



FIRE AND EXPLOSION HAZARD MANAGEMENT

Toolbox Talk - The Basics (Part 1)



PREVENTION OF FIRES AND EXPLOSIONS

» It's about hazardous energy:



Chemical



Pneumatic

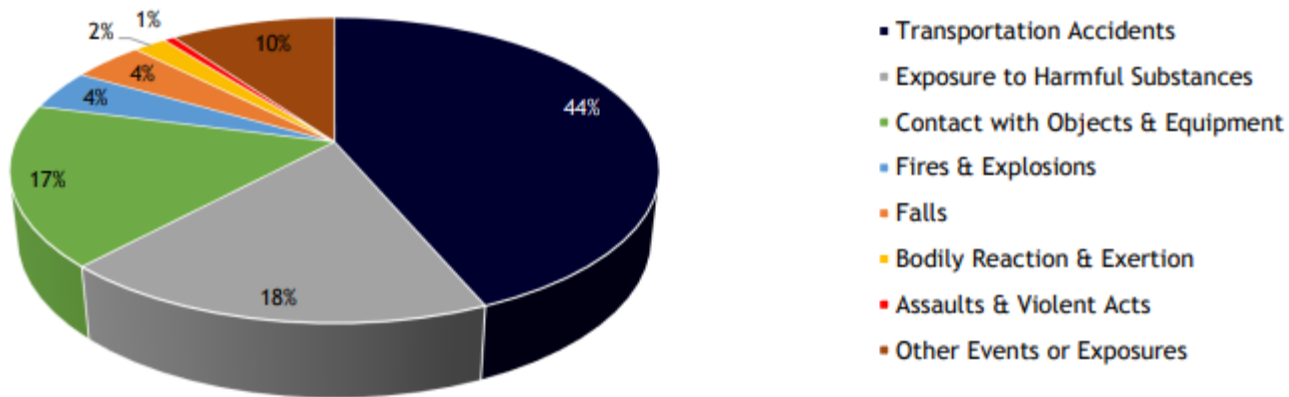


Thermal

» Fire and explosions release an enormous amount of hazardous energy that can lead to injuries, fatalities and damaged equipment

WHAT DOES THE DATA SAY?

- » There have been 13 fatalities from fires and explosions over the last 17 years in the three western provinces within the upstream oil and gas Workers' Compensation Board (WCB) codes
- » Fires and explosions rank 4th for Event or Exposure type (by Fatality Count) in the Oil and Gas Industry from 2001 to 2017



- » For a copy of a preliminary fatality analysis report click [here](#).

WHAT SHOULD I KNOW ABOUT FIRES AND EXPLOSIONS

- » One-size-fits-all solution does not exist
 - Oil and gas operations, their various workplaces, and a range of products both produced and used are much too diverse

- » Site specific strategies for each particular operation and situation are required
 - Equipment, operations, substances and worker competency may be different each time

- » Most significant risk factors are:
 - Competency
 - Not recognizing the risks and warning signs (complacency)
 - Normalizing the risk (we've always done it this way)

FIRE TRIANGLE

» A fire requires three ingredients:

- Fuel source
- Oxygen source
- Ignition source



FUEL SOURCES

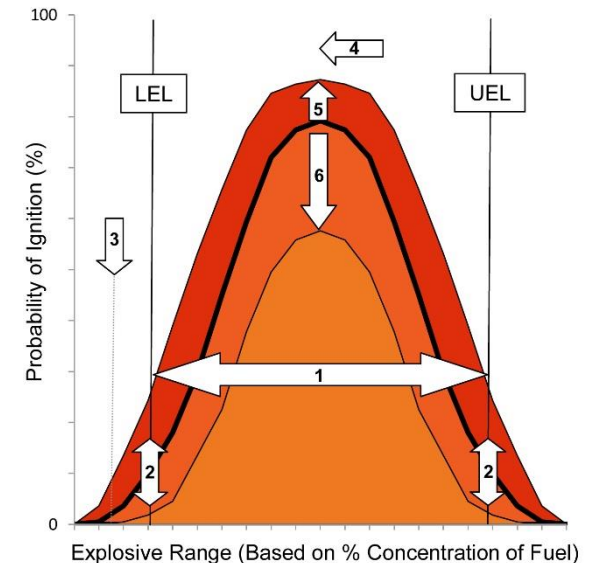
» Fuels can be gases, liquids or solids. Some examples are:

- Gases:
 - Methane
 - Liquid petroleum gases (LPG)
 - Hydrogen sulphide (H_2S)
 - Carbon monoxide
- Liquids:
 - Condensate
 - Crude Oil
 - Methanol
 - Produced water that contains flammable gases or liquids
- Solids:
 - Office paper
 - Coffee whitener (combustible dust)
 - Solid sulphur (combustible dust)
 - Gilsonite - a drilling additive (combustible dust)
 - Coke - oil sands (combustible dust)
 - Waxes



FLAMMABILITY

- » Fuels are flammable when the ratio of fuel to oxygen is within a certain range for that fuel
- » This range is defined as the lower explosive limit (LEL) and upper explosive limit (UEL)
- » For methane the LEL is 5% and the UEL is 15%
 - There must be 5% by volume methane in the air for a flammable concentration to be reached. Below this, the fuel/air mixture is too lean to burn
- » Different fuels have different LELs and UELs
- » Remember the fuel's LEL does not provide an indication of how likely that fuel is to be in the air



CLASSIFICATION – FLASH POINT AND BOILING POINT

- » Flash point provides an indication of whether a liquid fuel will generate enough vapours to be flammable based on temperature
- » Flash point combined with boiling point is used to classify flammable liquids in WHMIS 2015 as indicated below:

Classification Elements		Hazard Statement	WHMIS 2015	TDG
Flash Point*	Boiling Point			
<23°C	≤35°C**	Extremely flammable	Category 1	Packing Group I
<23°C	>35°C	Highly flammable	Category 2	Packing Group II
≥23°C and ≤60°C	>35°C	Flammable	Category 3	Packing Group III
>60°C - ≤93°C	N/A	Combustible	Category 4***	N/A***

* - closed-cup method

** - TDG regulations currently indicate “Any” flash point

*** - provided temperature of liquid is less than flash point

EXAMPLES

» Which substance would you choose to work with and does this change based on the situation or as you have more information?

Substance A ✓

LEL 6%

Substance A

LEL 6%

Flash Point 20°C

Substance A ✓

LEL 6%

Flash Point 20°C

Operating Temp 15°C

Substance B

LEL 0.8%

Substance B ✓

LEL 0.8%

Flash Point 40°C

Substance B

LEL 0.8%

Flash Point 40°C

Operating Temp 60°C

Substance A has a higher LEL than Substance B

Substance B has a flash point that is higher than Substance A and therefore a higher temperature is required to be flammable

Substance A has a lower flash point than Substance B, but the operating temperature is below the flash point, while the operating temperature of Substance B is above the flash point.

OXYGEN

- » The air contains 21% oxygen
- » Oxygen could be introduced chemically such as hydrogen peroxide
- » In general, do not introduce air into active process equipment
- » Oxygen expands the flammable range
 - For example the fabric aramid found in some flame resistant coveralls requires 23% oxygen to burn and therefore is considered inherently flame resistant
- » Oxygen reduces the minimum ignition energy
- » Oxygen increases the intensity of a fire
- » Oxygen is all around us - therefore, controlling fuel and ignition sources is typically more successful in preventing fires



COMMON SOURCES OF IGNITION

- » Hot work
 - Welding, grinding, etc.
- » Engines and equipment
 - Vehicles, generators, light stands, etc.
- » People smoking
- » Static electricity
 - People
 - Pressure washing
 - Abrasive blasting
 - Product transfer
- » Chemicals
 - Iron sulphide (spontaneous ignition)
- » Sources of ignition are everywhere!



<https://www.iflscience.com/physics/the-reason-you-get-more-static-electric-shocks-in-cold-weather/>

MITIGATING THE RISK OF FIRE OR EXPLOSION

- » If any one of these three elements is missing, fire cannot be created
- » On the other hand, even if all elements of the triangle are present in the right amounts and in the vicinity of one another, it does not necessarily guarantee that a fire or explosion will occur
- » By removing or minimizing any of the three elements of the fire triangle, you can minimize or eliminate the risk of a fire or explosion

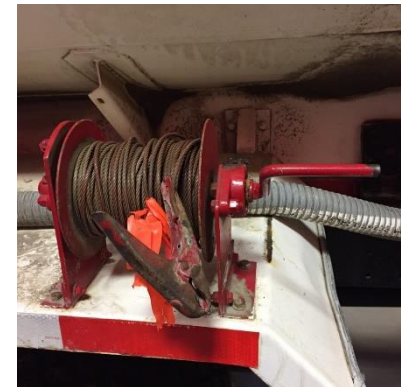
CONTROLLING FLAMMABLE ATMOSPHERES

- » Flammable atmospheres are all too common, especially when breaking containment or with temporary operations
- » As a result, many focus on controlling ignition sources and may not focus on the prevention of flammable atmospheres
- » This is when a strong focus on engineering out flammable atmospheres is needed
- » Where in your work site might the presence of flammable atmospheres exist (normalization)?

BONDING AND GROUNDING

- » Bonding means is ensuring an adequate connection between two pieces of equipment
 - Bonding equalizes an electrical potential
 - Hoses and pipes that are not made of conductive materials (metal) must be designed with a built-in wire to accumulate and transfer static charge that may build up

- » Grounding means establishing a connection between one piece of equipment and the ground
 - Grounding removes any electrical potential

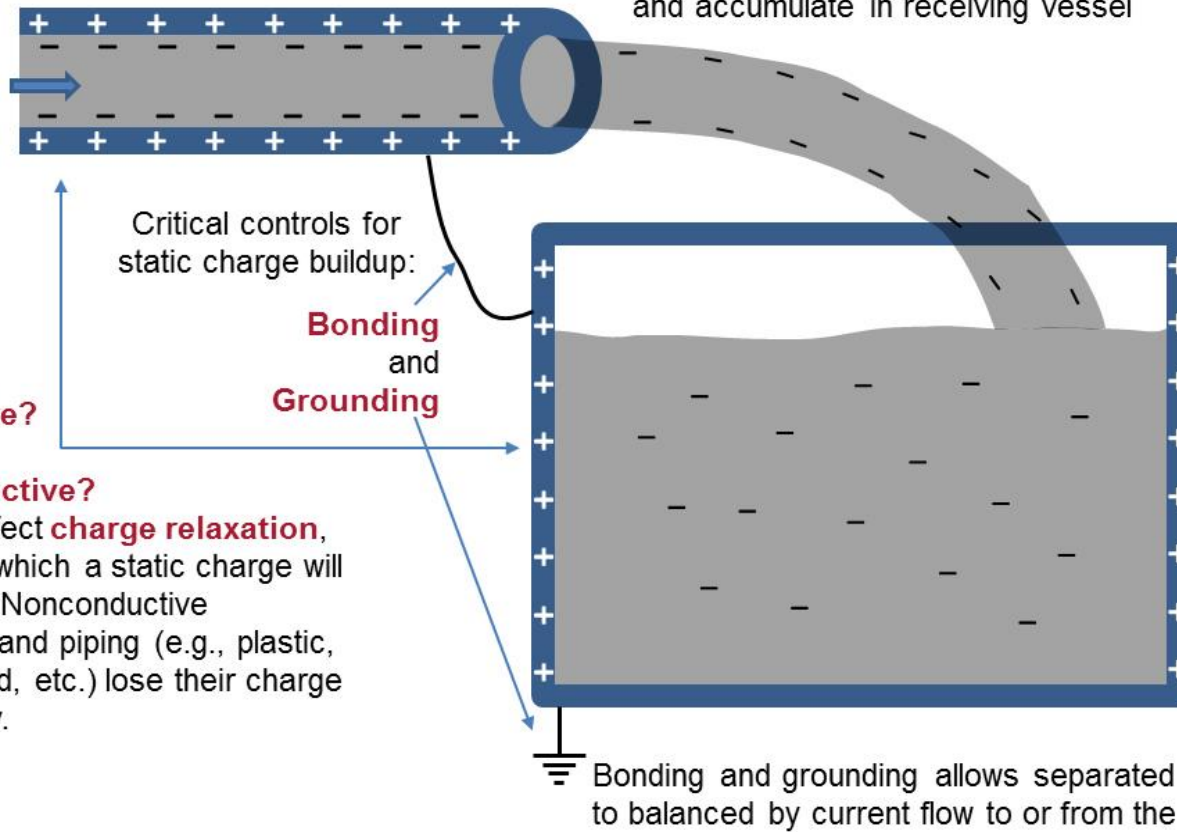


BONDING AND GROUNDING

The rate of charging increases with:

- Increased surface area between liquids and surface
- Increased velocity of liquids

A charge buildup in pipe may be carried and accumulate in receiving vessel



Critical controls for static charge buildup:

Bonding and Grounding

Conductive?

or

Nonconductive?

This will affect **charge relaxation**, the rate at which a static charge will dissipate. Nonconductive containers and piping (e.g., plastic, rubber, lined, etc.) lose their charge more slowly.

Bonding and grounding allows separated charges to be balanced by current flow to or from the ground

COMPONENTS OF A FIRE AND EXPLOSION HAZARD MANAGEMENT PLAN

1. Define the strategy and scope of operations and the roles and responsibilities of workers and supervisors
2. Assess fire and explosion hazards for your particular operations
3. Identify appropriate hazard controls and prepare fire and explosion prevention plans
4. Identify the training requirements for workers and supervisors
5. Implement fire and explosion prevention plans and monitor for effectiveness

ADDITIONAL RESOURCES

- » [Fire and Explosion Management Toolbox Talk - Practical Applications \(Part 2\)](#)
- » [Fire and Explosion Hazard Management Guideline](#)
- » [Flame Resistant Workwear \(FRW\): A Program Development Guide](#)
- » [Controlling Chemical Hazards \(CCH\) - A Program Development Guideline](#)
- » [Preliminary Report: Occupational Fatalities in the Upstream Oil & Gas Industry in Western Canada \(AB, BC & SK\): 2001 to 2017](#)
- » [NFPA 77 Recommended Practice on Static Electricity](#)
- » [Drilling and Completions Committee \(DACC\) Industry recommended practices](#)
 - [IRP 4: Well Testing and Fluid Handling](#)
 - [IRP 8: Pumping of Flammable Fluids](#)
 - [IRP 14: Non-Water Based Drilling Fluids](#)
- » ESC Safety Bulletin
 - [Positive Air Shutoff](#)
- » WorkSafeBC Alerts
 - [Non-bonded fuel hoses](#)
 - [Pyrophoric materials](#)
 - [Hydrocarbon storage tank explosions and static electricity](#)