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**Gas Cylinders**

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**Gas**

- Means a material which has a vapor pressure greater than 300 kPa (43.5 psia) at 50°C (122°F) or is completely gaseous at 20°C (68°F) at a standard pressure of 101.3 kPa (14.7 psia).

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**Non-liquefied Compressed Gas**

- A gas, which when packaged under pressure for transportation is entirely gaseous at -50°C (-58°F) with a critical temperature less than or equal to -50°C (-58°F)

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**Liquefied Compressed Gas**

- A gas, which when packaged under pressure for transportation is partially liquid at temperatures above -50°C (-58°F), is considered to be a liquefied compressed gas.

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**Liquefied Compressed Gas**

A liquefied compressed gas is further categorized as follows:

1. High pressure liquefied gas which is a gas with a critical temperature between -50°C (-58°F) and +65°C (149°F), and
2. Low pressure liquefied gas which is a gas with a critical temperature above +65°C (149°F).

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### Compressed Gas In Solution

- A “compressed gas in solution” is a non-liquefied compressed gas which is dissolved in a solvent.
  - Acetylene in acetone or other solvent is common

### Cryogenic Liquid

- A “cryogenic liquid” means a refrigerated liquefied gas having a boiling point colder than -90°C (-130° F) at 101.3 kPa (14.7 psi).

### Service Pressure

- The term “service pressure” means the authorized pressure marking on the packaging.
  - For example, for a cylinder marked “DOT 3A1800”, the service pressure is 12410 kPa (1800 psig).

### Properties

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### Gas Properties

- Gases can be:
  - Flammable
  - Non-flammable
  - Oxidizers
  - Corrosive
  - Asphyxiants
  - Poison
  - Inert
  - Or a mixture



### Pressure

- By definition all gases have pressure associate with them



### Question



- What is the pressure inside the L.P.G cylinder...?
  - 70 F = 96 PSI
  - 100 F = 127 PSI
  - 110 F = 230 PSI
  - PRD = 250 psi
  - The regulator reduces it to around 11 lbs for a grill

### High Pressure Gas

- Can cause equip. to fail with explosive force
- When released can diffuse into the atmosphere very rapidly, and an entire room may be thoroughly contaminated within seconds!



### Liquefied Compressed Gases

- Contents of a liquefied compressed gas cannot be determined by the pressure in the container, and weight of contents must be used



### BLEVE

- Cylinder exploded inside a building
- Cylinder exploded outside
  - May occur with liquefied petroleum gas (LPG) propane and butane being main components or
  - With liquefied natural gas (LNG) of which methane is the largest component



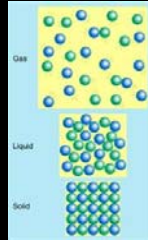
### Inert Gas

- Gas which does not react with other materials such as nitrogen, helium, argon, krypton, neon, xenon

## Expansion Ratio

### Gas Expansion Ratio

- Methane 625:1
- Propane 270:1
- Butane 284:1
- Nitrogen 696:1
- Oxygen 860:1
- Chlorine 444:1



## Cryogenic

- Heat expands a gas
- If we pressurize a gas while cooling it, we can turn a gas into a liquefied gas
- Further cooling and pressure may convert it to a cryogenic gas
- This increases the amount of product that can be put in a container





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## Gases

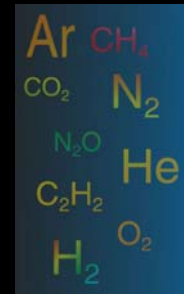


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## The Gas: Rule #1!

- Know the properties of the materials involved



## How Many Regulated DOT

- By name
- About 47 flammable gases
- About 47 Non flammable gases
- About 49 Toxic gases
  - 70 have secondary hazards
  - Does not include mixtures

## Think Pyrophoric

- Silane
- Disilane
- Phosphine
- Methyl Silane
- Diborane
- Dichlorosilane
- Arsine
- Germane





### Think Oxidizer

- Oxidizing potential
  - $O_2 = 1$
  - $Cl_2 = 0.67$
  - Air = 0.21
  - $NF_3 = 1.56$
  - $ClF_3 = \text{OMG}$

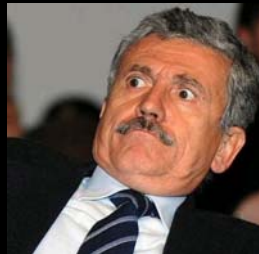
### Acid & Alkaline

- Shipped as Toxic
  - Boron Trichloride
  - Bromine Trifluoride
  - Chlorine Trifluoride
  - Hydrogen Fluoride
  - Iodine Pentafluoride
  - Silicon Tetrafluoride
  - Sulfur Tetrafluoride
  - Tungsten Hexafluoride

**THINK  
Highly Reactive**

### Highly Toxic Gases

- Arsine
- Boron Trichloride
- Bromine Trifluoride
- Bromine Pentafluoride
- Chlorine
- Fluorine
- Germane
- Hydrogen Cyanide
- Hydrogen Selenide
- Hydrogen Sulfide
- Nitric Oxide
- Phosgene



### Most Commonly Used Cryogenics

- Liquid nitrogen (LIN)
- Liquid oxygen (LOX)
- Liquid argon (LAR)
- Liquid carbon dioxide
- Liquid hydrogen
- Liquid helium
- Liquid ethylene
- Liquefied natural gas (LNG)
- Liquefied petroleum gas (LPG)

### Flammable

- Not just flammability
- Think RICH – asphyxiation

### Hydrocarbon Gases

- Contain hydrogen and carbon in their make-up
  - Flammable
  - Non-corrosive
  - Non-toxic
  - Colorless





### Liquefied Petroleum Gas

- LP Gas or LPG –
  - Any material with a vapor pressure not exceeding that allowed for commercial propane
  - Composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutene) and butylenes



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### Liquefied Natural Gas

- Also called LNG
- A fluid in the cryogenic liquid state that is composed predominantly of methane



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### Compressed Natural Gas

- Also called CNG
- A gas in the vapor state that is composed predominantly of methane



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### Oxygen

- Not flammable
- Sensitizes flammable and combustible materials requiring less input heat for ignition
- In some cases, materials impregnated with oxygen can be ignited with static electricity



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### Cylinders

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### Have You Heard the One

- Employee killed when cylinder turned into a rocket because its valve was knocked off
- Employee suffocated after entering a space filled with nitrogen
- Facility damaged when acetylene cylinder heated up and exploded
- Eyebrows singed when lighting a gas BBQ

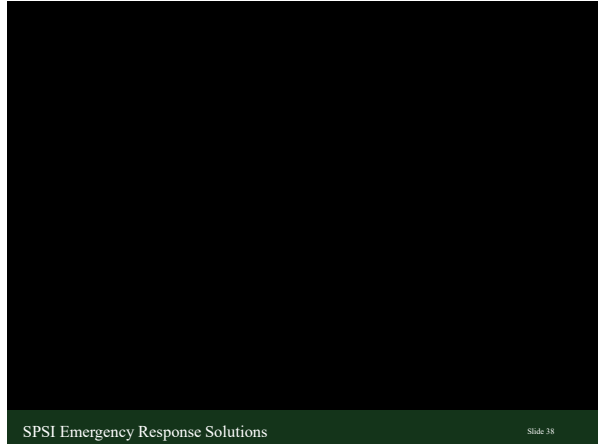
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