, but the CGI can be damaged if moisture is drawn into the unit. During wet weather conditions, it may be necessary to bar-hole at deeper depths than normal to get below the saturated ground line. See **Figures 4 and 5**.

Figure 4: *Heath Plunger Bar/Bar Hole*
[Courtesy of Heath Consultants]

Figure 5: *Sensit Gold CGI*
[Courtesy of Sensit]

2.1 Wet Weather Considerations

Wet weather conditions can impede the ability of utility first responders to perform a complete leak investigation. In such cases, the utility first responder should take additional steps to ensure safety of life and property.

- If a leak investigation is carried out in situations where there is standing water or saturated soil, the investigators should attempt to take readings where gas is likely to vent: at higher ground or at the edge of the water.
- If a gas leak is suspected but the exact source of the leak cannot be immediately identified and access cannot be obtained to all area structures to properly check for any gas readings during the investigation, consider contacting the local electric utility (if known) to eliminate ignition sources. Notify the fire department for assistance when needed; they can assist with the removal of potential ignition sources.

Note: While not particular to wet weather conditions, one of the first places that a leak investigation should focus on is at known locations of third-party work (e.g., construction, electrical, water, sewer, fiber optics, etc.).

Figure 6: *Inspecting sewer with Gazomat Inspectra pump-driven surface sampling detector*

[Courtesy of Heath Gazomat]

3. Assessing Viable Gas Migration Pathways

Gas from an underground leak can migrate through soil, sewer lines and buried conduits, or under concrete slabs for a distance before reaching the surface. The gas can also enter a nearby structure, where it can accumulate and potentially lead to a fire or explosion.

3.1 Water-Saturated Ground

When the ground is saturated with water (or frozen), gas flow to the surface is impeded and below-grade CGI readings may not be feasible. In such situations, operators should consider the following actions when there are indications of gas but the source cannot be identified:

1. The investigator should conduct a surface scan near all available above- and below-ground structures and buildings adjacent to the reported odor or to the area of highest odor concentration. Probe available opening such as storm drains, utility boxes, water meter boxes, etc. with a CGI. The region of investigation should be expanded if the weather conditions interfere with the investigator's ability to obtain useable readings.
    a. Notify Emergency Dispatch of any indication of gas inside any building; Dispatch should notify Field Operations of an existing or probable hazard to persons or property.
    b. If there is a positive reading at any inside building sample point, immediately evacuate the residents[3], look for a point of entry, and check the inside of adjacent buildings for gas readings.
    c. Extend the survey and check all structures within the identified area of possible leak migration.

[3] Evacuation is a recommendation specific to wet weather but is not typical for other situations.

2. The investigator should look for indications of below grade gas leakage such as bubbling in bar holes and puddles, blowing of water out of bar holes, etc. The investigator should pay special attention to gas readings at foundation walls of each structure in the vicinity of the odor call.
3. Use additional equipment, like RMLD, to scan an entire area (including structures) for gas presence from a distance. Consider expanding the area of investigation more than normal to assess unknown migration paths. If you do not have access inside structures and do not have RMLD technology, use a CGI to check foundation, attic vents and any gaps around doors or windows. RMLD readings can be impacted by rain[4]. Each operator must have a thorough understanding of the limitations of their equipment prior to use in the field.

   ***Note*:** Fire Department assistance may be required to gain access to structures within an area of interest.

3.2 Puddling or Ponding

Where any required test point is inaccessible for sampling due to puddling or ponding (see **Figure 7**[5]) on roadways or inside property lines, the leak investigator should expand the perimeter of the leak investigation. CGI readings can be taken at bar holes and subsurface structures surrounding the flooded area. The investigator should "zero out" positive readings in a linear path toward any building. Zeroing out entails expanding the search area until a "zero" reading is obtained on the CGI when taking bar hole readings. The investigator should also "zero out" in all directions (North, South, East, West).

[4] What is impacted is the distance the laser can travel, limiting the effective distance.
[5] NTSB Investigation Overview slides presented by Sara Lyons, Investigator-In-Charge, dated February 23, 2018

Figure 7: *Water Saturated Ground with Puddling*

3.3 Flooding

When flooding or severe wet weather conditions prevent the first responder from performing a complete investigation (e.g., not able to access required sampling points), or the investigation indicates the presence of gas that cannot be zeroed out when approaching buildings / manholes / substructures (thus presenting an opportunity for gas migration), consider evacuation and/or shutting down a section of the main until such time as readings can be taken to prove that no hazard exists. See the next section for details.

4. When to Consider Shutting Down or Isolating a Distribution System

Operators have differing criteria for when to shut down their system and given that there are far-reaching consequences of doing so; it is typically done after much planning and consideration of the trade-offs. However, gas leaks that pose an immediate danger to employees and the public may warrant an unplanned system shutdown. Alternatively, it may be appropriate to isolate and pressure test a portion of the distribution system to better pinpoint a gas leak. The decision to shut down or isolate a system is typically made by the operator after careful consideration based on the unique circumstances of the situation.

4.1 Criteria

Although the specific criteria used by operators to determine whether to shut down or isolate their system during a wet weather leak investigation will vary based on the unique nature of their system and the specific circumstances on the ground, the following criteria may be helpful to operators when considering whether to shut down or isolate a system during wet weather leak investigations:

- Proximity of readings to structures. The closer a positive reading is obtained to a structure, the higher probability that gas migrated into the structure. When weather conditions prevent readings at exterior walls, and access to the structure cannot be achieved, it may be appropriate to shut down the main or service and avoid the risk of potential gas accumulation in the structure.
- Non-contiguous readings. Water saturated or frozen ground may impede gas reaching the surface along the full migration path. This can produce situations where you have positive readings in the street and then again near an exterior wall, but nothing in between. This can make finding the source of the leak even more difficult than normal.
- Multiple calls in an area. Multiple calls in the same general vicinity may indicate widespread migration along some sort of channel or multiple leaks.
- Bubbles from cracks in hard surfaces. Especially for hard surfaces that cover large areas, like parking lots, gas will travel to the path of least resistance and find its way through weak points which can aid in leak pinpointing.
- Unable to adequately survey area due to no access.

  Note**:** Where bar-holing and CGI measurements are impeded by the weather, the operator should consider the use of alternative equipment (e.g., RMLD).

- Pressure test of mains and services. If there are readings that indicate unsafe conditions, after the lines are isolated, the operator can use a pressure test of that area to help isolate the network. This process should be done in reasonable sized chunks to aid in pinpointing the leak.
- Water infiltration. Determine if gas mains are water infiltrated. If so, consider taking action to vent gas from the affected ground since water infiltration will cause gas to fill all vacant open spaces underground and force gas migration towards structure.

4.2 Isolation Process

Wet weather may result in inconsistent readings and potentially hinder a full investigation. For those situations, the following is an example of steps an operator could consider taking to determine whether to shut down or isolate a system when conducting a leak investigation in wet weather (the order of the steps may vary):

1. Pull up map of the area, and if time and resources permit, include location of other utilities.
2. Plot calls and any positive readings.
    a. Investigate if there have been recent calls in the vicinity of the current region/structure of interest.
    b. Investigate service records for the area noting recent work, uncompleted work, and/or repeat work.

3. Identify slabs/hard surfaces (park lots, roadbeds, slab-on-grade construction).
4. Identify structures where gas can accumulate (buildings, sewers, conduits).
5. Identify any third-party projects in the vicinity.
6. Evaluate if any of the calls/readings can be linked by slabs/hard surfaces or if there are structures where gas can accumulate in the vicinity of the calls/readings.
7. Evaluate population density.
    a. Consider that the speed that you can do things will differ depending on the population density and building types.
8. Identify nearest valve(s) or station(s) feeding the area.
9. Select which is most appropriate: single block isolation, full area shutdown, other isolation option.
    a. Estimate timeframe and system impact for each.
    b. Will pipeline exposure/excavation be necessary?
10. Isolate and purge gas.
11. Excavate and test for leak source.
12. Check to see if water entered the main or service.
13. Purge the line back into service.
14. Conduct emergency locates.

4.3 Evacuation

A common response to a gas leak investigation is to evacuate a building if there is a gas reading at or above the operator's hazardous concentration threshold. In such cases, many operators turn off the gas at the meter to prevent further accumulation and shut down gas supply upstream of a suspected leak.

Where rain, snow, or sleet impede the ability of a first responder to determine the source of a gas leak or to make the necessary repairs, and there is reason to believe a severe gas leak exists, it is advisable to evacuate nearby buildings until the repair is completed and it is safe to do so. The radius of the evacuation zone depends on the severity of the leak as determined by gas concentration readings and the specific characteristics of the geographic area impacted.

5. Alternative Responses

5.1 Drones

Some operators and municipalities have historically had difficulties scouting inaccessible areas. One option that may potentially aid them in these situations is the use of unmanned aerial vehicles (UAVs), more commonly known as "drones". Camera-equipped drones can be used to visually determine the boundaries of the area affected by flooding, thereby informing the operator on areas that need specialized investigation (see the section on Assessing Viable Gas Migration Pathways above). Drones can also be outfitted with laser detectors and thermal cameras to help search for the leak source(s).

Considerations for incorporating drones in the leak detection process:

- They may not be a viable solution *during* the wet weather.
- They require additional training for operating them safely and effectively.

5.2 Advanced Metering Infrastructure

Where advanced metering infrastructure (AMI) is already deployed, the operator may be able to use the data collected by the network to help pinpoint the most probable location of the leak. Instantaneous data collected by AMI systems can include changes in gas consumption, changes in system pressure, and methane detection alarms. AMI enables continuous monitoring of the affected area, and remote shutoff. For more information on AMI, see AGA's primer: *Automated Meter Reading (AMR) and Advanced Metering Infrastructure (AMI) Basics for Natural Gas Utilities*.

Safety is always the top priority; operators should err on the side of caution when deciding how to respond to a gas leak that is complicated by wet weather.

6. Conclusion

Responders to leak/odor complaints must continually be aware of potential abnormal operating conditions. Investigators should consider how the weather may affect their typical investigation methods and instruments, then modify their process accordingly. This includes limitations to their instruments' functionality and changes in gas migration pathways due to soil conditions.

Continuous monitoring of possibly affected structures needs to be a priority and should be conducted throughout the event until the leak has been identified and the gas is ventilated.

It is also imperative that investigators look at the bigger picture to determine if any particular call is related to others in the vicinity. This will require investigating recent activity in the area. This can be done more quickly if the computer systems are set up to flag occurrences of multiple gas odor calls in a specified proximity.

Planning and training for situations with multiple complicating factors should also help enhance an operator's response to leaks that occur during wet weather.