Safety Barriers *(non-exhaustive list):*

Preventive barriers

Personnel qualification and training

Policies and check lists

Safety relief valves

Preventive and predictive maintenance of tanks and piping systems

Avoid collisions or impacts using:

- Fences, bollards
- Elevated pipe racks
- Speed limits

Eliminate possible sources of ignition in the affected area

Leaks detection devices

Work permit

Process interlocks

Protective barriers

Automatic closure of valves on leak detection

Preferred rupture zone

Containment dikes or walls

Written emergency procedures

Safe distances and land use planning

Emergency plan coordinated with local emergency response services

Emergency response drills

Fire detectors

Combustible gas monitors

Sirens

Response:

Quickly establish an initial safety perimeter

Analyze the situation

Assess risk / detect signs of BLEVE or burst

Wear the proper personal protective equipment

Use the proper detection equipment

Eliminate possible sources of ignition in the affected area.

For tank containing products that can generate cold as ammonia, cryogenic products, carbon dioxide, cool the tank shell with water spray avoiding direct water spray on relief device vents (to avoid frosting).

References:

- Guidelines for vapor cloud explosion, pressure vessel burst, BLEVE, and flash fire hazards. - 2nd ed., "Center for Chemical Process Safety." ISBN 978-0-470-25 147-8
- CPR 14E Methods for the calculation of physical effects. TNO (The Netherlands Organization of Applied Scientific Research).
- Emergency Response Plan, ERP Model for Propane, CPA, AQP, CRAIM, 2012.
- EPA 550-B-00-001 Risk Management Program Guidance for Propane Storage Facilities
- 2020 Emergency Response Guide,Transport Canada, 2020.

For more information, MIARC offers on demand workshops on Exlosions & BLEVE.

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Technical Popularization Pamphlet 7

CRAIM
MAJOR INDUSTRIAL ACCIDENTS REDUCTION COUNCIL*

The Explosions

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.

* Conseil pour la réduction des accidents industriels majeurs

Definitions

Explosion:

A release of energy that causes a change in the surrounding air density, pressure and velocity.

Deflagration:

A chemical reaction in which the reaction front advances at a velocity lower than the sonic speed. The generated blast wave is generally of a lower strength.

Detonation:

A chemical reaction in which the reaction front advances at a velocity higher than the sonic speed. The generated blast wave is generally of an higher strength.

Burst:

Violent rupture of a vessel causing noise, a shock wave and sometimes projection of fragments.

BLEVE (Boiling Liquid Expanding Vapour Explosion):

Is caused by the catastrophic failure of a pressurized vessel containing a liquid whose temperature highly exceeds its atmospheric boiling point. (INÉRIS according to Shield Le BLEVE, Phénoménologie et modélisation des effets thermiques, DRA-006, 2002)

HIT (Heat Induced Tear):

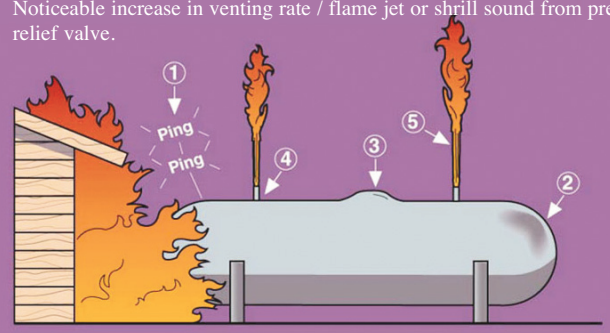
A heat induced tear (HIT) is a rupture of a NON-PRESSURE tank containing flammable liquids when exposed to the intense heat of a fire. The metal will soften and the pressure in the tank will increase which can lead to containment failure. The tear generally occurs at the vapor space (upper side) of the container, venting large quantities of flammable liquid and vapors at high speed. A fireball and an intense heat wave will occur.

VCE (Vapour Cloud Explosion):

Combustion of a flammable air/gas mixture at a more rapid rate than in a flash fire, resulting in the development of an overpressure. Most VCEs are deflagrations (low overpressure). For most of the gases, a detonation will be only possible in a confined or congested environment.

Detection and indices: BLEVE

1. Pinging sound from metal shell as it stretches under pressure
2. Discolouration of container (possibly cherry red)
3. Bubble or bulge on the container surface
4. Pressure relief valve venting
5. Noticeable increase in venting rate / flame jet or shrill sound from pressure relief valve.



Source : Essentials of Fire Fighting, International Fire Service Training Association IFSTA

Examples of some substances with their types of possible explosions

Substance	B	DEF	DET	C	BLEVE
Water	x				x
Acetylene	x		x		
Liquid hydrogen	x	x	x		x
Liquified Petroleum Gas	x	x		x	x
Ammonia	x	x		x	x

B =Burst, DEF = Deflagration, DET = Detonation
C = possible detonation only in confined or congested environment

Here is a non exhaustive list of bursts and other types of explosion causes:

- Phenomenon affecting the container (tank or pipe system)
  - Heat
  - Material fatigue
  - Design error or manufacturing fault
  - Corrosion or erosion
- Phenomenon involving the contents of the container
  - Overpressure
  - Overheating of gas
  - Overheating of liquid
  - Piston effect (hydraulic hammer during liquid filling)
  - Internal chemical reaction
  - Introduction of foreign (incompatible) material

To avoid an explosion, many safety barriers should be put in place. The following table gives some examples.

For the safety valves (preventive barriers) one must ensure they are functioning properly. This requires:

- Regular maintenance and calibration including review frequency to the test results obtained.
- Knowing the limits of the overpressure protection systems.

Because:

- The capacities of the valves (including safety factors) are provided at the time of the original design for normal operations.
  - They are not always sized for fires.
  - They are seldom provided for conditions during maintenance activities
  - They are rarely provided for connections with other sources of pressure.