



## Division 06

## Fire and Rescue Operations

# Chapter 08 – Incidents Involving Flammable Gases (Including Natural Gas, Propane, or Others)

March 2009

### POLICY

This General Order describes response procedures for incidents involving a suspected or confirmed release of a flammable gas. The primary goal of Fire/EMS Department personnel during such an emergency is to eliminate the fire or explosion hazard, while minimizing the risk to the public and responders.

### DEFINITIONS

**Boiling Liquid Expanding Vapor Explosion (BLEVE)** – A rapid energetic expansion of a liquid stored under pressure, to its gas state; a container failure with a release of energy, often rapidly and violently, which is accompanied by a release of gas to the atmosphere and propulsion of the container or container pieces due to an overpressure rupture

**NOTE:** BLEVE's are often accompanied by a large fireball if a flammable material is involved.

**Combustible Gas Instrument (CGI)** – A detection instrument capable of measuring the percent of the lower explosive limit of a flammable gas in air

**Compressed Natural Gas (CNG)** – Natural gas stored as a gas under high pressure (3000-4000psi)

**Emergency Response Guidebook (ERG)** – U.S. Department of Transportation (DOT) guidebook intended to provide guidance for

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hazardous materials response. A copy is carried on every response unit

**Flammable Range** – The range between the Lower Flammable (Explosive) Limit (LEL) and the Upper Flammable (Explosive) Limit (UFL), where there is a sufficient percent of a flammable vapor in air to support combustion

**Hot Zone/Isolation Area** – An area presumed to be immediately dangerous to life and health that requires the use of complete and appropriate protective clothing, and the evacuation/rescue of unprotected persons

**Lower Explosive Limit (LEL)** – The lowest concentration of a flammable vapor in air that will support combustion

**Liquefied Natural Gas (LNG)** – Natural gas stored in a liquid state by cryogenic cooling; when allowed to change from a liquid to a gas, LNG produces 614 cubic feet of vapor for every cubic foot of liquid (liquid to vapor expansion ratio)

**Liquefied Gas** – A gas that that has changed from a vapor phase to a liquid phase by compression, cooling, or a combination of both

**Natural Gas** – An odorless and colorless mixture of flammable gases composed of 80-96% methane; the odorant tert-butyl mercaptan is added so leaks can be detected by smell; natural gas is lighter than air

**NOS** – Not Otherwise Specified



**Percent LEL (%LEL)** – Percent of the Lower Explosive Limit; measurement of a flammable vapor in air; determines relative risk of explosion in a flammable environment

**Propane** – Odorless and colorless fuel gas typically stored as a liquefied compressed gas; the odorant ethyl mercaptan is added so leaks can be detected by smell. It is also known as LPG or LP Gas (Liquefied Petroleum Gas). In changing from a liquid to a gas, propane produces 270 cubic feet of vapor for every cubic foot of liquid (liquid to vapor expansion ratio). Propane is heavier than air.

**Hazards** – Characteristics that are constant for the material or container (Not specific to the incident)

**Risks** – Characteristics that are specific to the incident, such a weather conditions

**Structural Firefighter Protective Clothing (SFFPC)** – Department approved or issued protective clothing

**Self Contained Breathing Apparatus (SCBA)** – Department issued respiratory protection

**Vapor Density** – The relative weight of a vapor as compared to air (Air = 1); a vapor is lighter in air if it has a vapor density less than 1; vapor is heavier than air if it has a vapor density greater than 1

Natural gas and other flammable gas emergencies are the most common hazardous materials responses in the Department. As such, this response procedure is modeled after the Department Hazardous Materials Incident Response Process.

The Hazardous Materials Incident Response Process regardless of size, scope, or material is:

1. Scene Management and Control
2. Recognition and Identification
3. Hazard and Risk Assessment
4. Selection of Appropriate PPE , Tools, and Equipment
5. Information Management
6. Implement Response Objectives
7. Decontamination
8. Termination

### Three (3) Types of Flammable Gas Incidents

There are many flammable gases that could be encountered. However, there are three general types of incidents. Although the combination of the flammable gas and the situation generates specific considerations, this general incident procedure can be used for all flammable gas responses.

#### Open Space Release with No Fire

Flammable gases when released in open spaces may present a flammability hazard, especially if the gas is heavier than air. Examples of such an incident include:

- Incidents involving vehicles fueled by or transporting flammable gases
- Odor of flammable gas outside
- Flammable gas pipeline struck/damaged
- Pressure relief device, or overfill protection device activation or failure

## PROCEDURES

### 1. General Information

The goal when responding to the release of a flammable gas is to remove the fire or explosion hazard by controlling the flow of gas and ignition sources. This must be accomplished while minimizing the risk to the public and responders.



**Enclosed Space Release with No Fire**

Flammable gases present an increased risk for a catastrophic explosive ignition when released into a confined area. Examples of such an incident include:

- Odor of flammable gas inside a structure
- Flammable gas migrating into a structure

**Flammable Gas Release with Fire Incidents**

Fires that are fed by a flammable gas should not be extinguished until the gas supply is controlled. In some cases, this may not be recognized until normal after fire suppression operations are undertaken. Examples of such an incident include:

- Flammable gas fed fire in a structure
- Flammable gas fed fire outside a structure
- Reported explosion involving flammable gas
- Reported fire involving a flammable gas storage container
- Reported fire involving a flammable gas fueled vehicle

**2. Hazardous Materials Incident Response Process**

**STEP 1 – Scene Management and Control**

**• Positioning**

Apparatus should be positioned outside the hazard area so that fire suppression and rescue operations can be rapidly undertaken should an explosion or ignition occur. Units should not be committed inside the Hot Zone where an

explosion might kill or injure responders. Collapse zones and overhead hazards must be considered. Positioning should combine barrier protection and water supply considerations. Level II staging should be considered for other responding units.

**• Staging**

**1st Due Engine** – Stage apparatus at an upwind and uphill location where an appropriate water supply can be established outside the Hot Zone (330 feet/100 meters, as recommended by the DOT ERG, Guides “Gases NOS”). If water supply is not immediately available, consider additional resources.

**2nd Due Engine (if required)** – Stage apparatus at the water supply location selected by the 1<sup>st</sup> Due Engine and prepare to complete the water supply.

**3rd Due Engine Company (if required)** – Stage apparatus at an upwind and uphill location where a secondary water supply can be established outside the Hot Zone (330 feet). If secondary water supply is not immediately available, consider additional resources.

**4th Due Engine Company (if required)** – Stage apparatus at the water supply location selected by the 3<sup>rd</sup> Due Engine and prepare to complete the water supply.

**1st Due Truck (if required)** – Stage the apparatus at an upwind and uphill location outside the Hot Zone. This position should allow for a rapid transition to defensive fire suppression tactics on Side Alpha to contain fire spread and protect exposures.



**2nd Due Truck (if required)** - Stage the apparatus at an upwind and uphill location outside the Hot Zone. This position should allow for a rapid transition to defensive fire suppression tactics on Side Charlie to contain fire spread and protect exposures.

**3rd Due Special Service (if required)** - Stage apparatus at an upwind and uphill location where a rapid intervention crew can position to support personnel operating in the Hot Zone.

**Any Other Units** – Level II Stage in a position that will allow access to the area for other responders.

**Command Officer** – Establish a Command Post in an uphill and upwind position in the Cold Zone.

**EMS Units** – Stage apparatus in the Cold Zone while anticipating egress from the scene.

- **Incident Command**

Establish Incident Command System. Confirm the location and describe the conditions found. Provide direction and operational objectives for other responding units and personnel.

- **Establish Control Zones**

An initial Hot Zone should be established and all unprotected persons removed from this area. The size of this Hot Zone should include the entire structure and any attached structures and/or at least 330 feet (100 meters) from the release (as recommended by the DOT ERG, Guides “Gases NOS”). A Warm Zone should be established at logical control points for

pedestrian and vehicle traffic, but at least twice the size of the Hot Zone.

- **Public Protection**

Conduct/coordinate building and area evacuation if an odor of flammable gas is confirmed or any release is suspected. Any patients found within the Hot Zone should be extricated rapidly and removed to an EMS treatment area located in the Cold Zone safe area. Provide EMS care, if needed.

**STEP 2 – Recognition and Identification**

Refer to the DOT Emergency Response Guidebook (ERG) for further information and response guidance.

Observe vehicle placards or package labels confirming the presence of flammable gases. Examples include:



Consult shipping papers or material safety datasheets provided by vehicle operator or facility personnel.

Locate reporting party, vehicle operator, or building personnel to determine the possible location and cause of the release.

**STEP 3 – Hazard and Risk Assessment**

In assessing the potential for hazards and risks:

- Determine the appropriate physical and chemical properties of the material, such as vapor density



- Determine if the material is stored as a liquefied compressed gas, such as propane (LPG); if so, the potential for BLEVE exists if involved in fire
- Determine the approximate size, volume, pressure, and location of the gas supply
- Anticipate the potential course and harm of the incident and modify tactics accordingly

#### **STEP 4 – Selection of Proper PPE**

Structural Firefighter Protective Clothing (SFFPC) and Self-Contained Breathing Apparatus (SCBA) shall be used when conducting operations within the established Hot Zone area.

#### **STEP 5 – Information Management and Resource Coordination**

To ensure appropriate management of information and effective coordination of resources:

- Request emergency assistance from the appropriate utility company or gas supplier, and provide them pertinent information regarding the release
- Coordinate control efforts with appropriate utility company or gas supplier personnel
- Consider additional fire suppression, EMS or hazardous materials resources
- If a natural gas explosion is suspected, contact the on-duty Investigator and on-duty Hazardous Materials personnel.

#### **STEP 6 – Implement Response Objectives**

Response objectives shall be as follows:

- Minimize the number of personnel operating in the Hot Zone; personnel

- should only enter the Hot Zone area after being given specific objectives
- Maintain required “2-in, 2-out” personnel or establish Rapid Intervention Crew while personnel operate within the Hot Zone
- Conduct initial operations to affect immediate rescues and protect egress; attack lines should not be initially committed within the Hot Zone, and remote master streams should be considered
- Determine location of emergency shut-offs or control valves
- Eliminate possible ignition sources systematically and safely from the area of highest hazard to the area of lesser hazard
- Using CGI’s, evaluate surrounding structures for migration of natural gas; if found, consider additional resources and adjust tactics accordingly
- Utilize proper detection equipment (CGI) to measure flammability hazard
  - LEL values > 10% - SFFPC and SCBA required
  - LEL values > 20% - Fire/EMS Department personnel shall evacuate the area and defensive tactics and ventilation will be undertaken
  - Leak detecting “Gas-Trac style” devices may be used to locate sources, but they cannot be relied upon to measure the flammability hazard; they should only be used in conjunction with a CGI
- Control the source of the release from a remote above ground control valve; below ground valves are only to be used by gas utility personnel
  - Fire/EMS Department personnel are not authorized to dig for, clamp, pinch, or otherwise control the flow of



gas from the point of the release. Static discharge from the point of the release may ignite the released gas causing an explosion. If needed, this control will be completed by personnel from the gas utility or hazardous materials units.

**STEP 7 – Decontamination**

Flammable gases do not generally present a hazard that requires decontamination. However, if the odorant impregnates protective clothing it should be removed from service and commercially decontaminated.

**STEP 8 – Termination**

Anytime the Fire/EMS Department must secure a gas supply, a Fire/EMS Department Notice to Repair/Condemnation Correction Order shall be issued to document and direct the restoration of service only under the supervision of a qualified professional. If there are significant or repetitive issues with a gas supply or a type of vehicle, contact on-duty Hazardous Materials personnel.

**FORMS/ATTACHMENTS**

FORM 1 – Notice to Repair/Condemnation Correction Order

ATTACHMENT 1 – Incidents Involving Flammable Gases Response Checklist

ATTACHMENT 2 – Common Flammable Gases Reference

**REFERENCES**

Callan, Michael; Responding to Utility Emergencies; Red Hat Publishing, 2004.

North American Emergency Response Guidebook (ERG), Department of Transportation, 2008

Noll, Hildebrand, Yvorra; Hazardous Materials: Managing the Incident; 3rd Edition; IFSTA, 2005

National Propane Gas Association (NPGA) Training Course, “Propane Emergencies” Prince George’s County Code, Subtitle 11 [Fire Safety], Section 11-160



# FIRE/EMS DEPARTMENT PRINCE GEORGE'S COUNTY, MARYLAND

## NOTICE TO REPAIR/CONDEMNATION CORRECTION ORDER

Incident # \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Occupant: \_\_\_\_\_ Phone: \_\_\_\_\_

Address: \_\_\_\_\_

Owner/Mgmt: \_\_\_\_\_ Phone: \_\_\_\_\_

Address: \_\_\_\_\_

Pursuant to Subtitle 11 [Fire Safety] of the Prince George's County Code, Section 11-160,  
**Notice to repair, alter; condemnation tags:**

Whenever the Fire Chief or his authorized representative deems any chimney, smoke stack, stove, oven, incinerator, furnace, or other heating device, electric fixture, or any appurtenance thereto, or any item regulated under provisions of this Subtitle in or upon any building, structure, or premises, to be defective or unsafe so as to create an immediate hazard, he shall serve upon the owner or the person having control of the property written notice to repair or alter as necessary, and shall notify any other authority enforcing codes, laws, or regulations regulating such equipment.

A repair/condemnation order has been issued for the following items:

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The parties listed above are directed to **immediately comply** with the following notice:

- 1) The use of those items listed above is hereby prohibited until appropriate repairs or alterations are made.
- 2) This order may be removed only by the order of the Fire Chief or his authorized representative and may be removed only when the hazard to which the order pertains has been eliminated in an approved manner.
- 3) Until removed, that item or device which has caused the hazard shall not be used or permitted to be used.
- 4) Once repairs have been completed, please contact the representative listed below for resolution of this Order.

**FAILURE TO COMPLY SHALL CONSTITUTE A VIOLATION OF SUBTITLE 11, VIOLATORS SHALL BE SUBJECT TO THE PROVISIONS OF SECTION 11-114, CRIMINAL PENALTY FOR VIOLATION.**

Responsible Party: \_\_\_\_\_ Issued By: \_\_\_\_\_

Title: \_\_\_\_\_ Title: \_\_\_\_\_ Phone: \_\_\_\_\_

**FOR FIRE OR EMERGENCY MEDICAL SERVICE DIAL 911**

## Common Flammable Gases Reference Sheet

### Acetylene

Oxyacetylene is the hottest burning fuel gas. Approximately 20 percent of national acetylene production is used for oxyacetylene gas welding and cutting due to the high temperature of the flame; combustion of acetylene with oxygen produces a flame of over 3300 °C (6000 °F)

Flammable Range:

3-82%

Vapor Density:

0.91 (lighter than air)



NFPA 704:

### Natural Gas (Methane)

A gaseous fossil fuel consisting of 80-96% methane but including significant quantities of ethane, butane, propane, carbon dioxide, nitrogen, helium and hydrogen sulfide. The odorant tert-butyl mercaptan is added so leaks can be detected by smell.

Flammable Range:

4-16%

Vapor Density:

0.61-0.69 (lighter than air)



NFPA 704:

### Propane

Propane is normally found as a gas, but is compressible to a liquid that is transportable (liquefied compressed gas). It is commonly used as a fuel for engines, barbecues, and home heating systems. When commonly sold as fuel, it is also known as liquefied petroleum gas (LPG or LP-gas) and can be a mixture of propane with smaller amounts of propylene, butane, and butylene. The odorant ethyl mercaptan is added so leaks can be detected by smell.

Flammable Range:

2-10%

Vapor Density:

1.50 (heavier than air)



NFPA 704:



# Incidents involving Flammable Gases Response Checklist

## **STEP 1: Scene Management and Control**

- **Positioning and Staging** –
  - Outside the Hot Zone (330 feet)
  - Position upwind and uphill
  - Consider water supply
  - Consider barrier protection
  - Level II Stage other responding units
- **Incident Command** –
  - Establish Incident Command System
  - Confirm location and conditions
  - Provide direction for other units
- **Establish Control Zones** –
  - Initial Hot Zone at 330 feet
  - Remove all unprotected persons
- **Public Protection** –
  - Conduct/Coordinate building and area evacuation.
  - Provide EMS care as needed

## **STEP 2: Recognition and Identification**

- **Refer** to the DOT Emergency Response Guidebook for further information.
- **Locate** reporting party, vehicle operator, or building personnel to determine the possible location and cause of the release.

## **STEP 3: Hazard and Risk Assessment**

- **Hazards** – Characteristics constant for the material or container.
  - Physical and chemical properties material.
  - Construction of the container
  - Liquefied compressed gas (BLEVE)
- **Risks** – Situations specific to the incident
  - Determine the size, volume, and pressure, of the gas supply.
  - Estimate potential course and harm of the incident and modify tactics accordingly.

## **STEP 4: Selection of Proper PPE**

- **Utilize** SFFPC and SCBA within the established Hot Zone.

## **STEP 5: Information Management and Resource Coordination**

- **Request** emergency assistance from the utility company or gas supplier

- **Provide** pertinent information regarding the release
- **Coordinate** control efforts with appropriate utility company or gas supplier personnel.
- **Consider** additional fire suppression, EMS or hazardous materials resources.

## **STEP 6: Implement Response Objectives**

- **Minimize** the number of personnel operating in the Hot Zone.
- **Maintain** required “2-in, 2-out” personnel or establish Rapid Intervention Crew (RIC) while personnel operate within the Hot Zone.
- **Perform** immediate rescues and protect egress.
- **Locate** emergency shut-offs or control valves.
- **Eliminate** ignition sources from the area of highest hazard to the area of lesser hazard.
- **Evaluate** surrounding structures for migration of natural gas.
- **Utilize** proper detection equipment (CGI) to measure flammability hazard.
- **Control** the source of the release from a remote above ground control valve.

*Fire/EMS Department personnel are not authorized to dig for, clamp, pinch, or otherwise control the flow of gas from the point of the release. If needed, this control will be completed by personnel from the gas utility or hazardous materials units.*

## **STEP 7: Decontamination**

- **Decontaminate** protective clothing if the odorant has impregnated protective clothing.

## **STEP 8: Termination**

- **Issue** Fire/EMS Department Correction Order to document and direct the restoration of service.
- **Contact** on-duty Hazardous Materials personnel if there are significant or repetitive issues with a gas supply or type of vehicle.