Fire/Fire Response
Natural Gas Emergencies
Effective Date: January 2011
Revised: December 2020

1. PURPOSE

This model procedure is endorsed by the King County Fire Chiefs Association as a template for operations and training for all fire departments in King County.

2. POLICY

Refer to *Operations Policy*

3. DEFINITIONS

None

4. PROCEDURE

See King County Procedure below

5. REFERENCES

KING COUNTY FIRE MODEL PROCEDURE
Section 29 - Natural Gas Emergency Response

Adopted - 2/21/18

1. PURPOSE

1.1. This model procedure is endorsed by the King County Fire Chiefs Association as a template for planning, training and deployment for all departments within King County.

1.2. This Natural Gas Emergency Response plan is to provide a basic understanding of natural gas characteristics, recognition of hazardous conditions and incident response steps and defensive measures when responding to emergencies involving local and regional natural gas delivery infrastructure.

2. OVERVIEW

2.1. In general, a natural gas emergency should be approached in a manner similar to a hazardous material emergency. This does not necessarily require that it generate a hazardous materials response.

2.2. A natural gas incident can vary depending upon location of the leak (i.e., inside or outside), the size of the supply line (i.e., less or greater than 2 inches), and the pressure being supplied (i.e., ¼ to 2 psi on the consumer side of the meter vs. 35psi or greater on the supply side of the meter).

2.3. Natural gas has a low vapor density that causes it to rise in air. This can be beneficial when exterior, but needs to be taken into account when interior or near a structure. Do not rely only upon ground level air monitor readings. Areas at ceiling level, void spaces in dropped ceilings, elevator shafts, upper floors, and stairwells should be checked.

2.4. In an underground or confined release, natural gas may migrate to remote locations, creating an explosive atmosphere in adjacent structures, interconnected utility systems, or even up through the street or open ground. If the gas seeps up through the ground the Mercaptan may be 'scrubbed out' and an odor may not be detectible.

2.5. Due to the enormous potential associated with a natural gas emergency, it is vital that a hazard recognition/identification process begin at a safe distance and slowly advance inward based upon gathered information and the Risk Benefit Analysis (RBA). Many 911 callers lack accurate information, therefore responding personnel should use a systematic approach regardless of the reported

leak size. Collect and verify information before determining a deployment strategy.

3. REFERENCES

3.1. Williams NW Pipeline Emergency Response Plan & Pipeline Industry Background for Emergency Responders

3.2. WAC 480-93-18601 Gas Pipeline Safety; Leak Classification

3.3. Natural Gas Pipeline Safety Act, 49 CFR part 192

3.4. Puget Sound Energy: *Energy System Restoration Plan 2012-2013*

4. DEFINITION

4.1. Natural Gas: A colorless, odorless naturally occurring hydrocarbon gas:

4.1.1. Composed of approximately 94% methane

4.1.2. Flammability range of 3 to 15 percent gas to air mixture

4.1.3. It has a vapor density of 0.6 (Natural Gas is 40 percent lighter than air and will rise)

4.1.4. Flammable range of 4 to 14 percent

4.1.5. Ignition point of 1200 degrees Fahrenheit

4.2. **Mercaptan**: An odorant that is added before natural gas reaches the consumer, which contains sulfur that creates a distinct rotten egg odor detectable at extremely low levels. Extended exposure to Mercaptan can cause olfactory fatigue and create unreliable sensory indication. As required by DOT, the odor threshold for Mercaptan in natural gas is .8 percent which is 20 percent of the Lower Explosive Limit (LEL).

4.3. Categories of Natural Gas Emergencies:

4.3.1. **Natural Gas Odor**: Involves a report of an odor of natural gas inside of or outside of a structure.

4.3.2. **Minor leak:** Involves a broken gas line (or known leak) with a diameter less than two inches. May also describe a gas leak in a residential structure, and/or a gas leak of short duration.

4.3.3. **Major leak**: Involves a broken gas line with a diameter of two inches (2”) or greater. May also describe a gas leak in a commercial or multifamily structure, and/or a gas leak of extended or unknown duration.

4.4. **Combustible Gas Indicator**: Detection instrument that has the capability to recognize flammable range, oxygen deficiency, presence of carbon monoxide and hydrogen

sulfide. Flammability range will typically alarm at 10 percent of lower explosive limit. May also be known by their brand name or known as “4 gas” or “5 gas” detectors.

4.5. **Transmission Pipeline:** High Pressure “interstate highway” at 300-1200 psig

4.6. **Distribution Main:** High Pressure “city streets” at 60-300 psig

4.7. **Distribution Line:** Intermediate Pressure “residential delivery” at 5-60 psig

4.8. Control Zones:

4.8.1. **Cold Zone**: The area of the site that is free from contamination and that may be safely used as a planning and staging area.

4.8.2. **Warm Zone**: The transition area between the Cold and Hot Zones. This area is where responders enter and exit the exclusion zone and where decontamination activities take place.

4.8.3. **Hot Zone** (20 percent LEL): The area with actual or potential contamination and the highest potential for exposure to hazardous substances. Full PPE in place with atmospheric monitoring is required when operating in the Hot Zone.

4.8.4. **Action Zone:** The area within the hot zone where mitigation measures may take place based upon the Risk/Benefit Analysis (RBA) up to 50 percent LEL

5. POLICY STATEMENT

5.1. The policy statement of the King County Fire Chiefs Operations Group is the recommended guideline for natural gas emergency response and mitigation capabilities within the Authority Having Jurisdiction (AHJ).

6. STRATEGY

6.1. The initial strategy at a natural gas response should be offensive, starting from the periphery and working inwards, as the RBA allows. The first arriving Officer is responsible for performing a RBA that confirms or changes the deployment strategy or operational mode.

6.2. Information gathering is critical to a safe operation and effective strategy and should be an initial priority. It can include location and size of release, wind direction, responsible party, air monitor readings, structures involved, civilians, witness reports, audible and olfactory clues.

6.3. Protect responders by staging appropriately. Minimize the number of responders in the hazard zone to accomplish essential tasks. Do not approach the area of the release without proper PPE. Proactively use air monitor readings and other available information to locate and evaluate the leak.

6.4. Protect life through a combination of appropriate actions that may include isolation and/or evacuation and denial of entry.

6.5. It should be a top priority of personnel to shut natural gas off at the lowest acceptable risk (e.g., stop the leak by shutting the valve at the appliance, meter, or meter riser).

6.6. Protect exposures during a fire fueled by a natural gas leak.

6.7. Unless protecting life, do not extinguish a natural gas leak that is on fire except by eliminating the leak at the source.

6.8. Consult with PSE prior to demobilization.

6.9. Evaluate dispatch info, wind direction, and topography. Upon approach, stay up wind.

6.10. Turn on the combustible gas detector(s) en route to assist in establishing the Initial Isolation Perimeter.

7. RESPONDING

7.1. SCENE RECOGNITION:

7.1.1. Occupancy type and size (e.g., construction, dimensions, compartmentation) and how it may affect concentration levels (e.g., SFR, warehouse, apartment).

7.1.2. Internal or external leak (proximity to structure).

7.1.3. Supply and pressure possibilities based upon location and occupancy:

7.1.3.1. Small leak possibility: < (less than) 2 inch residential line on the consumer side of meter with ¼ psi.

7.1.3.2. Medium leak possibility: < (less than) 2 inch multi-family/commercial line on the consumer side of meter with up to 2 psi.

7.1.3.3. Large leak possibility: > (greater than) 2 inch supply line with 35 psi or greater.

7.1.4. Estimate leak duration and possible saturated area(s) with high concentration levels.

7.2. ARRIVAL:

7.2.1. Stop 300 feet away, establishing the Initial Isolation Perimeter. Do not park over utility access.

7.2.2. Openings /covers: Avoid parking a vehicle where it would likely be struck by debris from an explosion inside a building.

7.2.3. The Officer should initiate Command responsibilities, perform a 360 (when possible) and conduct an RBA. Within the descriptive size-up the term "Natural Gas" should be stated, establishing that this this Policy is in effect.

7.2.4. Establish and articulate Control Zones

7.2.5. A Base (or initial Staging) location should be identified and incoming companies directed accordingly.

7.2.6. Evaluate audible and/or olfactory clues:

7.2.6.1. If odor is present, increase the Initial Isolation Perimeter to a point of no odor in incremental steps of 100 feet.

7.2.6.2. If no odor is present, continue gathering information to establish the Hot Zone.

7.2.7. The Hot Zone will be established based upon an odor and/or 20 percent of the LEL reading. The Hot Zone is considered an IDLH environment and 2 in/2 out rules shall apply.

7.2.8. Gather information by interrogating reporting/responsible party(s) for known information; location, size and duration of leak (i.e., large/small, exterior/interior, etc.).

7.2.9. Number of structures involved and types (for multiple reports).

7.2.10. Structure proximity to external leak; evaluate possibility of migration (e.g., crawl space vents, gable vents, HVAC, open windows/doors, soffits, etc.).

7.2.11. Adjust the Initial Isolation Perimeter as appropriate.

7.2.12. Verify and/or request appropriate resources (i.e., PSE, local utilities department, HazMat Team, Technical Rescue Team). Establish a Unified Command if appropriate.

7.2.13. Ongoing life safety concerns (e.g., number of occupants if any, what evacuations have been completed, special need civilians, reliability of the reporting parties), based upon their location to the hazard and/or estimated possible saturated areas with high concentrations levels.

7.2.14. Identify and minimize ignition sources (e.g., utilities/systems/appliances using electricity, spark producing machines/equipment/tools, HVAC).

7.2.15. Obtain a water supply and assign Unit(s) to stage for hose deployment. Hose should not immediately be deployed and staffed within the Hot Zone due to explosion potential.

7.3. APPROACH (Hot Zone Assessment):

7.3.1. Do not approach odorous atmosphere without air monitoring equipment and proper PPE.

7.3.2. Full structural PPE and SCBA are donned and covered when operating in the Hot Zone.

7.3.3. During Hot Zone evaluation, it is critical to understand crew location and concentration levels, and take actions based upon an ongoing RBA.

7.4. ACTIONS:

7.4.1. Determine action thresholds (i.e., Go/No-Go) based upon the RBA's life profile and then property profile.

7.4.1.1. Crews must be aware that gas migration may have varying levels of interior concentration in relation to their current location and the point of origin.

7.4.2. Evacuation should be a priority when it is assumed there is an elevated saturation level or confirmed LEL reading is at or above 20 percent of the LEL within the structure.

7.4.3. Interior mitigation and/or evacuation actions can be conducted within the Hot Zone up to a threshold of 50 percent of the LEL unless additional risk is supported by the RBA (see examples) (Action Zone).

7.4.4. It is imperative that readings are constantly monitored for changes and that gathered information from the exterior or interior be used to project and estimate the downrange/forward concentration levels. Crews must use judgment and incorporate all RBA factors when determining the associated level of engagement.

7.4.4.1. Example 1: A severed pipe after a visible exterior meter shutoff may allow a crew to quickly enter the Hot Zone with concentration levels above 50 percent of the LEL while shutting the quarter turn valve.

7.4.4.2. Example 2: With readings rising to 20 percent of the LEL outside an apartment door and, upon entering, rising to 50 percent of the LEL within feet of a known leak source (i.e., gas appliance) it would be allowable to close the valve mitigating the interior hazard.

7.4.4.3. Example 3: After initial entry, a saturated apartment hallway nearing 50 percent of the LEL with an unknown leak source, firefighters should notify Command. Command should

implement a defensive strategy, order withdrawal, and develop an evacuation plan.

7.4.4.4. Example 4: If, while evaluating the outside perimeter of an unoccupied single family residence, air monitor readings approach 40 percent of the LEL, then it is likely interior conditions may be within the explosive range. This indicates a defensive strategy should be employed.

7.4.4.5. Example 5: Upon entering a 100 x 200 foot warehouse with 30 foot ceilings, crews have consistent ground level air readings of 35 percent of the LEL. A reasonable RBA projection may estimate ceiling concentration levels approaching the explosive range requiring a change in deployment strategy.

7.4.5. When air monitoring, evaluate entry points, open windows, crawl space vents, gable vents, HVAC, etc., as appropriate, remembering that natural gas can accumulate in elevated areas. In addition to the use of the Combustible Gas Monitor, consider the use of a specific combustible gas detectors (i.e., CD100A and/or Gas-Trac) when available due to their sensitivity in sensing a combustible gas.

7.4.6. Carbon monoxide readings result from incomplete combustion and indicate there is likely an ignition source.

7.4.7. Consider forcible entry only after monitoring door jambs. Do not use spark-producing equipment if readings are at or above 20 percent of the LEL (e.g., irons).

7.4.8. Consider natural gas migration and check adjacent structures, connected underground utility vaults and passageways.

7.4.9. A failure in the natural gas distribution system at one point may cause a release elsewhere in the system, especially in cases of mechanical or accidental damage. Confer with PSE.

7.4.10. Shutting off natural gas:

7.4.10.1. Shutting the gas off at the valve in the street should only be done by qualified PSE personnel.

7.4.10.2. It should be a top priority of responding personnel to shut natural gas off at the lowest acceptable risk (e.g., at the meter or appliance).

7.4.10.3. Once a natural gas valve is closed it should only be opened by PSE.

7.4.10.4. Personnel should not perform crimping or plugging actions.

7.4.11. With a high suspicion of gas saturation and high concentrations, evaluate requesting the local utilities department to eliminate ignition sources by cutting the power at the pole. Decision will be made via a Unified Command.

7.4.12. Confirm no emergency backup generators or emergency lighting will re-introduce power. Use building managers/engineers or reporting parties for information. Assure the pole is not in an affected or gas saturated area.

7.4.13. Power cuts are very situational and incident dependent. Occupancy type and evacuation profile must be considered. Power cuts may create further ignition sources through evacuating occupants (e.g., using spark producing items such as a light, flashlight, or cell phone). Evaluate time vs. task completion and the control of the civilian evacuation.

7.5. EVACUATION:

7.5.1. When evacuating, Command should evaluate ventilation consistent with this SOG.

7.5.2. Consider using apparatus PA systems or other remote means of notification in order to evacuate the Hot Zone (e.g., possibly move Chief's vehicle or aid car closer to structure(s) based upon conditions, such as upwind, etc.). Do not use systems within a structure (i.e., fire alarm or building PA systems) that could themselves provide an ignition source.

7.5.3. Include in repeated verbal evacuation instructions the importance of not creating ignition sources (e.g., "Do not use light switches, flashlights, elevators, cell phones.").

7.5.4. Provide an assembly area for evacuated civilians.

7.5.5. Ventilation should be based upon RBA and life safety factors in consideration with ventilation options and timing.

7.5.6. When an atmosphere is above the Upper Explosive Limit (UEL), ventilation efforts or natural dilution will move the atmosphere through the flammable range once the gas is shut off. Command must evaluate incident factors, formulate an RBA, and determine a ventilation plan.

7.6. VENTILATION:

7.6.1. No Ventilation: May be used when a structure is saturated with concentration levels above the UEL. This may result in a reduced risk to personnel operating in the Hot Zone; however, the risk of explosion may remain for a longer period of time. Command may wait on ventilation

until ignition sources can be confirmed (e.g., power cuts) and then balance the RBA with a ventilation strategy.

7.6.2. Natural/Horizontal Ventilation: During Hot Zone assessment from investigating teams, ventilation openings can be made as the crew(s) progress systematically through the structure. Understanding the natural flows or building characteristics and using prevailing winds to assist through an established ventilation corridor is highly recommended. Natural ventilation may be slow, but is the least likely to find an ignition source (e.g., common strategy in a single family residence with an interior gas leak).

7.6.3. Forced Ventilation or Positive Pressure Ventilation (PPV): Provides a faster ventilation process, but can be an ignition source. Depending on saturation levels, PPV may also create a potential challenge in establishing a reliable exit point that does not direct gas to an ignition source. Fans should be placed upwind, in a clean area verified by a monitor. Entry and exit points should enhance the buildings natural ventilation characteristics and/or construction features. Example: place fans upwind at the stairwell base of a three story structure with a third floor saturated apartment and a favorable vent corridor and exit point. This strategy may be implemented if an incident RBA favors quickly passing through the explosive range or preventing a release from reaching the LEL.

7.6.4. Mobile Ventilation Unit (MVU): Seattle Fire Department has a truck mounted High Volume Ventilation Unit that is primarily used for large scale operations and used consistent with forced ventilation. Example: a saturated warehouse with no life profile and secured power/ignition sources and a favorable vent/exit corridor.

7.6.5. Combination Strategy: As in all ventilation strategies, methods may phase in and out or be simultaneous depending on the RBA and specific incident factors and assessments.

8. KING COUNTY CHIEFS DIRECTIVE

8.1. This procedure was adopted by the King County Fire Chiefs as a standard for all fire departments within King County. Other than numbering this procedure to match the local system, it shall be placed in

the located departments SOG/SOP verbatim, to ensure countywide standardization. Changes to this procedure must be with the concurrence of the King County Fire Chiefs Association.