Leak Detection 101

Investigating a leak is simplified if you know the basics.

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Every day new gas services are added to provide economical energy to residents and businesses alike. These services are installed to exacting standards and procedures and normally provide years of maintenance free use. However, at some point, the service may require repair due to an unpredictable phenomenon, the gas leak. These leaks can be easy to locate and identify or they can be very tricky to find.

Properties of Gas - With any leak investigation it is important to know the basic properties of the gas(es) involved. All gases require three basic components to burn; a combustible gas, an oxidizer or air, and heat. Without the right mixture of all three of these components, fire or explosion will not occur. But put them all together in just the right amounts and the results can be catastrophic. The gases that most service personnel deal with include propane, butane and natural gas. Each of these gases has specific physical properties that service personnel should know and understand. It will make the job of locating the sources of gas leaks easier and much more complete.

Flammability Chart

Gas Formula Ignition					
Gas	**Formula**	**Ignition Point**	**LEL (LFL)**	**UEL (UFL)**	**Specific Gravity**
Methane	CH4	App 1193°F	5.3%	15.05%	.55
Ethane	C2H6	993-1101°F	3.0%	12.5%	1.04
Propane	C3H8	957-1090°F	2.2%	9.5%	1.56
Butane	C4H10	912-1056°F	1.9%	8.5%	2.01
Natural Gas	Blend	1100-1200°F	4.5%	14.5%	.65
Gasoline	Blend	App 632°F	1.4%	7.5%	3-4.00
Carbon Monoxide	CO	1191 - 1216°F	12.5%	74.0%	.97
Hydrogen	H2	1076 - 1094°F	4.0%	75.0%	.07
Hydrogen Sulfide	H2S	655-714°F	4.3%	45.0%	1.18

When we review the flammability chart each gas has a name, chemical formula, specific gravity, ignition temperature in air, and the limits of flammability. Most of these gases are made up of carbon and hydrogen (thus the chemical formulas). The specific gravity is the weight of the gas when compared to air.

Looking at the chart, methane and natural gas are both lighter than air and their respective specific gravities are less than one. Propane is one and a half times heavier than air; butane

is about two times heavier than air. Consequently, when a gas heavier than air begins to leak, it will accumulate in low areas, and for those gases lighter than air, they will accumulate in high areas.

The ignition temperature is the minimum temperature needed to ignite the fuel in air. If the ignition temperature is too low, there is no way to burn the fuel. Don't believe for a minute that eliminating ignition sources is easy. One of the most common and most unpredictable sources of ignition is static electricity, such as the sparks that result when a person touches something after walking across the carpet.

Finally the last ingredient necessary to burn gas is the flammability limit. Each flammable gas has a minimal amount of gas required to burn called the Lower Explosive Limit (LEL). After reaching LEL, too much fuel can be present and the gas will no longer burn in air. The greatest amount of gas that will burn in air is the Upper Explosive Limit (UEL).

Probably the best example of LEL and UEL is what happens when starting a cold lawn mower engine. Assuming the air filter is clean and there is a spark, the engine choke must be set to start it or there won't be enough gas to run because LEL hasn't been achieved. Choke it too long and there will be too much gas because UEL has been reached so the engine won't run. Get the mixture just right, add spark or heat and air and you have the controlled gas explosions of an internal combustion engine.

Causes of Leaks - Leaks come from a variety of sources but all of them can be put into four basic categories. These include outside or third party damage, mechanical failure, corrosion, and gas accumulations. Typically third party damage results from accidental damage that has occurred while performing construction around the area of the gas line. Examples of mechanical failure include broken couplings, leaky piping, or bad regulators. Corrosion occurs when piping systems or tanks are unprotected from sacrificing its metal to some other area like the ground where it is buried. Finally, gas accumulations occur when valves or piping systems have been left open and not properly capped. The gas concentration increases or accumulates until either the source is found and shut off properly or an incident occurs.

Tools for Detection - Typically, according to one leak detector manufacturer, a service person should carry a pressure gauge capable of reading pressure drops on a gas system in 1/10th inches of water column increments, a calibrated gas detector to alert the service person if they have entered a potentially hazardous environment, and leak detection solution. Finally, the service person needs appropriate hand tools to disconnect or shut off the gas supply in case an emergency situation arises. When handling leak investigations, the service person that has been called does not know if they have 10 days, 10 hours, 10 minutes or 10 seconds before something goes wrong. No one should perform an investigation without the proper tools.

There are many different gas detection instruments on the market today. All of them offer a variety of features and benefits. Keep in mind that the number one responsibility you have as a gas service person is protecting life and property.

Most gas detectors fall into three basic types:

- The leak detector is used for pinpointing small, hard to find, gas leaks on piping systems. These range in price and sensitivity. These are best used to help you speed up a leak investigation. Some brands offer separate calibrated alarms to warn you of gas build-ups approaching LEL. Leak detectors without calibrated alarms do not provide quantitative measurements to warn that you and your customer may be in a hazardous environment. Most leak detectors, though very sensitive, have a limited range and cannot locate leaks in areas with high concentrations. Leak detectors are traditionally sensitive to leak detection solutions. Use a leak detector first, then apply leak detection solution secondly.

- The combustible gas indicator, or CGI, will provide direct readings in percent LEL. When equipped with the proper sensors these instruments can measure up to 100% gas. These instruments are well suited to measure the volume of gas when entering a residence or business to identify if the area is safe from gas build-ups. However, these instruments may not be the best tool for locating a leak because they are not as sensitive. They are excellent for locating the source of underground leaks.

- Survey instruments are used outdoors to locate areas where small quantities of gas have migrated to the surface. These pump driven or venturi assist instruments are very sensitive and can speed up the time required to locate underground leaks. Many times these highly sensitive instruments can save a company from spending untold dollars digging up or replacing a service because they cannot find the leak. Sometimes survey instruments are known as "FI's" or flame ionization detectors though other technologies like semi-conductor sensors are used and available.

When using any instrument always be sure it is functioning correctly and it is calibrated per the manufacturer's instructions. Instruments that are not working properly can provide a false sense of security that can add to an already potentially dangerous situation. Calibration is typically an easy procedure that can be done in the field. This requires a known sample of gas to be applied to the instrument and adjustments made to the instrument to match the response that the calibration gas should provide. A record should be kept of all calibrations.

Investigation techniques - When receiving a report of a gas leak remember it is an odorant complaint. A service person should use all their senses to identify the possible source. When ready to approach the scene, the technician should:

- Inform the dispatcher he has arrived.

- Prepare any gas detection devices prior to entry. If you are going into a residence, knock, do not ring the doorbell, it can cause a spark.

- Evaluate at the door the gas concentration that may exist. If there are signs of a gas build up at the door, ask the customer to leave the premises and make sure there is no one else in the dwelling. Do not let the customer operate any light switches or the telephone.

- Shut off the supply to the gas, disconnect ignition sources, and properly ventilate the dwelling until it is safe.

- Contact should also be made with the dispatcher of any such gas emergency so local authorities can be contacted.

If there are no signs of a hazardous situation, the technician should discuss with the customer where and when the odor has been noticed. Identify the sources for gas in those areas and use a gas leak detector and/or leak detection solution to find the leak. Sometimes leak detection solutions can seal a leak or the leak is such that the solution is blown away from the source. Be sure to follow manufacturer's procedures when using these solutions and their applicators.

If the leak is outside and underground it may be necessary to place a series of holes near the gas line to measure the leakage. These holes are usually made using a plunger bar and driven to a depth at least equal to the depth of the gas line on an interval of five to 10 feet. A combustible gas indicator is used to sample each hole and the operator should look at the readings. The sample should be taken for 45-60 seconds for each hole recording the highest reading and the sustained reading after each test. The high reading relates to the accumulation of gas in the area while the continuous reading or sustained reading shows the rate in which the test hole continues to refill with gas. The hole with the highest sustained reading is typically closest to the leak. This process is commonly referred to as "bar holing" or "pinpointing."

Whenever there is an underground leak, always look for other structures that can be affected by the flow of the gas leak. These structures include water and sewer lines, electrical conduits, and telephone conduits. Be sure to inform any emergency personnel of any such findings.

Other factors that can affect the ease or difficulty of locating underground leaks include soil conditions. Harder soil causes the migration of gas to be more limited than softer soils. Water table or rain can prevent gas from migrating upward. Frost causes gas not to migrate to the surface except at openings. Furthermore, grades or hills cause heavy gases to accumulate in low lying areas. Again, look at the sustained readings, not the highest readings when trying to locate the source of the leakage.

If no leak sources have been found or if there is concern there are more leaks present, be sure to use a manometer and perform a shut-in test. There are no leaks coming from the gas system if there is no pressure drop shown on a manometer with the gas supply shut off. This test will not locate leaks, only identify if they exist. All pilot lights must be shut off for this test.

Documentation - After any leak investigation, completely document the tests performed. Documents should include customer name, location, date, applicable readings, and if leak(s) were found. It is also good to document any changes in location of gas lines for outside lights or gas grills. Mapping can make leak investigations much easier, especially in climates where snow might be present.

Gas leaks can be a serious problem. With proper tools and training from both company safety and training personnel and instrument suppliers, you will handle these situations with confidence. With the increased use of gas and increased competition this will be the

way your customers will judge your ability to supply them the safe and economical source of energy for their homes and businesses for years to come.

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