Emergency Response

1. Situation analysis

a. Initial steps

Establish a safety perimeter: evacuate within a radius of 1600m in case of fire and 800m in case of an important spill
Verify the condition and the behavior of the reservoir or tank
Determine if the situation is stable or deteriorating
Identify the local dangers and risks, quantities involved and number of affected people.
Determine the required resources for an appropriate response.

b. Evaluate the product behavior

Estimate the leak or spill flowrate
Obtain weather conditions (Wind speed and direction, temperature, humidity)
Identify more accurately the likely affected areas
Modify, if necessary, the security perimeter based on evaluation results.

c. Personal protection

Wear fireproof clothing and low temperature resistance fabric
Wear a self-contained breathing apparatus when approaching the spill source (danger of asphyxia).

d. Detection equipment

Use combustible gas indicator
Ensure proper calibration of indicator.

2. Possible response strategies

Never respond alone, approach with the wind at your back
Stop or plug leak if possible
Promote cloud dispersion using streams of water
Never spray a LNG pool directly (Possible RPT and ensuing overpressure)
A LPG cloud will infiltrate underground infrastructures (LPG is denser than air)
Prevent the flow of liquid LNG into sewer systems
Prevent the inflow of LPG or LNG vapors into buildings
Verify the presence of combustible gases in the sewers, underground structures and buildings (any confined spaces in proximity)
Do not extinguish a fire before interrupting the combustible source (danger of reflash (re-kindle) and flash fire)
Cool adjacent structures in case of a fire
If there is a risk of a BLEVE, evacuate the surrounding area and let the tank content burnout.

For additional information, please consult the following documents:

LPG:

API Standard 2510: Design and Construction of LPG Installations
API Publication 2510A: Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities
CCPS Guidelines for Evaluating the Characteristics of Vapour Cloud Explosions, Flash Fires & BLEVEs, Center for Chemical Process Safety

LNG:

CSA Z276, Liquefied natural gas (LNG) - Production, Storage, and Handling

Technical Popularization Pamphlet 5

2th EDITION

CRAIM
MAJOR INDUSTRIAL ACCIDENTS REDUCTION COUNCIL*

LPG (Liquefied Petroleum Gas) and LNG (Liquefied Natural Gas)

Vision and Mission of the CRAIM

Vision

CRAIM aims to be the benchmark in hazardous substance risk management within the scope of sustainable development by applying rigorous, responsible and concerted methodologies.

Mission

To Develop rigorous tools and methods that provide responsible management of risks related to hazardous substances.
To Promote and support a culture of collaboration between all stakeholders to effectively manage the risks involving hazardous substances.
To Foster, with stakeholders, a reduction in the risks of major industrial accidents through the implementation of appropriate prevention, preparedness, response and recovery measures.

This document, based on current available facts, is designed to familiarize the reader with certain basic concepts. The reader must be aware that the information provided in this document is not complete, and therefore, that other complementary sources must be consulted to avoid any unfortunate situations. The reader is entirely responsible for any decisions or actions taken on the basis of this document.

* Conseil pour la réduction des accidents industriels majeurs

Introduction

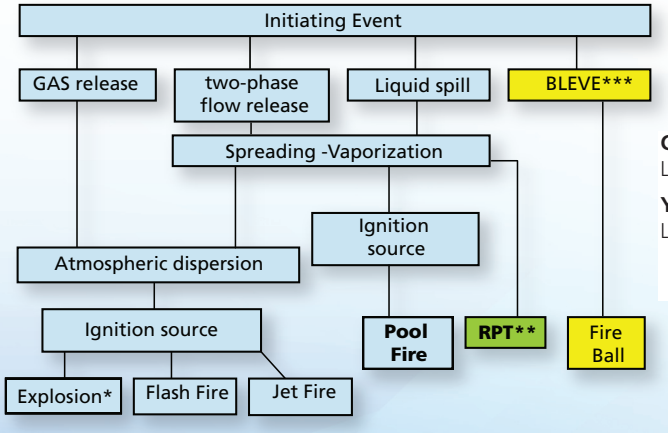
LPG and LNG are hydrocarbons mainly used as fuel for heating. LPG comprises propane and butane. LNG is essentially liquefied methane. LPG and LNG are stored and transported in a liquefied state in order to reduce their volume. LPG's are liquefied under pressure at ambient temperature, whereas LNG is cryogenically liquefied (using cold temperature) at atmospheric pressure.

Main physical properties:

Properties	LPG (propane)	LNG (methane)
UN number	1075 or 1978	1972
Color, odor	Clear, odorized with mercaptans	Clear, odorless
Specific gravity of liquid	0.51 to 0.58	0.42 to 0.5
Specific gravity of gas	1.5	0.6
Boiling Point (°C)	- 42	- 161
Auto-ignition temperature (°C)	470	595
Flammability Limit Gas	2.2 à 9.5%	5 à 15%
Flammability Liquid *	flammable	flammable
Water solubility	75 mg/l	26 mg/l

* All liquids never really ignite. It is the vapors, on the liquids surface, that are combustible. (Combustion, requires oxygen, which is not readily available in liquids)

Accident scenarios:



GREEN BOXE:
LNG accidents only

YELLOW BOXES:
LPG accidents only

* Explosions of Natural Gas in open air are highly unlikely and require confinement of the gas or the acceleration of the flame front with the presence of obstacles. (Margan and Hill, 1997)

Outflow behavior:

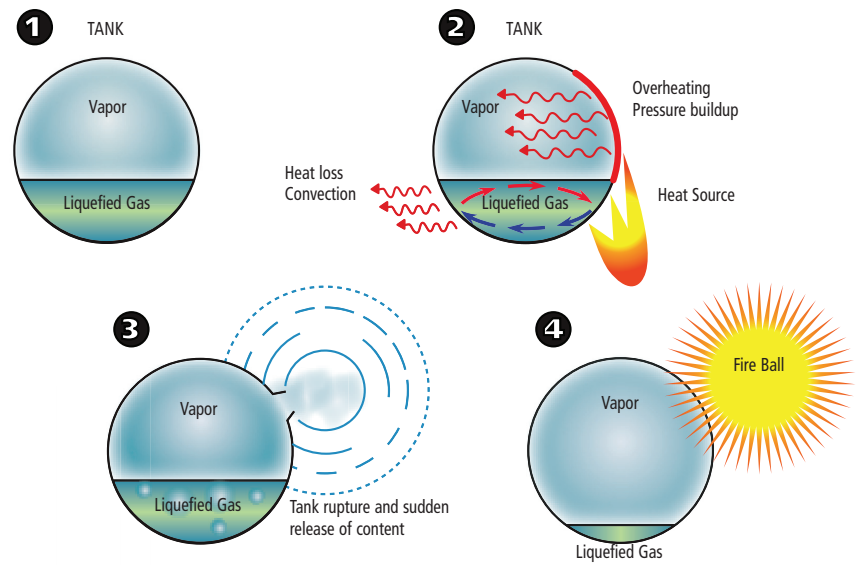
LPG (propane)	LNG(methane)
Produces a vapor cloud that remains on the ground, given that propane is heavier than air. Propane can create a pool of liquid under temperature below -42°C.	Produces a vapor cloud that remains on the ground until the cloud temperature reaches -100°C, it then rises. A liquid discharge creates a pool of liquid that spills towards the lowest points on the ground.

****RPT: Rapid Phase Transition:** A significant temperature difference between LNG and a warmer liquid (e.g. water) can instigate, under certain conditions, the "quasi–instant" vaporization of LNG. The sudden increase in volume (liquid to vapor) can generate a shock wave. This accidental phenomenon can be referred to as a "Cold explosion" (Sudden generation of overpressure, without combustion)

*****BLEVE (Boiling Liquid Expanding Vapor Explosion).** Specific situation related to LPG storage vessels. Can be caused by one of the following:

- Thermal aggression (most common)
- Mechanical impact
- Overfilling coupled with metal (tank) weakness

Figure illustrating the BLEVE phenomenon:



Safety Barriers

PREVENTION BARRIERS

a. Regular maintenance program
b. Personnel training
c. Building Codes
d. Electrical Classification
e. Combustible Gas detection systems with alarms
f. Automatic shutoff valves
g. Land use
h. Installing tanks far from buildings or flammable material
i. Anti-intrusion fences
j. Cameras

PROTECTION BARRIERS

a. Safety wall
b. Dikes
c. Sprinklers, water curtain
d. Fixed Fire Nozzles
e. Firefighting foam for LNG
f. Firefighting exercises
g. Evacuation procedures
h. Emergency plan
i. Fencing
j. Land use

For more information on safety barriers, please consult the TPP #3 or the CRAIM Guide (2007), chapter 4.