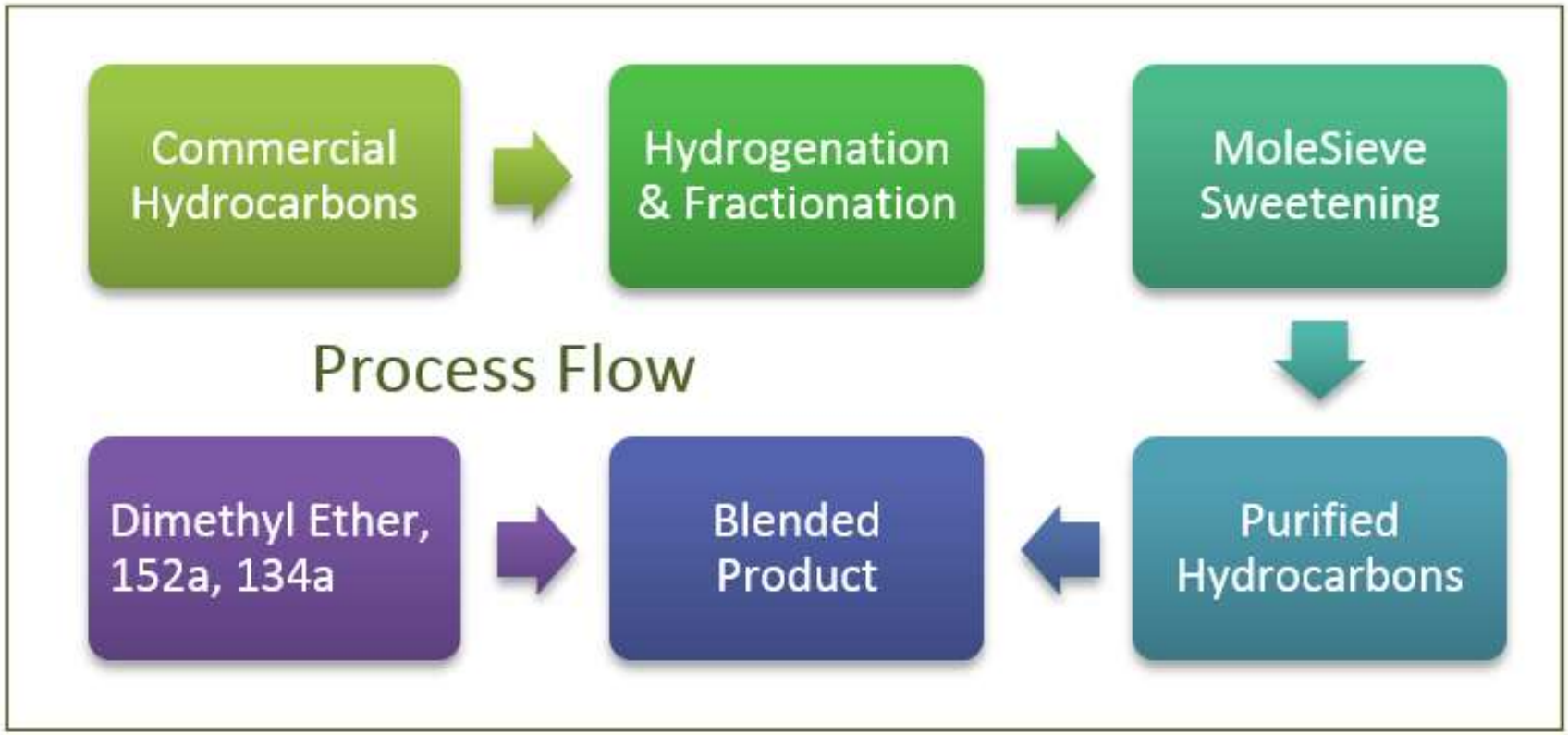
Shipping & Receiving/ Storage & Handling

Introduction



Our liquefied gas products (including all A, NP, & NIP blends), are manufactured, produced, and shipped in accordance with all applicable state, municipal, and federal regulations.
Trace contaminants normally found in commercial C3 - C4 hydrocarbons, such as, water, hydrogen sulfide, mercaptans, oxygenates, and unsaturated hydrocarbons are removed using hydrogenation, fractionation, and molecular sieve sweetening technologies, thus offering a cleaner, more consistent and stable product.

Introduction

Introduction

Introduction

Introduction

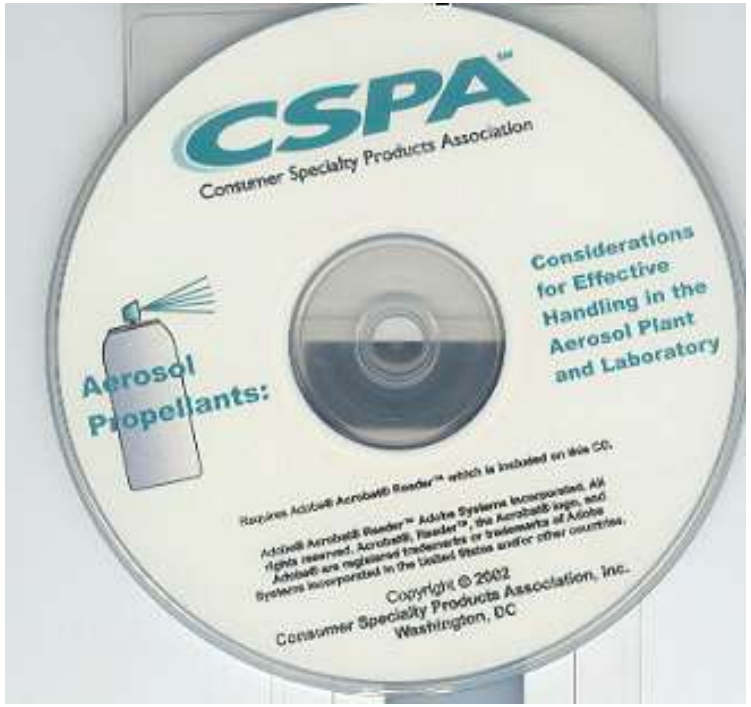
- Codes and Safety Guides
- General Information and Properties
- Shipping and Receiving
- Storage and Handling

Codes and Safety Guides

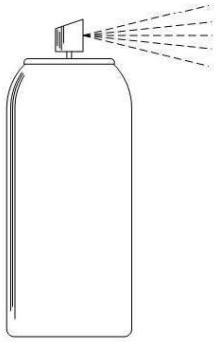
- NFPA 58: LP Gas Code
- NFPA 30B: Manufacture and Storage of Aerosol Products
- CSPA Publication: “Aerosol Propellants: Considerations for Effective Handling in the Aerosol Plant and Laboratory”

  (Third edition published in 2010)

CSPA Manual



CSPA
Consumer Specialty Products Association



Aerosol Propellants:

Considerations for Effective Handling in the Aerosol Plant and Laboratory

Third Edition 2010

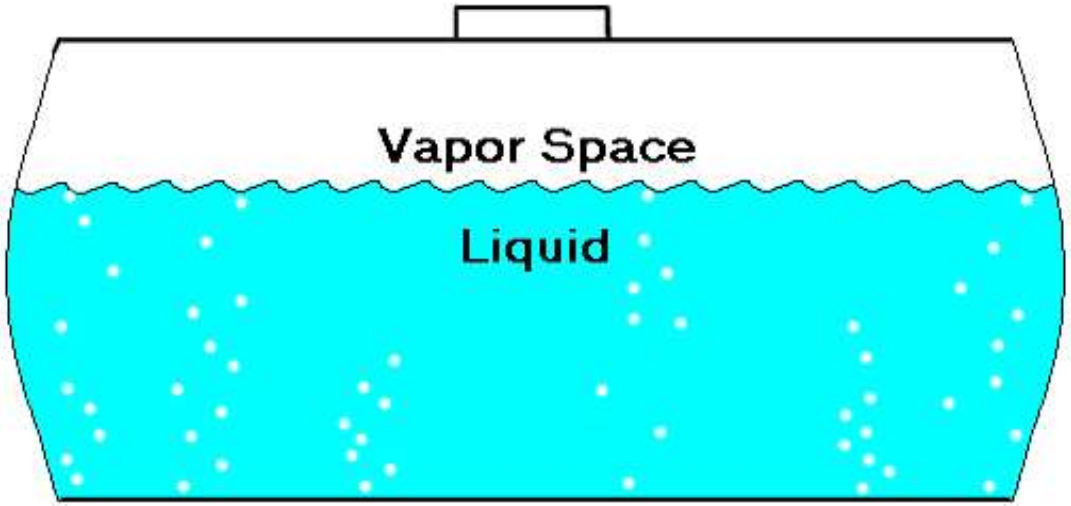
Categories of Aerosol Propellants

THREE CATEGORIES OF AEROSOL PROPELLANTS

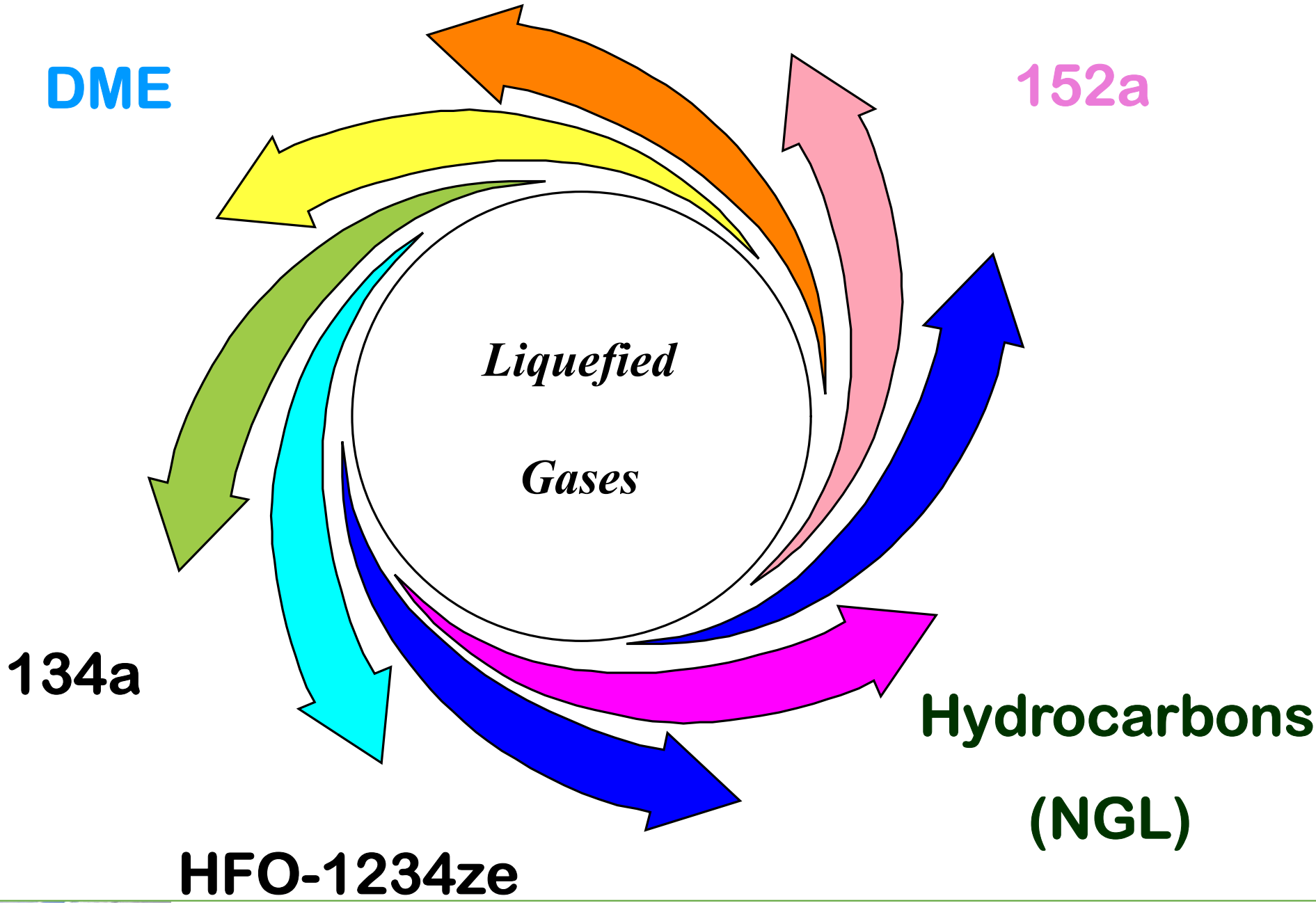
Categories of Aerosol Propellants

- Compressed Gases
- Soluble Compressed Gases
- Liquefied Gases

Liquefied Gas Stored Under Pressure



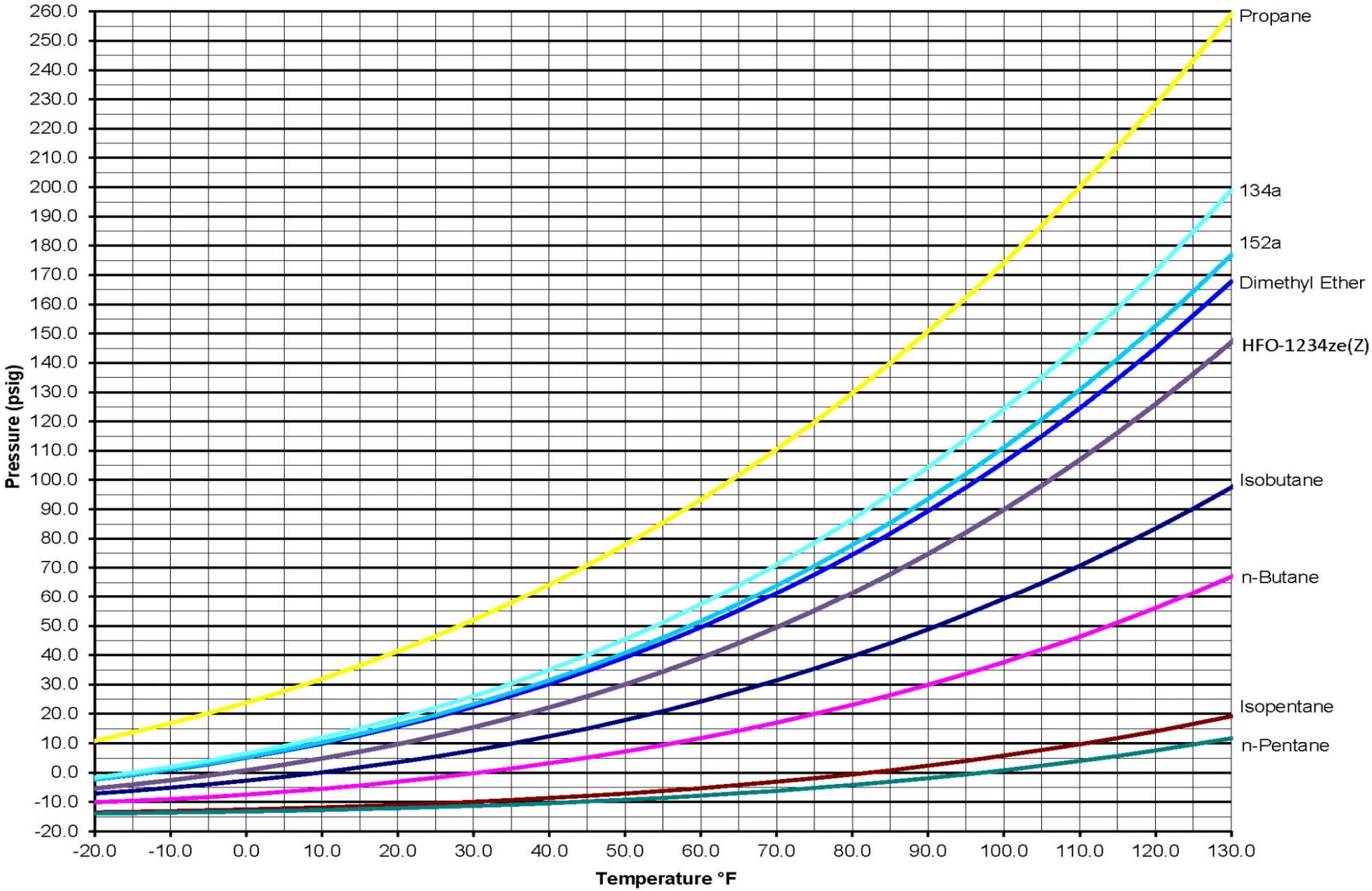
Common Liquefied Gases



Properties and Safety Issues of Flammable Liquefied Gases

- Flammable
- Gases Liquefied under Pressure
- Sudden Release of Pressure
- Low Boiling Points
- High Expansion Ratios
- Heavier than Air
- Vapors are Colorless and Odorless
- BLEVE (Boiling Liquid Expanding Vapor Explosion)

Liquefied Gases - Vapor Pressure



Hydrocarbon Physical Properties

	Propane	*Isobutane*	*n-butane*
Formula	C_3H_8	C_4H_{10}	C_4H_{10}(n)
Molecular Weight	44.1	58.1	58.1
Boiling Point (°F)	-43.7	10.9	31.1
Vapor Pressure @ 70° F (psig)	109.3	31.1	16.9
Density @ 70°F (g/cc)	0.51	0.56	0.58
Kauri-Butanol Value	15	18	20
Flammability Limits (volume % in air)	2.2 - 9.5	1.8 - 8.4	1.8 - 8.5
Heat of Combustion (kJ/g)	44.0	42.8	43.3

Dimethyl Ether – Physical Properties

Formula	CH_3-O-CH_3
Molecular Weight	46.1
Boiling Point	-12.7º F
Liquid Density	0.66g/cc
Vapor Pressure	61.3 psig @ 70° F
	174 psig @ 130° F
Kauri Butanol Value (KB)	60
Flammability Limits	3.4 -18.0 volume % in air
Heat of Combustion	26.5 kJ/g

1,1 Difluoroethane Physical Properties

Formula	$C_2H_4F_2$
Molecular Weight	66.1
Boiling Point	-13° F
Liquid Density	0.91 g/cc
Vapor Pressure	63.9 psig @ 70° F
	177 psig @ 130° F
Kauri Butanol Value (KB)	11
Flammability Limits	3.9 - 16.9
Heat of Combustion	6.3 kJ/g

1,1,1,2 Tetraflouroethane Physical Properties

Formula	$C_2H_2F_4$
Molecular Weight	102.0
Boiling Point	-15.2° F
Liquid Density	1.22 g/cc
Vapor Pressure	71 psig @ 70° F
	200 psig @ 130° F
Kauri Butanol Value (KB)	9.2
Flammability Limits	nonflammable

HFO-1234ze Physical Properties

Formula	trans-CHF=$CHCF_3$
Molecular Weight	114.0
Boiling Point	-3° F
Liquid Density	1.17 g/cc
Vapor Pressure	47 psig @ 70° F
	140 psig @ 130° F
Kauri Butanol Value (KB)	N/D (<10)
Flammability Limits	nonflammable

Densities And Expansion Ratios of Liquefied Gases (@60 °F)

Liquefied Gas	Liquid (lb./gal.)	Vaporized Liquid (ft^3/gallon)	Liquid to Vapor Expansion Ratio	Gas Specific Gravity
Propane	4.234	36.35	273	1.52
Isobutane	4.699	30.59	229	2.01
N-butane	4.864	31.75	238	2.01
DME	5.579	46.12	345	1.59
Dymel 152a	7.696	44.20	331	2.28
R-134a	10.384	38.64	289	3.52
HFO-1234ze	9.746	31.50	236	4.05

Liquefied gases expand substantially from a liquid to a gas when released to the atmosphere. Vapors are heavier than air.

Transportation

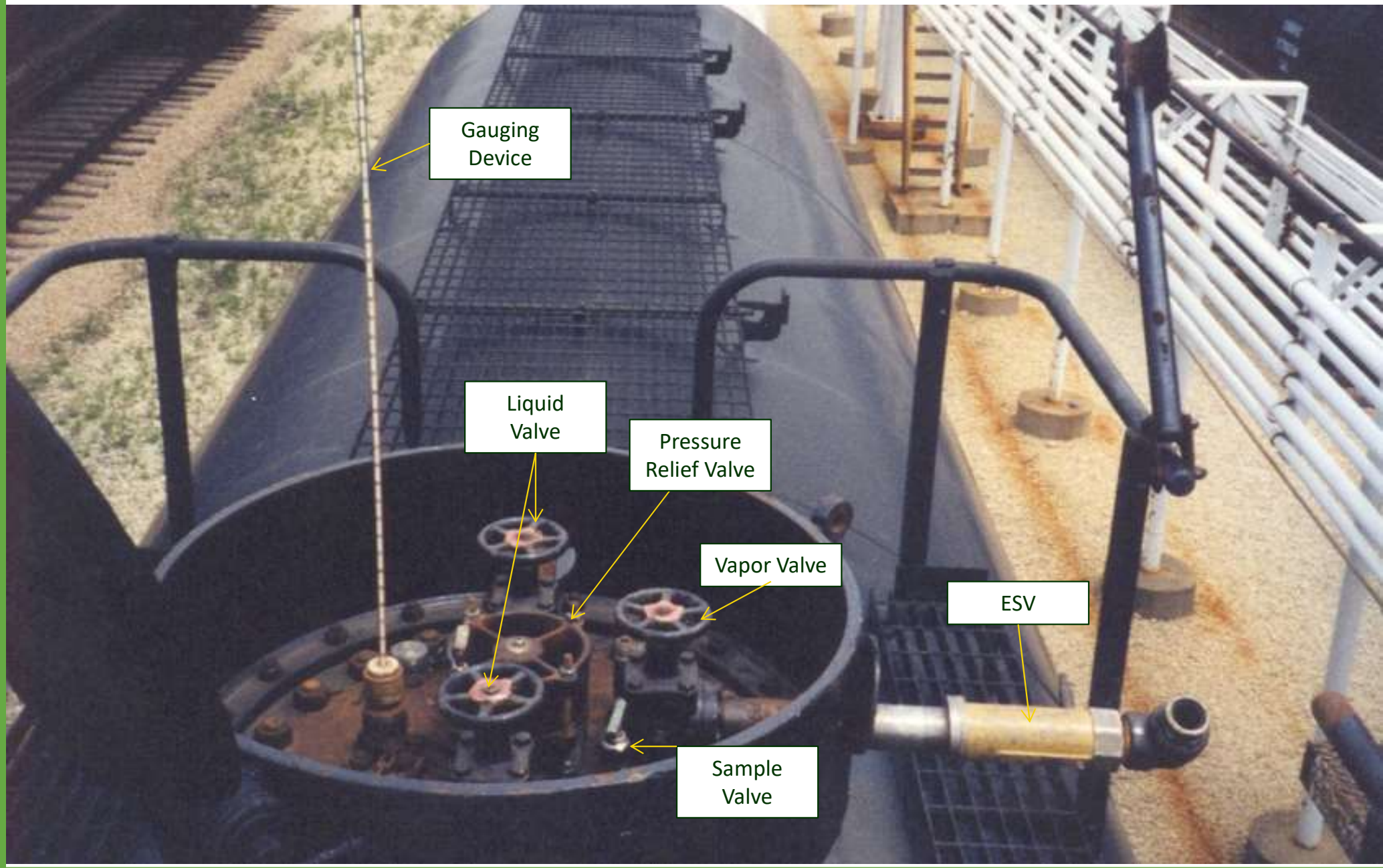
- Truck Transports
- Railroad Tank Cars
- ISO Containers
- DOT Cylinders

Trucks

Rail Cars


LIQUEFIED PETROLEUM GAS
DOT 105J300W
STATION STENCIL
QUALIFIED
DUE
TANK QUALIFICATION
UTEC
2002
2012
THICKNESS TEST
UTEC
2002
2012
SERVICE EQUIPMENT
UTEC
2002
2012
PRD: VALVE
247.5 PSI
UTEC
2002
LINING
UTEC
2002
2012
88.B.2 INSPECTION
2012
STUB SILL INSPECTION
DB-10
DB-20
LUB
NO
BLT - 7 - 02
PAINTED 7 -02

Rail Cars


Gauging Device
Liquid Valve
Pressure Relief Valve
Vapor Valve
ESV
Sample Valve

ISO Containers

Cylinders


1# (laboratory sample)
20# (barbecue size)
100#
200#
420# (1/2 ton water capacity)
(capacities vary depending on product density)

Liquefied Gas
Tank Farm Operations

Delivery
And Unloading

Location of Transfer Operations

- Distance to buildings = 25 feet
- Distance to property line = 25 feet
- Distance to public way = 10 feet
- Distance of Transport to Tank being filled = 10 feet

Truck Unloading Bulkhead

Truck Unloading Bulkhead

Emergency Shutoff Valves (ESVs)

- 3 methods of shutoff
  - Manual (local)
  - Thermal (fusible element)
  - Remote (cable or pneumatically operated)

Remote Station for ESVs

Between 25 and 100 feet from the ESV

Electro-Pneumatic Remote Station for ESVs

ALLOWS FOR AUTOMATIC SHUTDOWN OF PUMPS AND COMPRESSORS IN STORAGE TANK FARM

Liquid Unloading Piping

- Metal Seated back-flow check valves are acceptable as an alternative to ESVs if the flow is only in one direction (toward the storage tank)

Sight Glass

Sight Glass Back Flow Check Valves

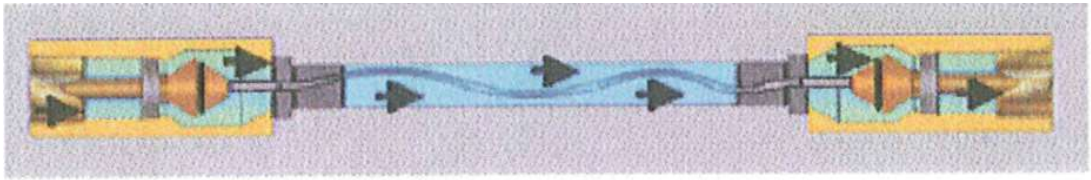
Transfer Hoses

- Fabricated of Materials resistant to the materials handled
  - Hydrocarbon (C_3 –C_4), 152a, 134a - Approved rubber hose is acceptable
  - Dimethyl Ether - Stainless Steel Hose Recommended (Not Authorized for LP Gas Use)
- 350 psig working pressure
- 5 to 1 safety factor
- Hose assemblies with connectors - design rating of 700 psig or greater

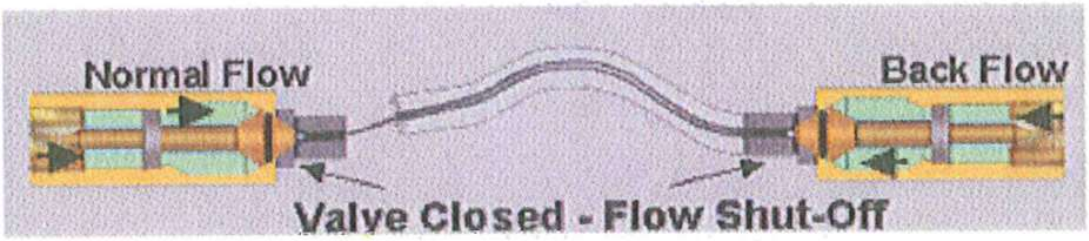
Truck ESV Station

Truck Unloading

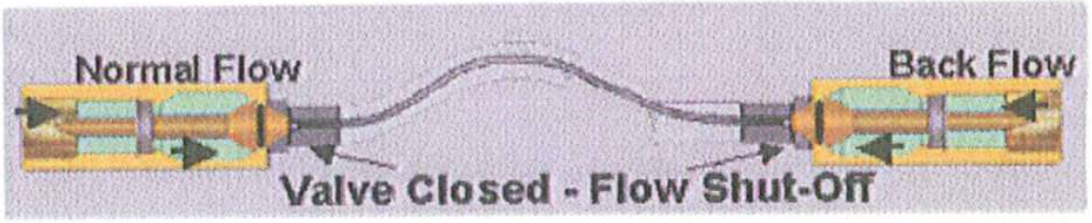
Smart-Hose® (Transport Unloading - Liquid)
(Passive Shutdown Requirement for transport trucks per DOT regulations)



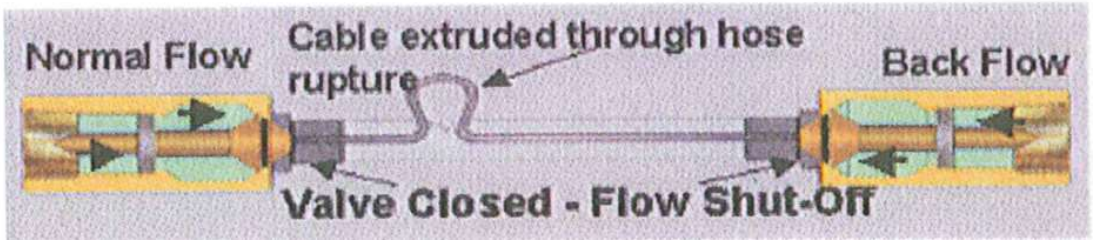
Hose Failure - Coupling Ejection



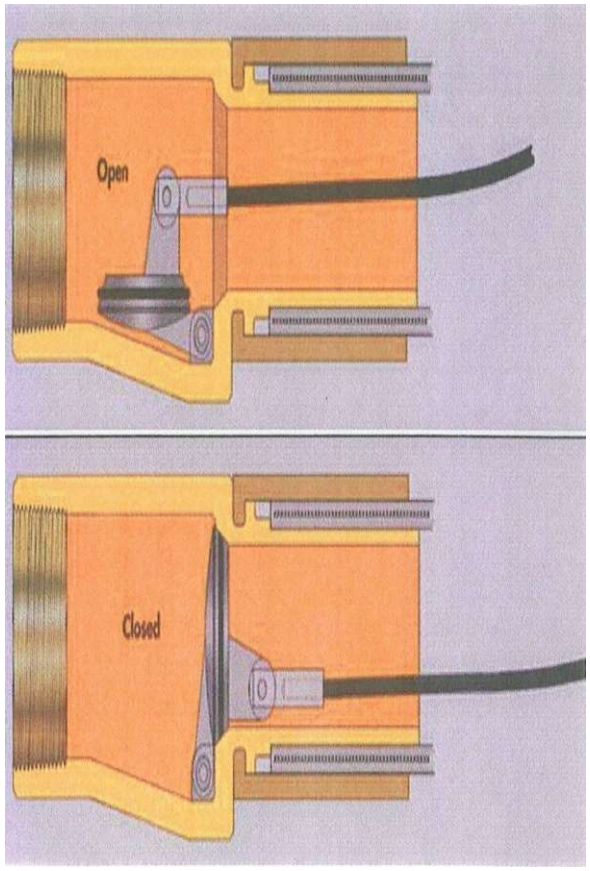
Hose Failure - Hose Separation



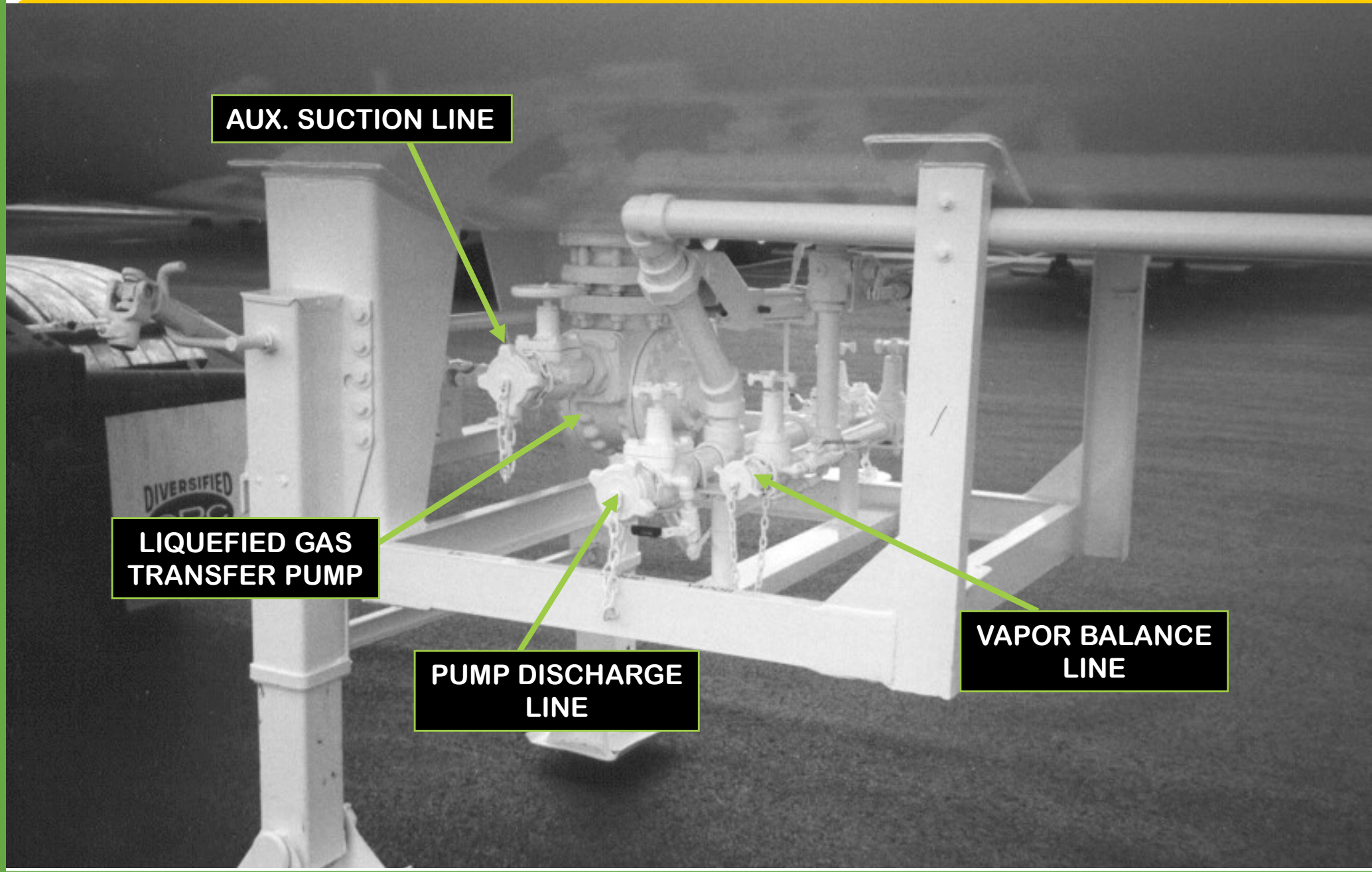
Hose Failure - Hose Rupture*



Smart-Hose® (Liquid Transfer)



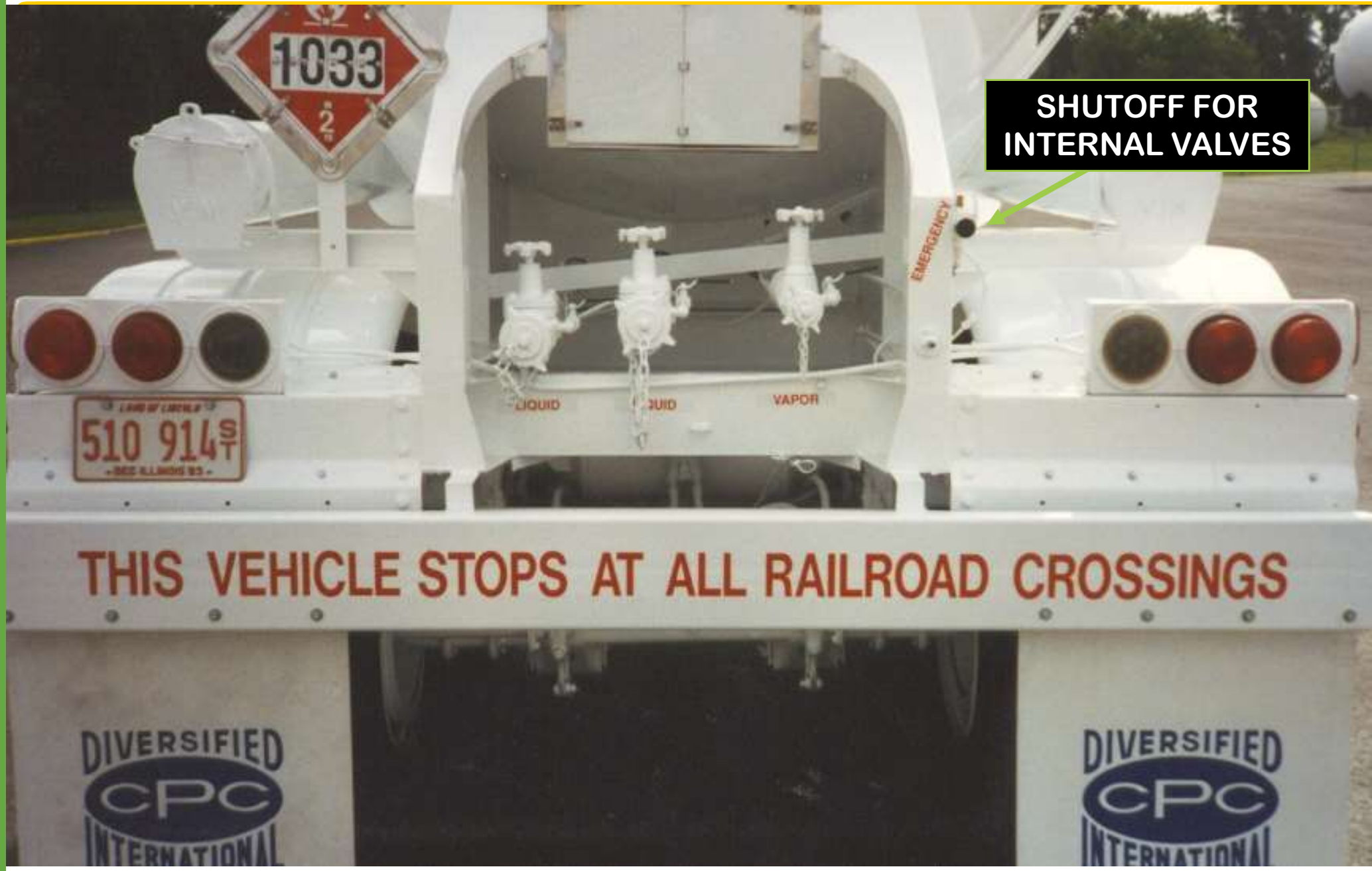
Transport Liquid Transfer Pump



Transport Gas Transfer Compressor

Transport Internal Safety Valve

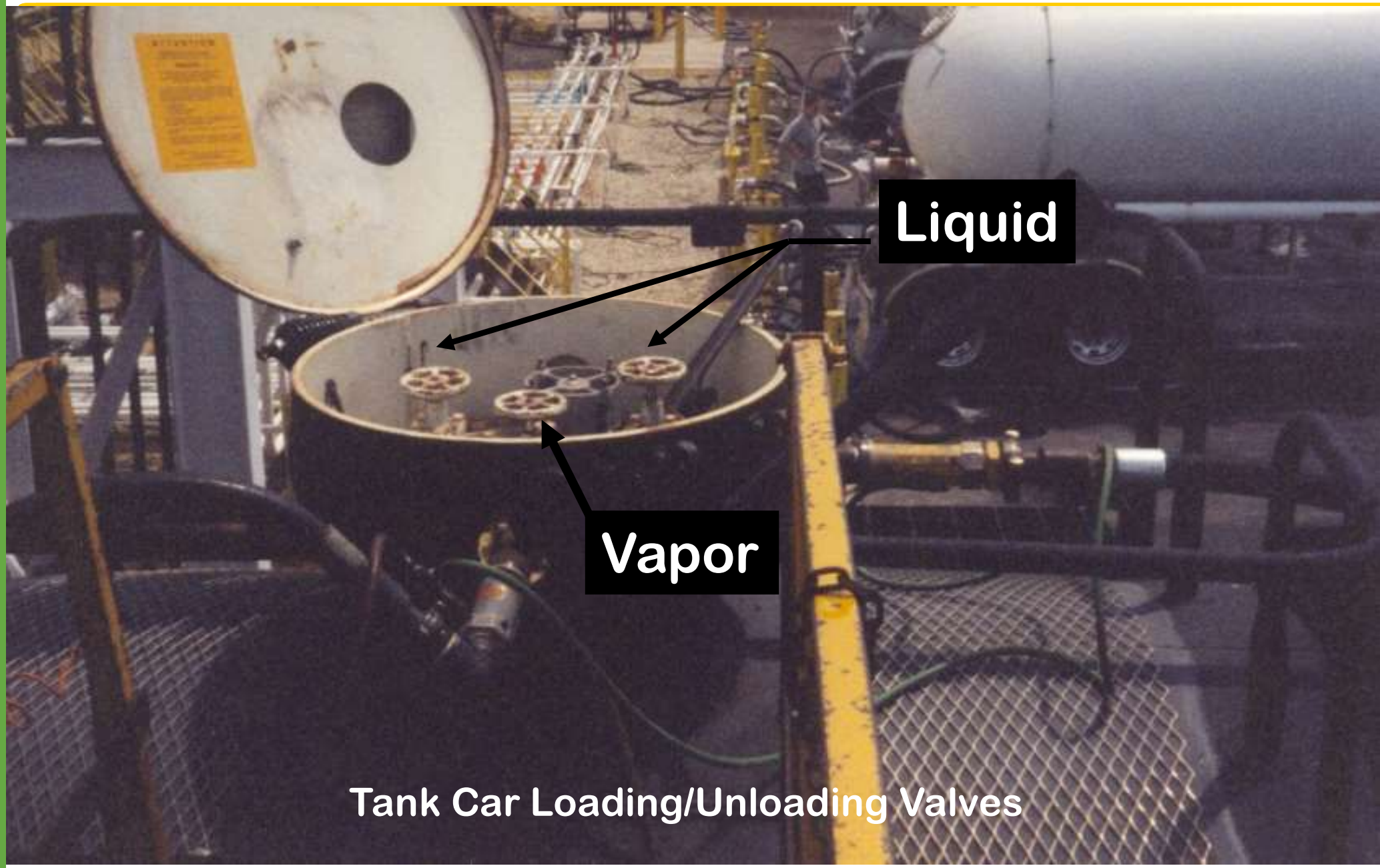
Transport Shutoff for Internal Valves



Driver Must Remain with the Vehicle During the Entire Unloading Operation!

An attendant from the customer must remain close by as well to react quickly to any plant-related issues that may arise.

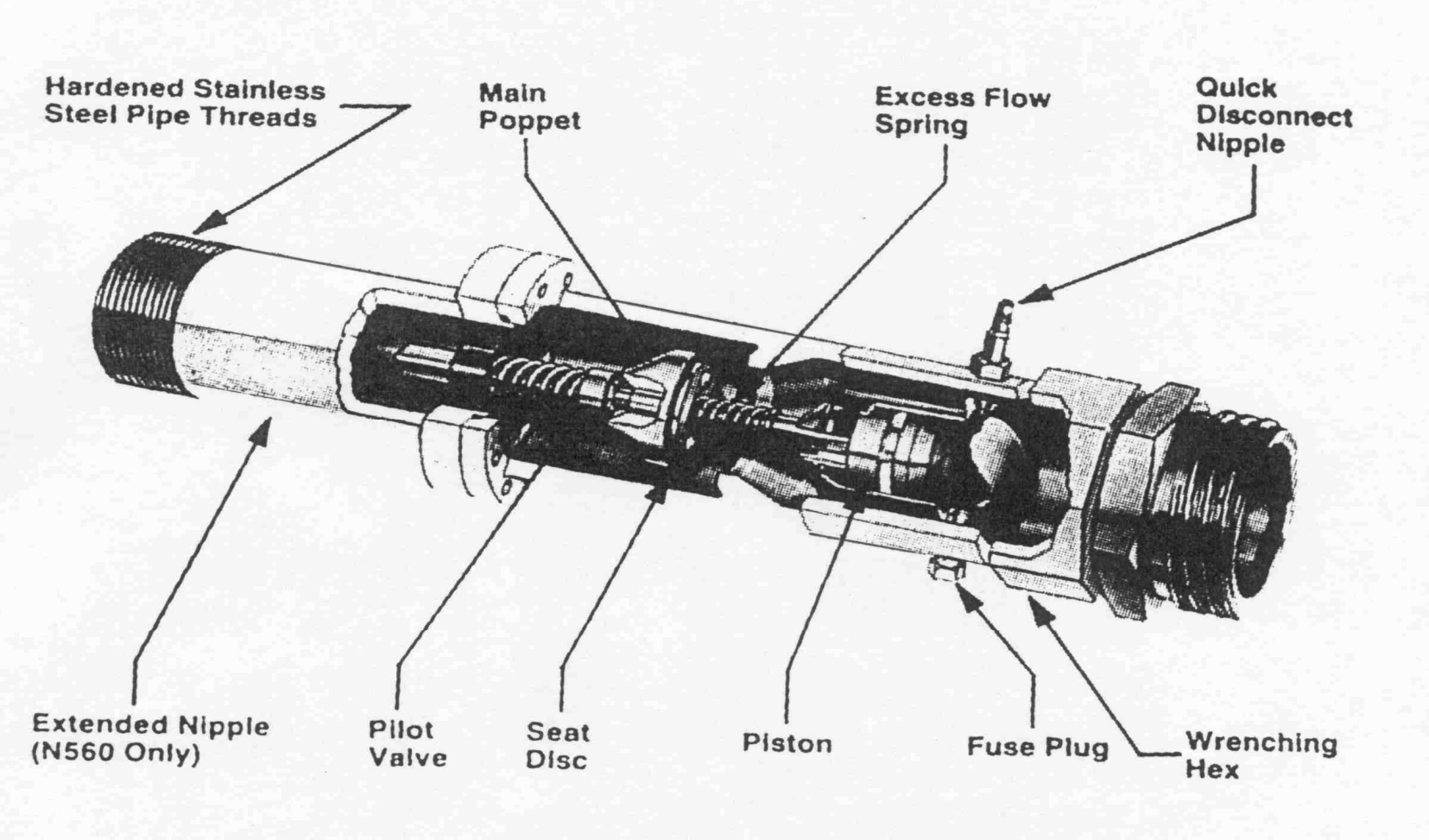
Tank Car Loading/Unloading Valves



Tank Car Emergency Shutoff Valve

Tank Car ESV Diagram

TANK CAR ESV (FISHER CONTROLS)



Gas Transfer Compressor

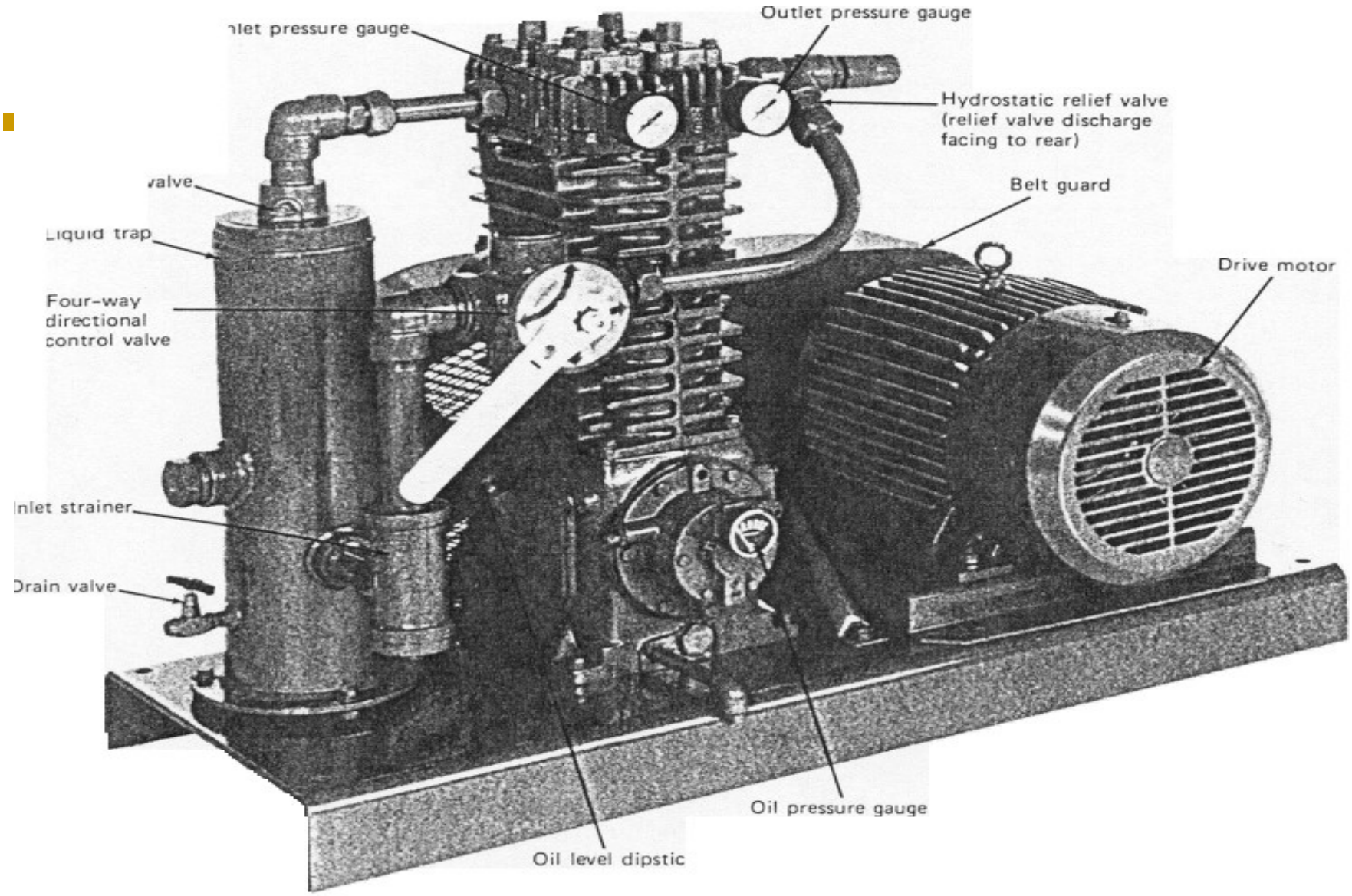
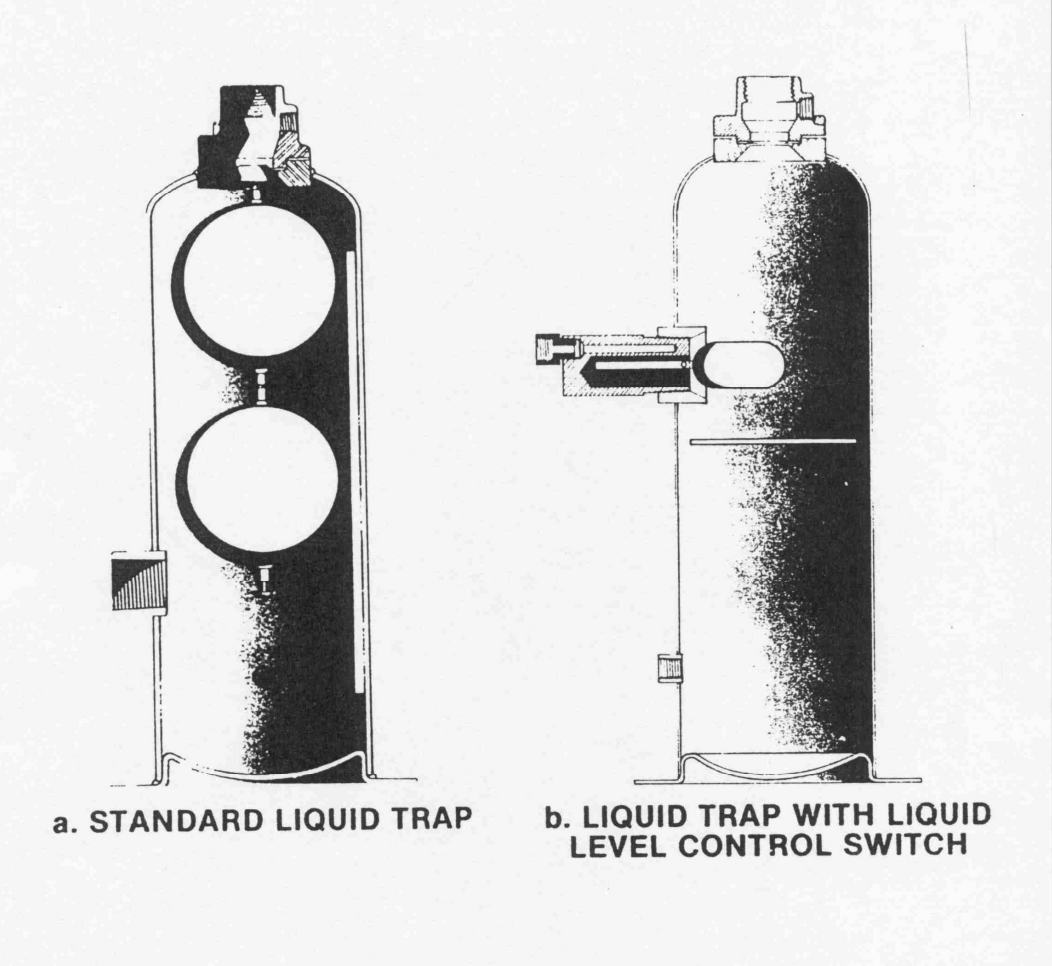


Figure 2.21(a) Compressor with Protection Devices.

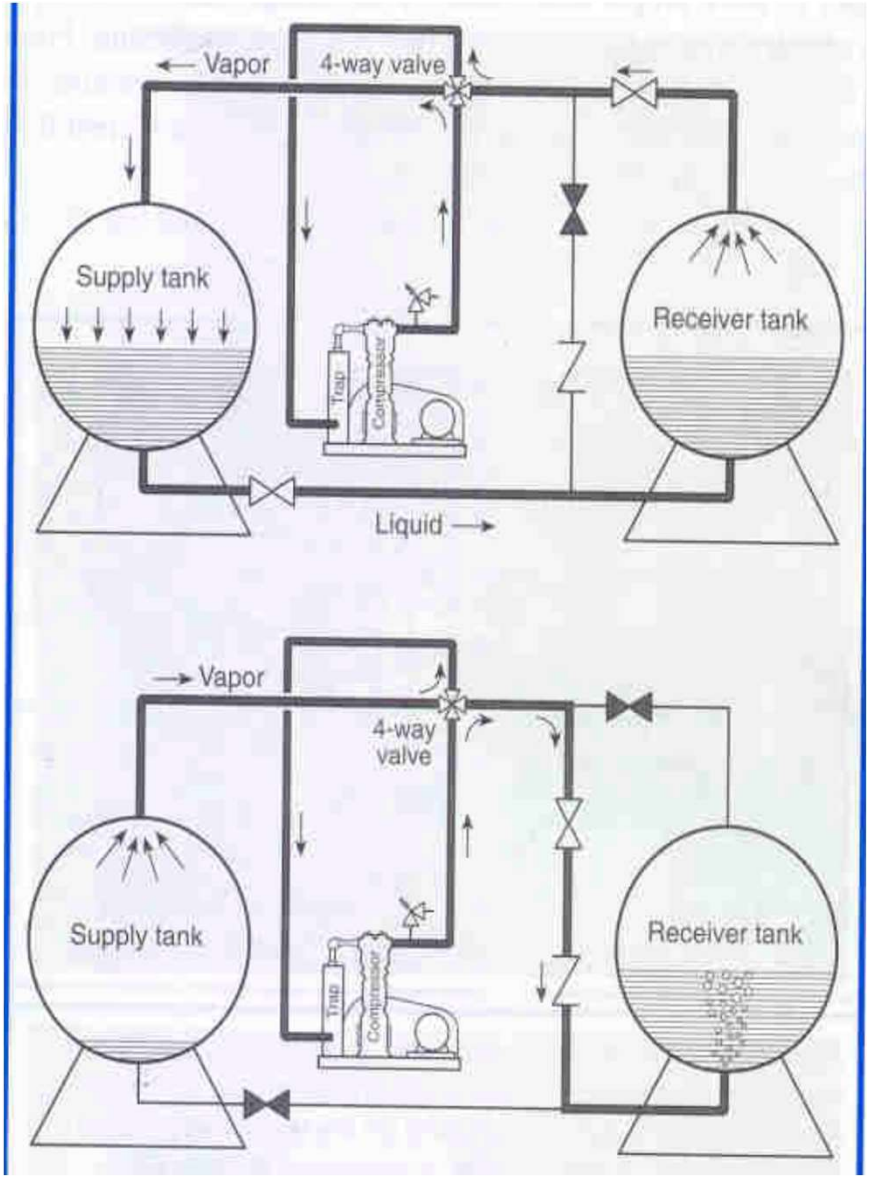
Liquid Traps for Compressor Suction Line



a. STANDARD LIQUID TRAP

b. LIQUID TRAP WITH LIQUID LEVEL CONTROL SWITCH

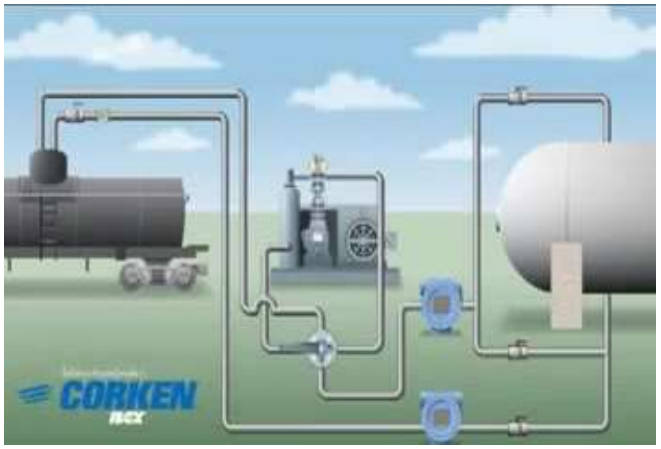
Gas Compressor Operations



- **Liquid Transfer Using a Gas Compressor**

  (Tank Car Unloading)

- **Vapor Recovery Operations**



Trained Personnel

- Qualified personnel must be present during the entire unloading procedure. These persons must be properly instructed and made responsible for careful compliance with the standards and regulations for flammable, liquefied gases.

Container Filling

- Never fill a liquefied gas container to 100% volume.

- Bulk storage tanks can be filled slightly higher in warm weather, but generally not more than 85% volume. NFPA 58 contains maximum filling limit charts based on liquid density.

Storage Tanks, Equipment, and Safety Systems

Location on Property

For above ground bulk tanks 2000 - 30000 gallons

- Distance from buildings = 50 feet
- Distance to property line = 50 feet
- Distance between containers = 5 feet

Tank Farm

Tank Farm

Tank Farm

Manufacturer's Data Plate for Pressurized Storage Tank

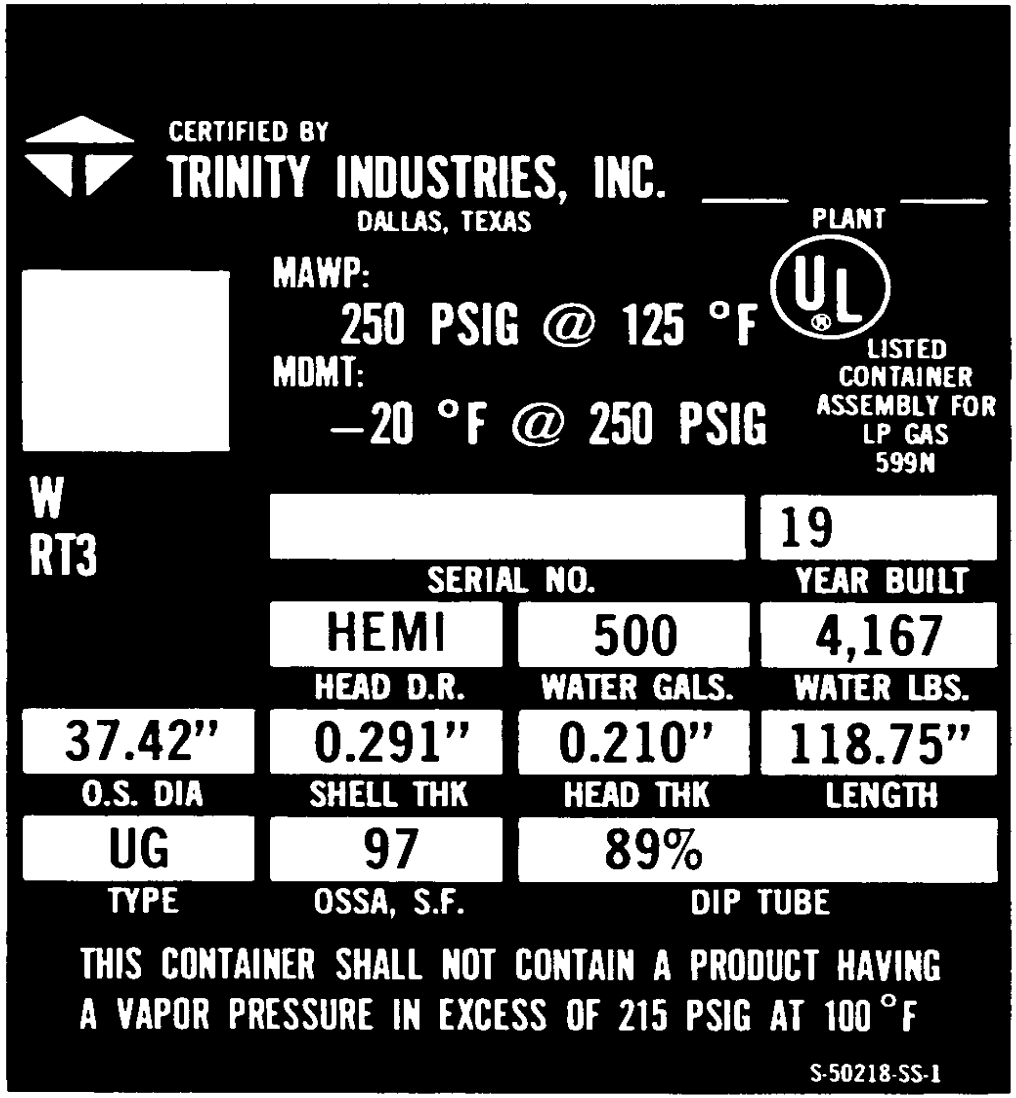
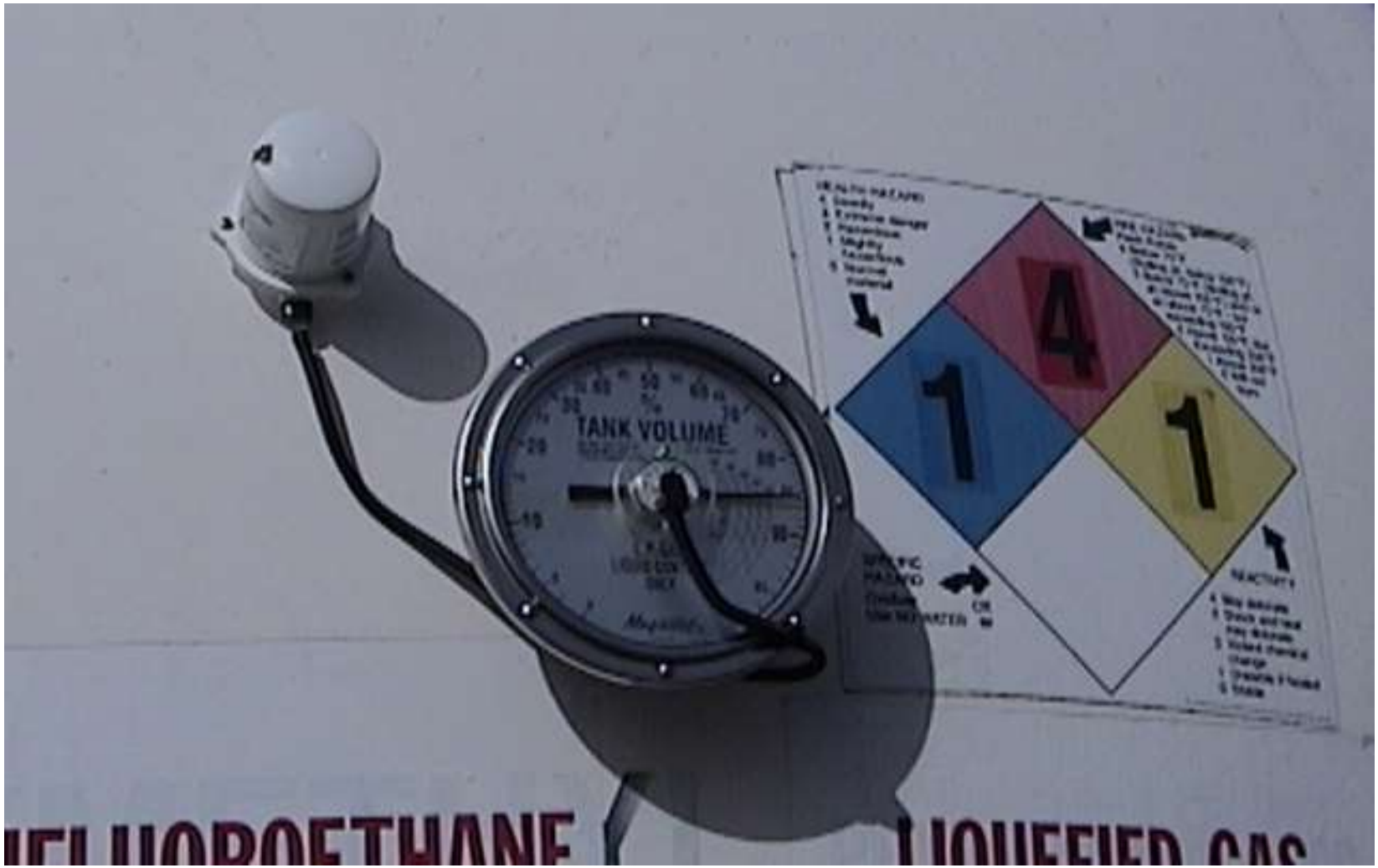


Figure 2.8 Marking Required by 2-2.6.5 as Given on a Nameplate. Container listing [in this example, by Underwriters Laboratories Inc. (UL)] is optional.

Manufacturer's Data Plate for Pressurized Storage Tank

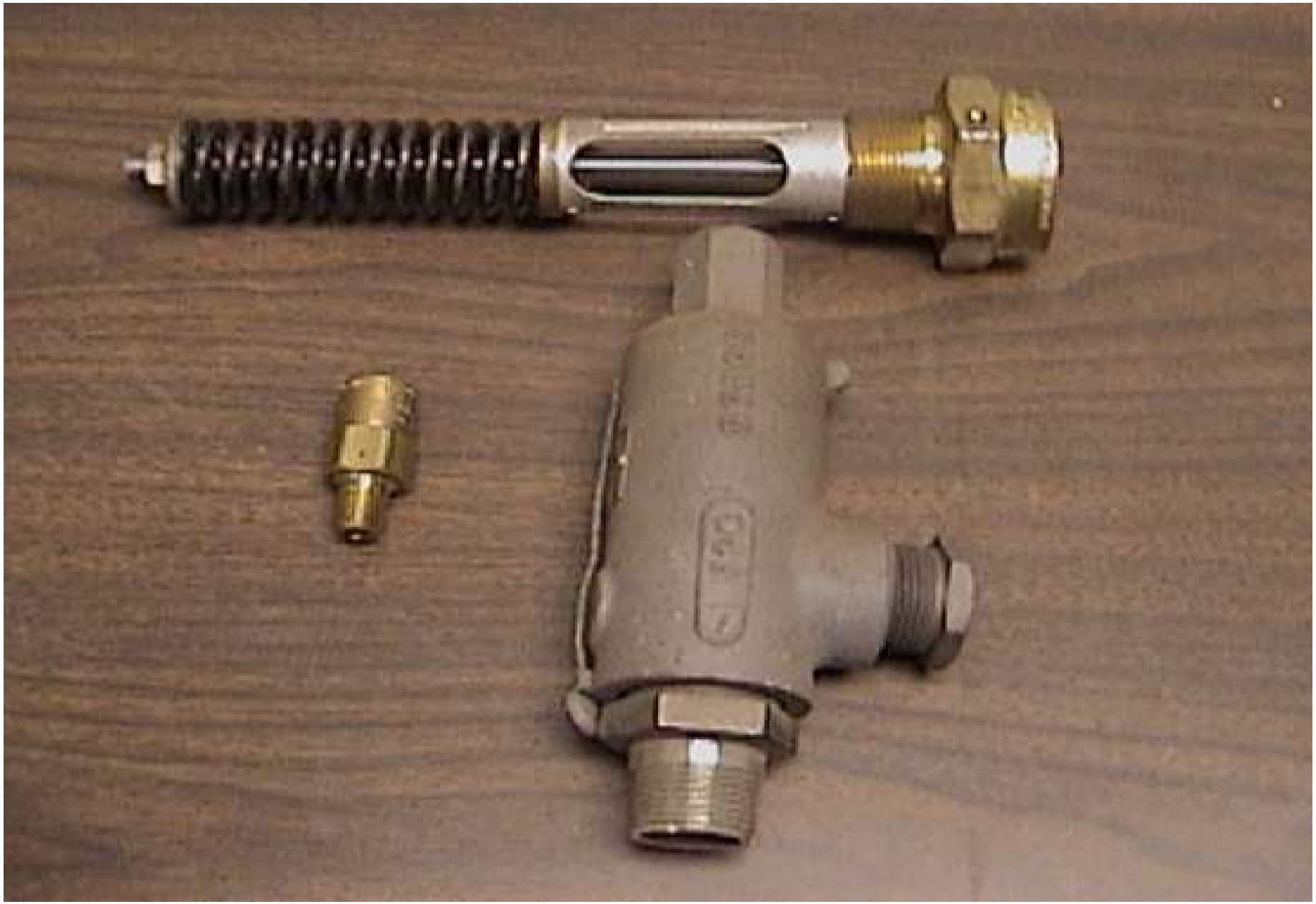
Liquid Level Gauges



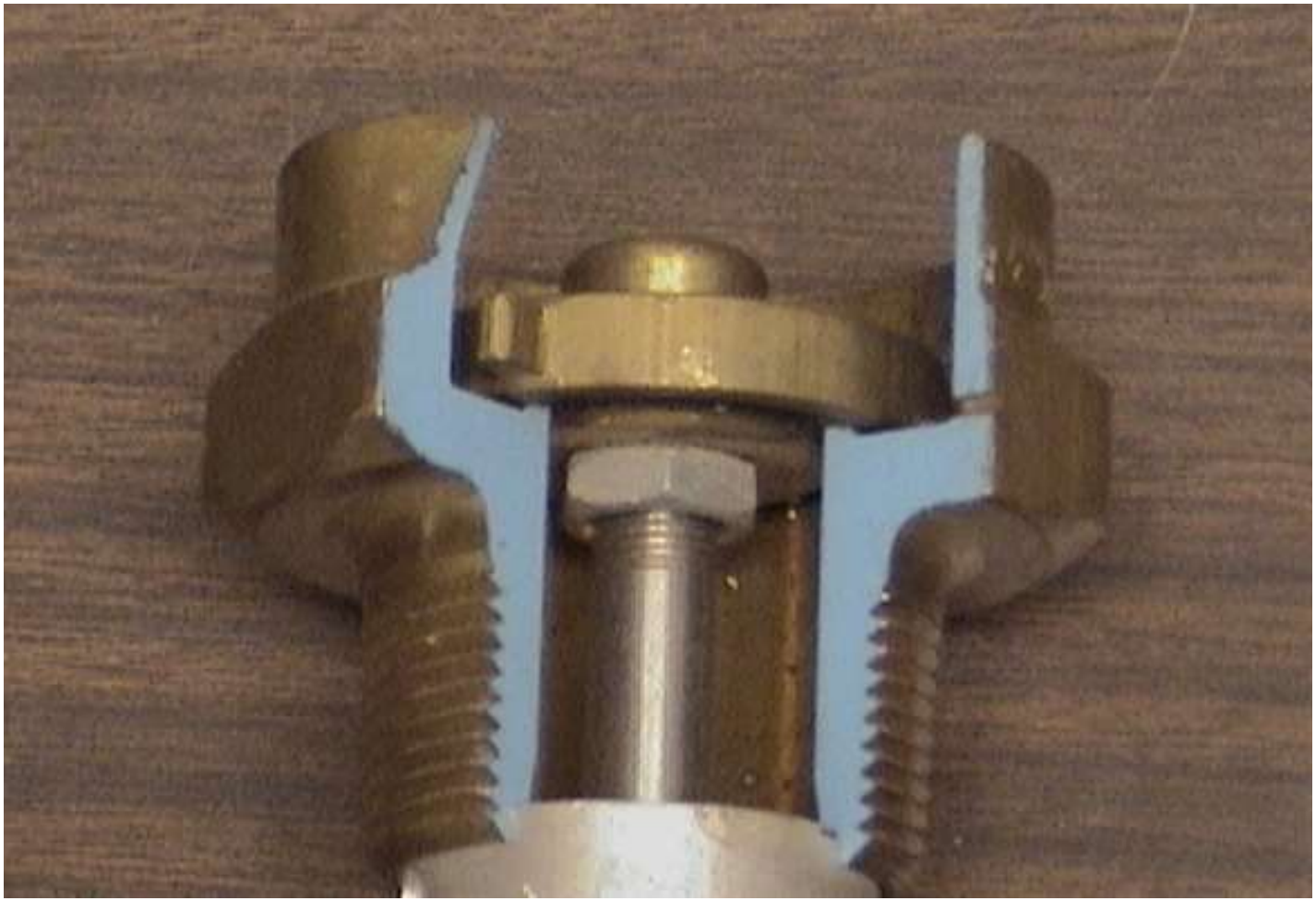
AVAILABLE WITH BATTERY-OPERATED REMOTE TRANSMITTERS

Liquid Level Gauges

Safety Relief Valves



Safety Relief Valves



Relief Valve Manifolds

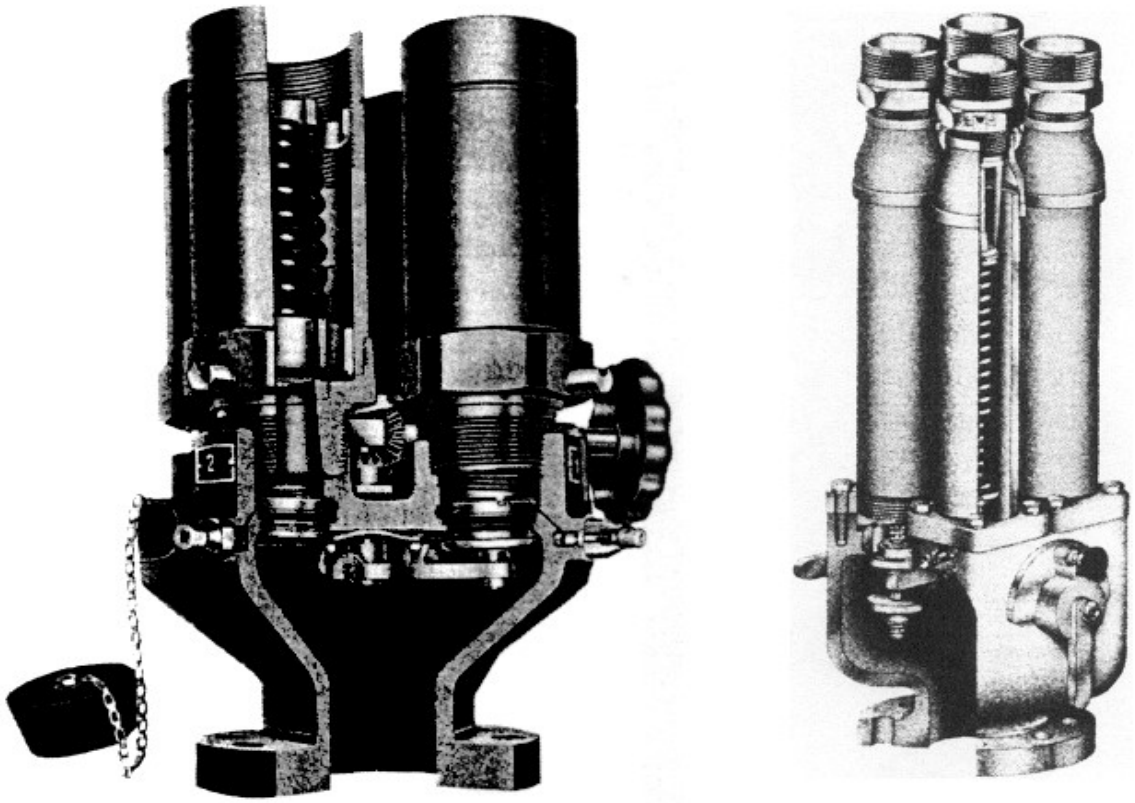


Figure 2.12 ASME Container Relief Valve Manifolds. The container requires three relief valves. The manifold contains four. By manipulating the handwheel or lever, an internal clapper-type valve can be rotated to isolate any one of the four relief valves for testing, maintenance, or replacement.

- Allows for testing, maintenance, or replacement with product still in the tank

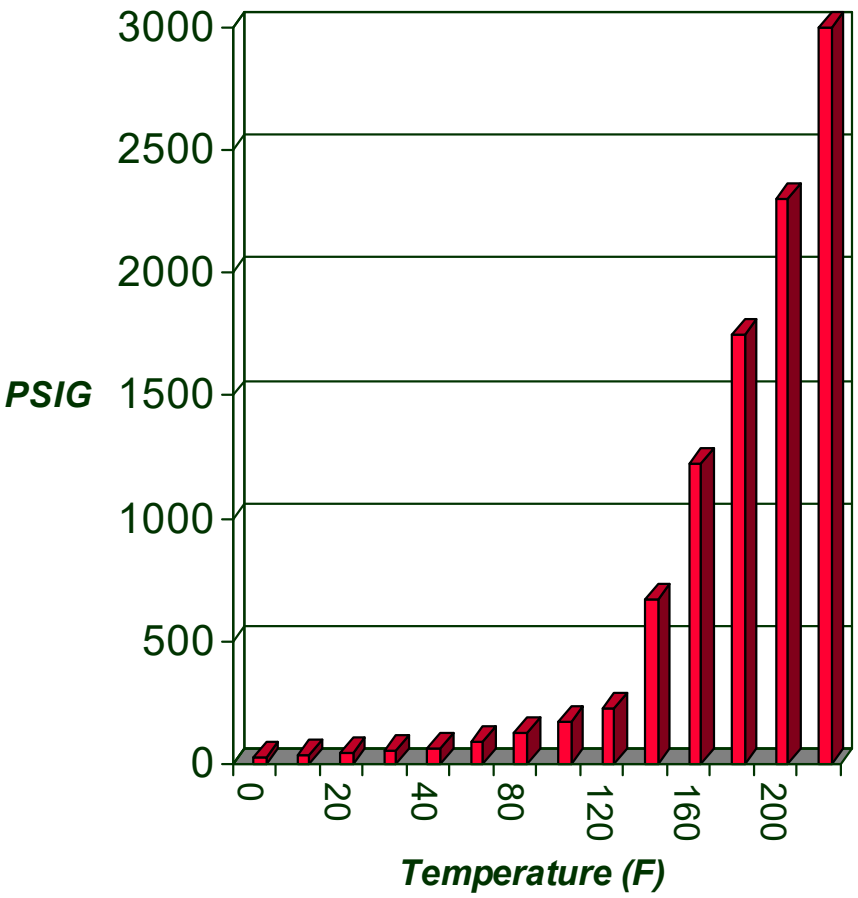
7’ Pipe-Away with Rain Cap

Required for storage tanks larger than 2000 gallons prior to NFPA 58 - 2011 edition. The 2011 edition of NFPA 58 no longer requires pipe-aways.

Hydrostatic Relief Valves

Installed in liquid piping between two shutoff valves or where liquid can be trapped

Hydrostatic Relief Valves



Pressure Rise in a Constant Volume Vessel or Pipe

Why Hydrostatic Relief Valves are Necessary:

Pressure Increases From 24 to 3000 psig as Temperature Rises from 0 to 220 °F

(Basis-100% Propane Liquid Full at 130 °F)

Excess Flow & Backflow Check Valves

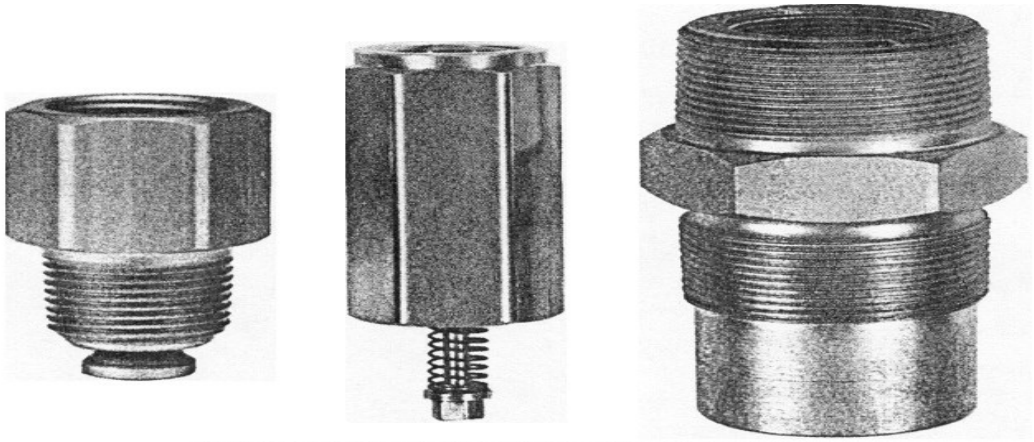


Figure 2.13(b) Various Excess-flow Check Valves.

stopped or reversed. Both valves of double backflow check valves shall comply with this provision.

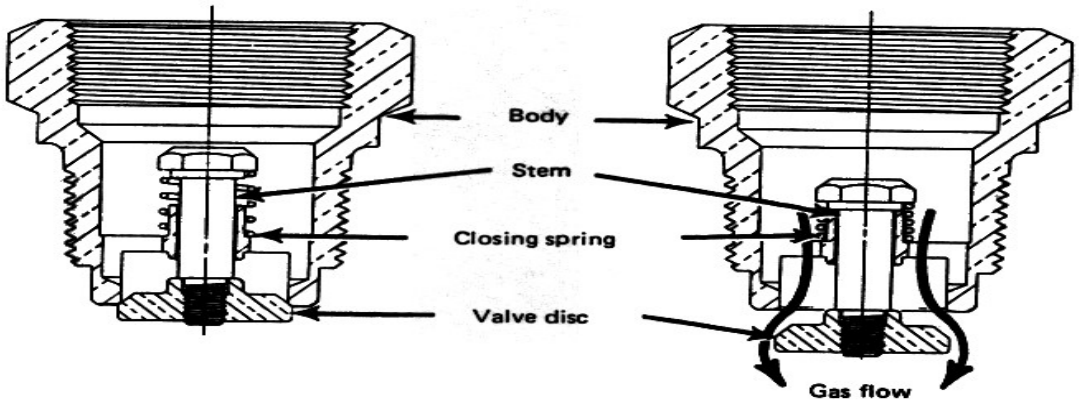
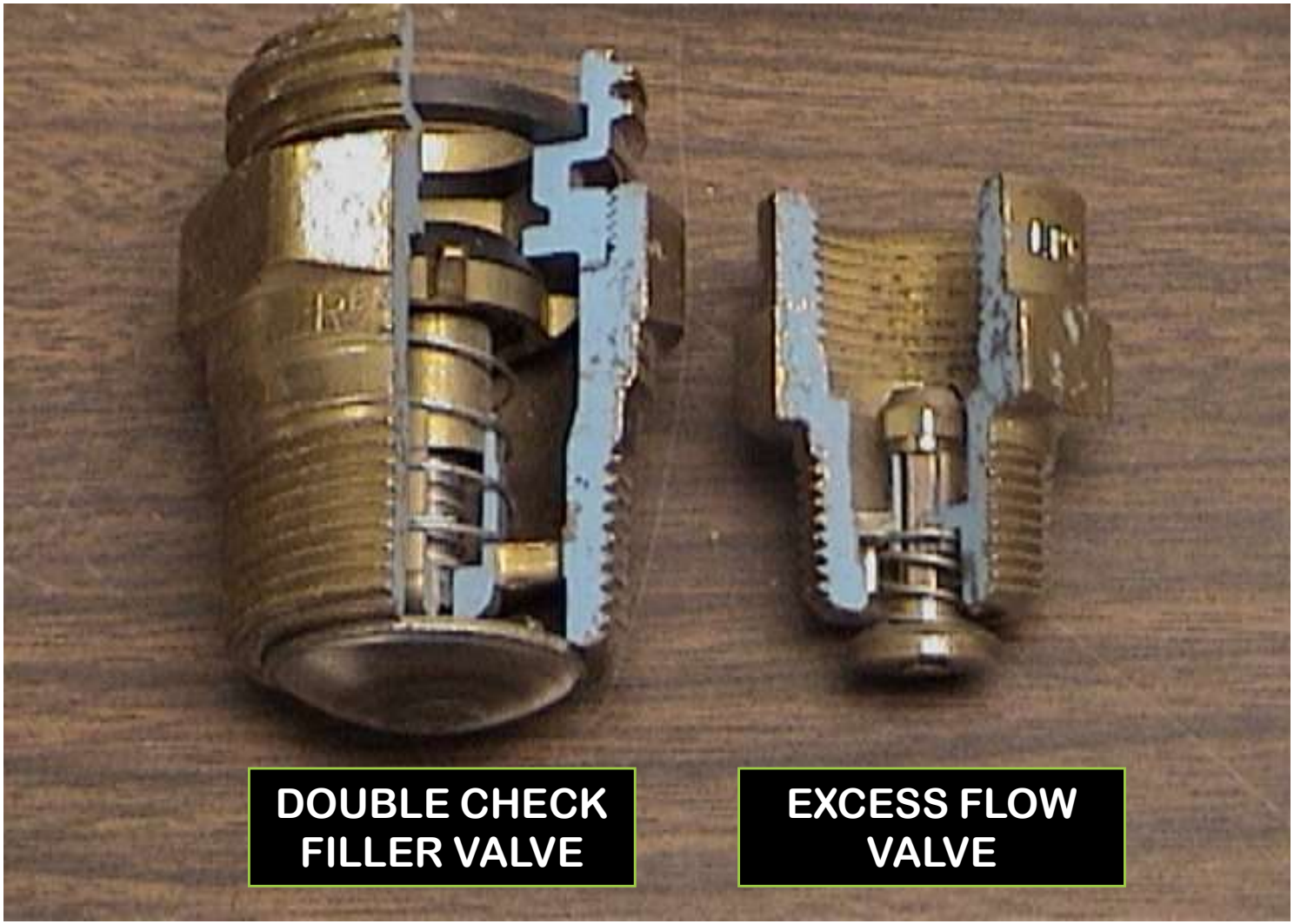


Figure 2.14 Operation of Backflow Check Valve.

Installed in Storage Tank Nozzles or in piping systems

Storage Tank Safety Valves

Storage Tank Safety Valves



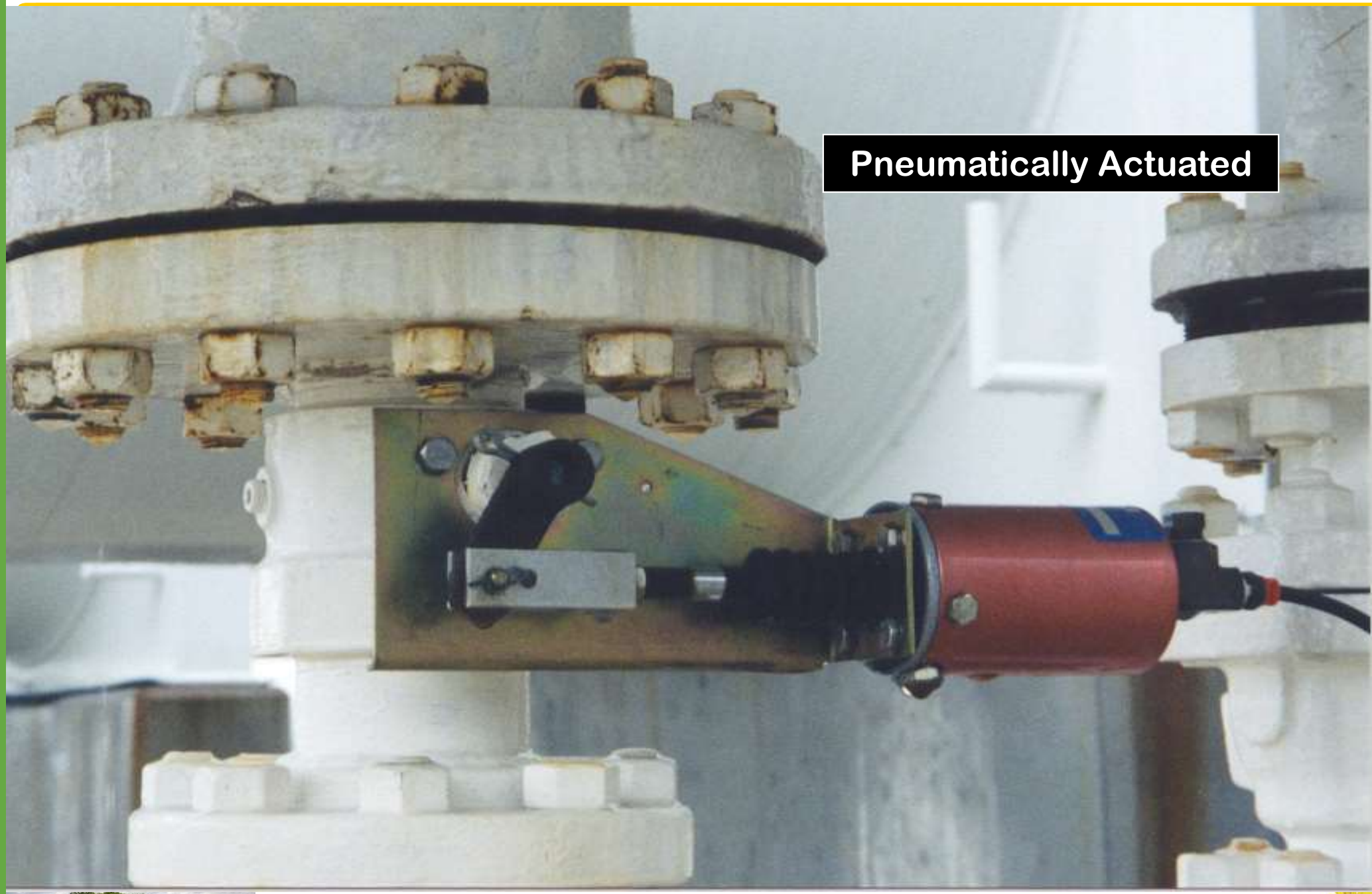
Storage Tank Safety Valves

NFPA 58 - 2001 Edition Code Change

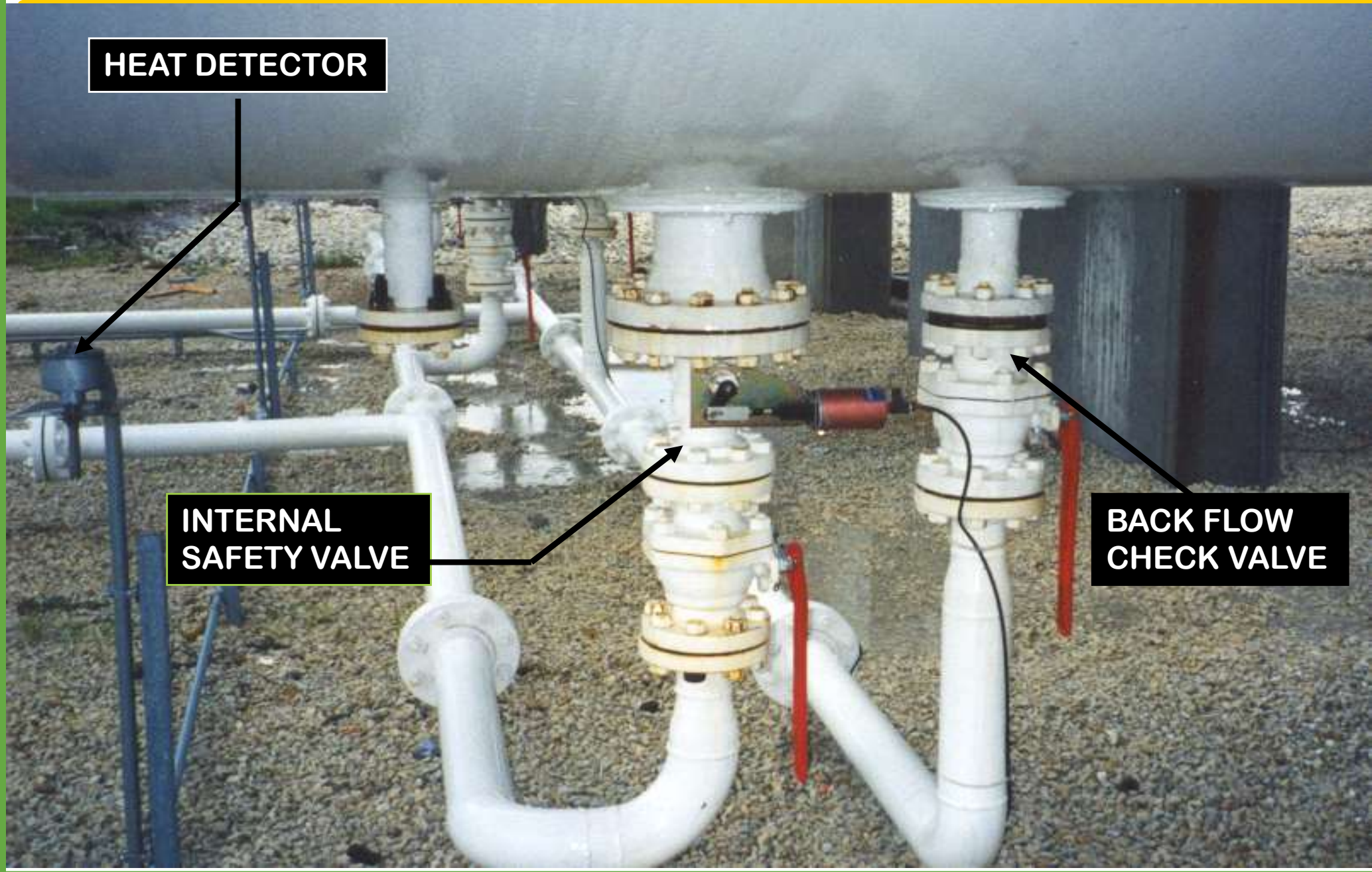
- For Liquid Withdrawal Openings in Storage Tanks over 4,000 gallons capacity:
  - *Internal valves equipped with remote closure and automatic shutoff using thermal actuation*
    or
  - *An emergency shutoff valve equipped for remote closure and automatic shutoff using thermal actuation installed in the line downstream as close as practical to the existing positive shutoff valve*

- Deadline for Retrofit: July 1, 2011

Internal Safety Valve (Fisher Controls)



Storage Tank Farm



Remote ESD Station for ESVs

PNEUMATIC ESD

ELECTRO-PNEUMATIC ESD

Pipe and Pipe Fittings

- Carbon Steel schedule 80 pipe and 2000# forged steel fittings are recommended to be used throughout the storage and handling system for maximum safety and maintenance flexibility.

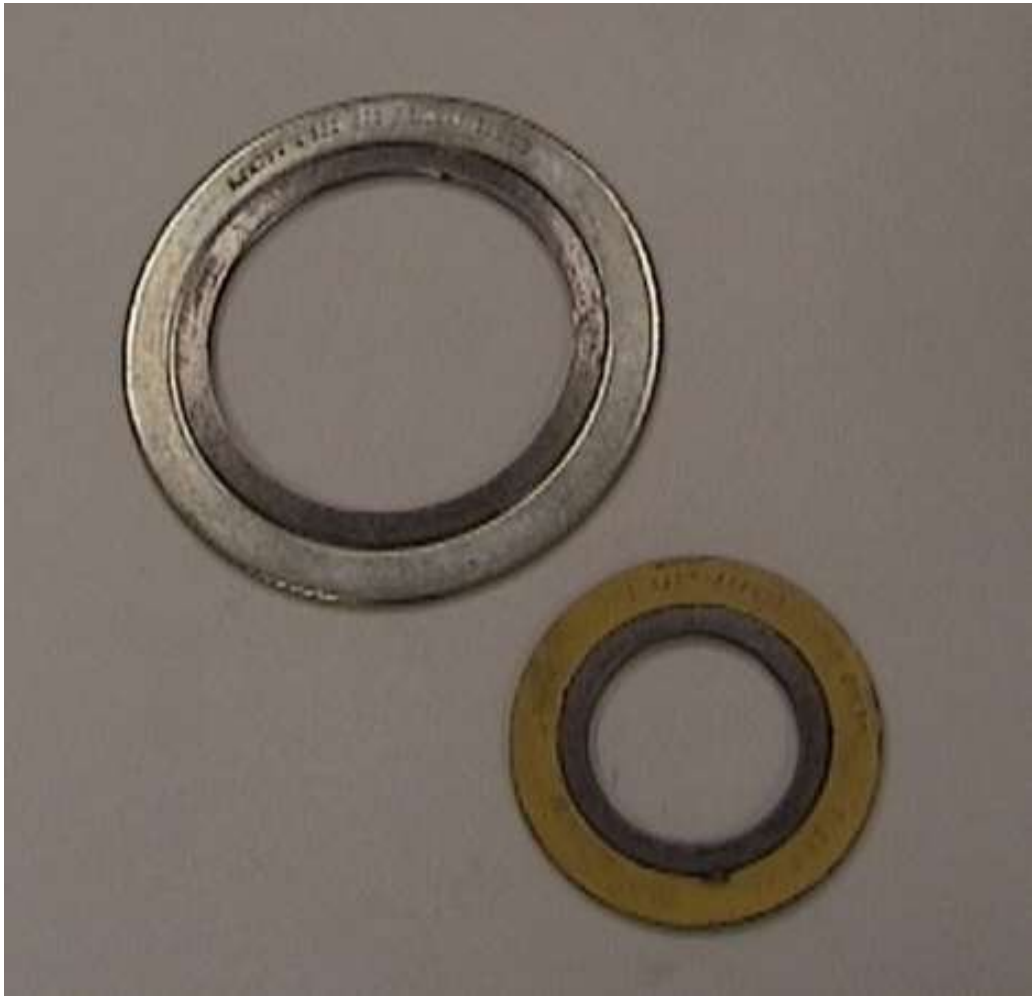
- Pipe joints may be threaded, flanged or welded. Welded joints are preferred to minimize the potential for leaks, especially in long piping runs or piping that is hard to reach for inspection.

Pipe and Pipe Fittings

- Piping must be designed and installed in accordance with NFPA 58 and ASME B31.3 *Chemical Plant and Petroleum Refinery Piping.*
- Cast Iron fittings must not be used. (Malleable or ductile iron may be used for equipment handling liquefied gases).
- All materials must be inert to the chemical action of the product.
- Metal or Spiral wound metal gaskets required.

Pipe and Pipe Fittings

Metal or Spiral wound metal gaskets required



Pipe and Pipe Fittings

- Piping should be installed above ground and must be well supported and protected against damage.
  - Buried piping requires special protective coating systems and cathodic protection. Buried piping has limited use in the industry due to corrosion, settling and difficulty with leak detection. For buried piping considerations, see NFPA 58, Chapter 6 (section 6.9.3.12 – 6.9.3.16)
- Grounding of the piping system is recommended.
- Piping Systems must be properly labeled.

Pipe and Pipe Fittings

- Elastomers
  - Hydrocarbons and Hydrofluorocarbons
    - *Buna-N, Neoprene and Butyl Rubber acceptable*
  - Dimethyl Ether (DME)
    - *Teflon® is a suitable plastic sealant*
    - *Kalrez®, Chemrez® and Ethylene Propylene (EP) are the best elastomers for DME service*

Forged Steel Sch. 80 Pipe And 2000# Fittings

Visible Leak – Liquid Piping

Liquid Transfer Pumps

2-5.2 Pumps.

2-5.2.1 Pumps shall be designed for LP-Gas service and may be of rotary, centrifugal, turbine or reciprocating type.

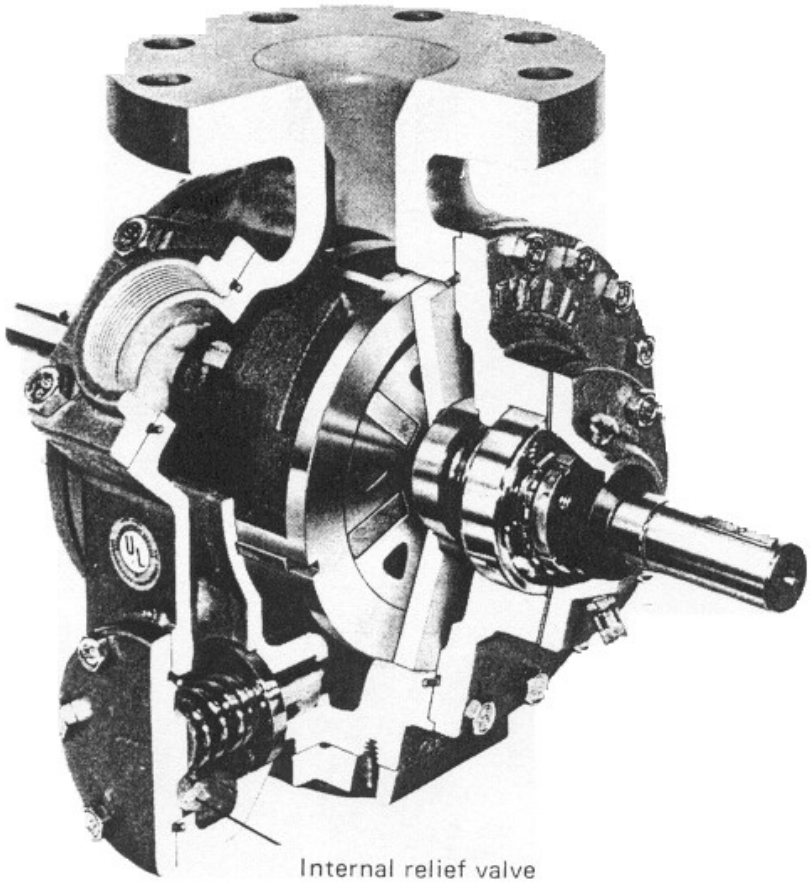
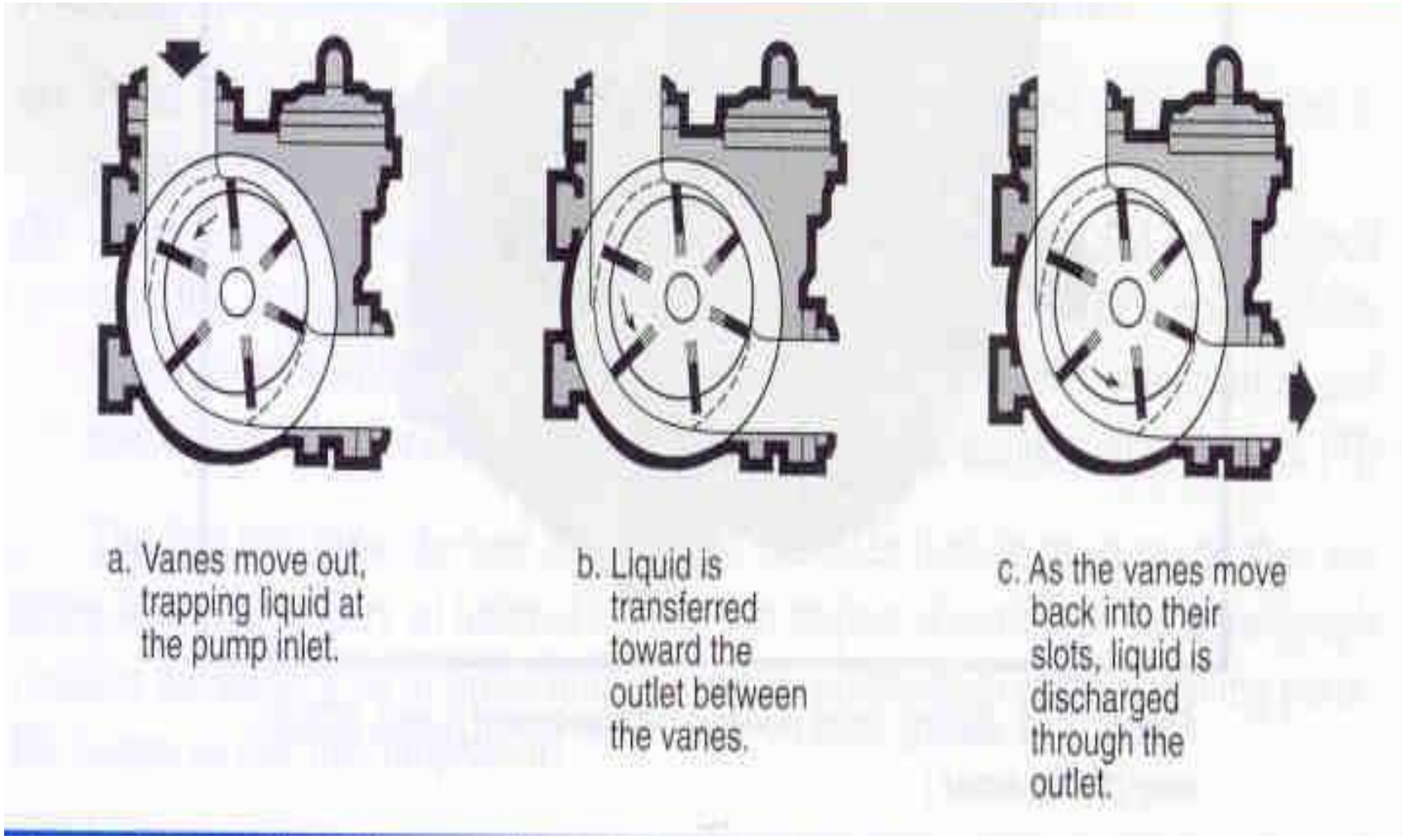


Figure 2.20(a) Sliding Vane Positive Displacement Pump.

Operation of a Slide Vane PD Pump

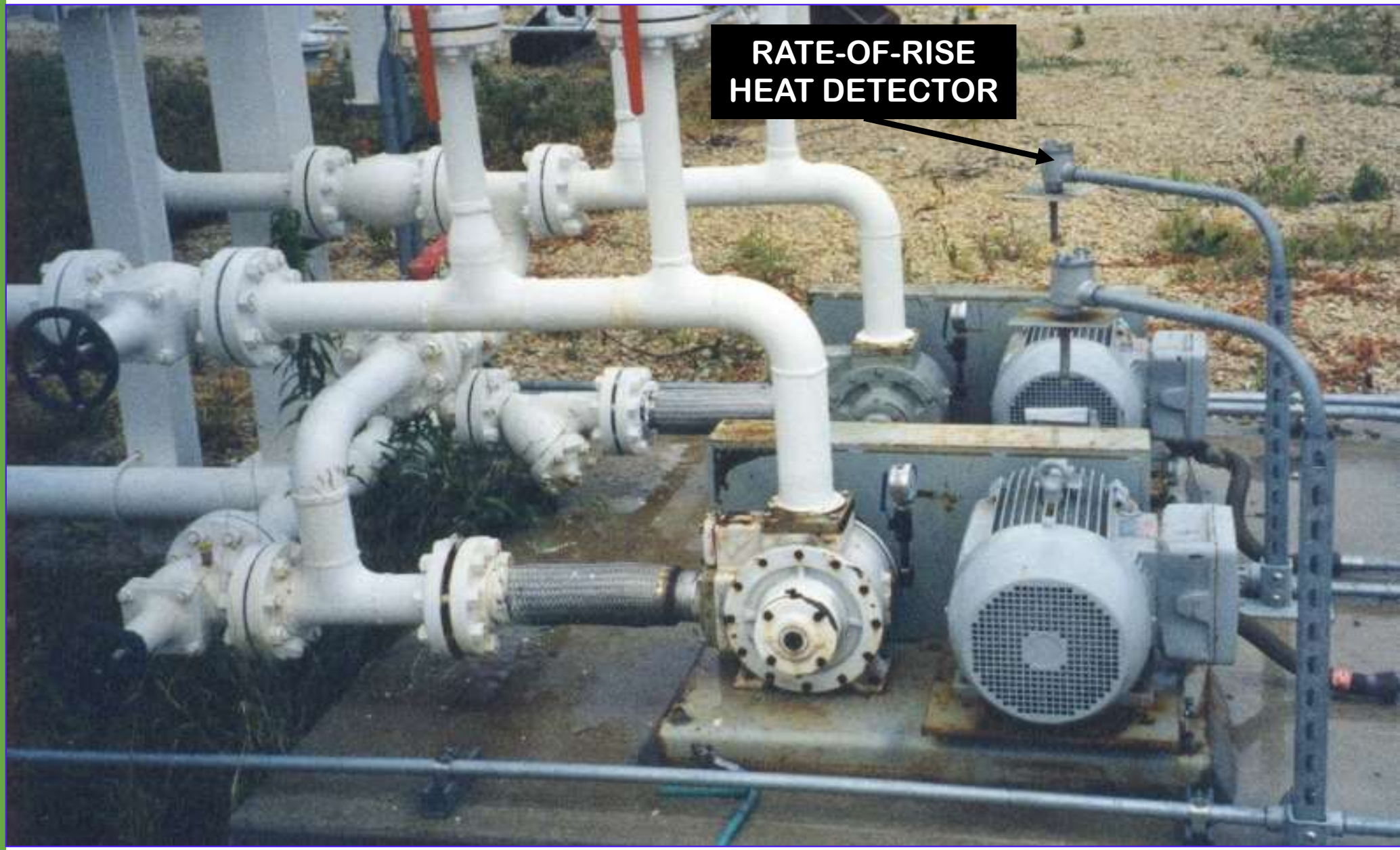


a. Vanes move out, trapping liquid at the pump inlet.

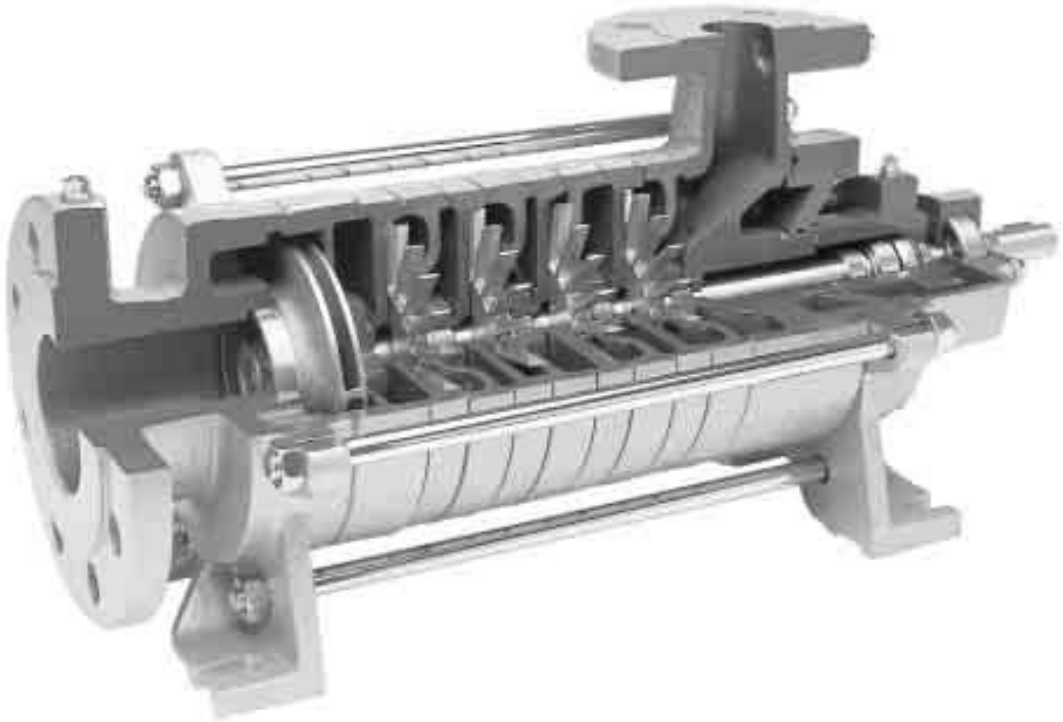
b. Liquid is transferred toward the outlet between the vanes.

c. As the vanes move back into their slots, liquid is discharged through the outlet.

Liquid Transfer Pumps



High Differential Pressure Pumps for Bulk Storage Tanks



Multistage Side Channel Pump

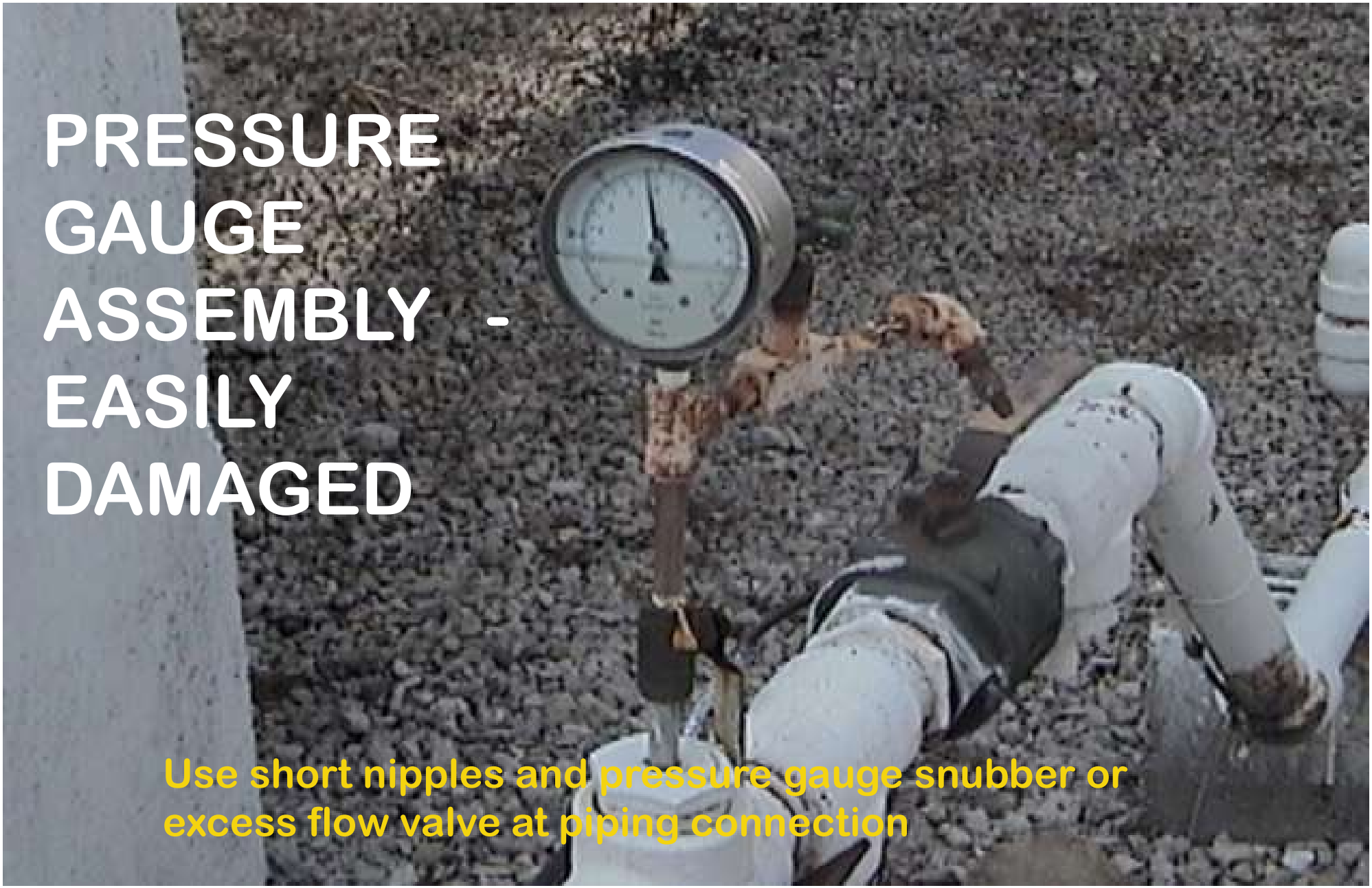
Autogas Series
Regenerative Turbine Pump

Pumps manufactured by Corken

Coupling Guards

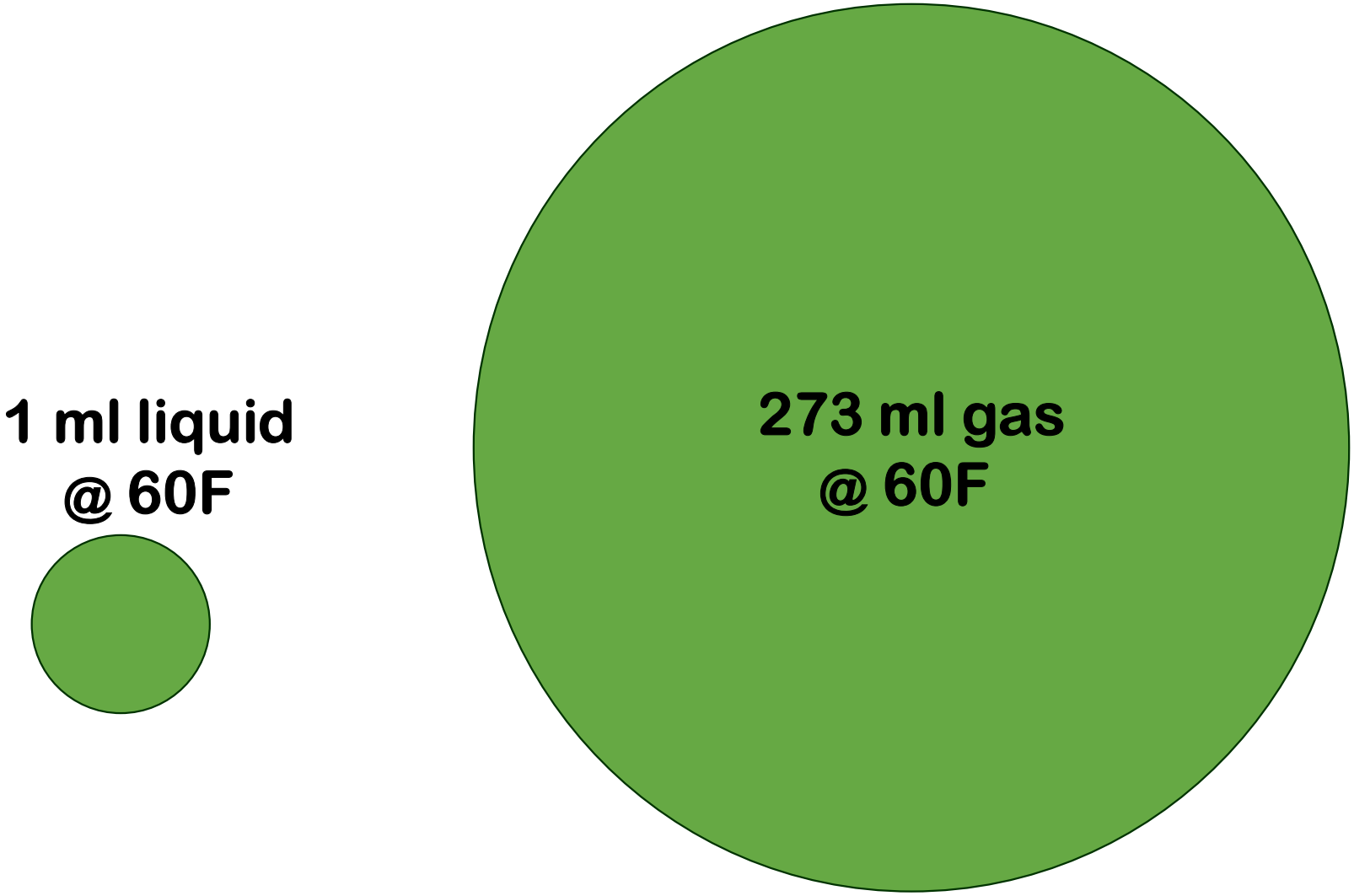
Missing guard on rotating equipment violates OSHA Standards

Pressure Gauge Assembly



Liquid to Gas Expansion

A-108 (Propane):



Theoretical Maximum Release of Liquefied Flammable Gas

The theoretical maximum release of 3 different hydrocarbon gases @ 70 °F to the atmosphere through a 0.25” dia. opening has been calculated to be:

Natural Gas Liquid	Pressure (psig)	Vapor (ft3/sec)	Liquid (gal/min)
Propane	108	12.20	28.60
Isobutane	31	5.94	14.39
N-butane	17	4.66	10.50

Liquid to Gas Expansion

Liquid to Gas Expansion

LP Gas Fire Test

NFPA 58 (2001 Edition Code Change)

- **Fire Protection shall be provided for installations of ASME Storage Tanks of more than 4,000 gallon aggregate water capacity**

- **The mode of such protection shall be determined through a written fire safety analysis for new installations, and for existing installations, by 3 years from the effective date of this code.**

NFPA 58 (2004 Edition Code Change)

- Added Chapter 14 – Operations and Maintenance

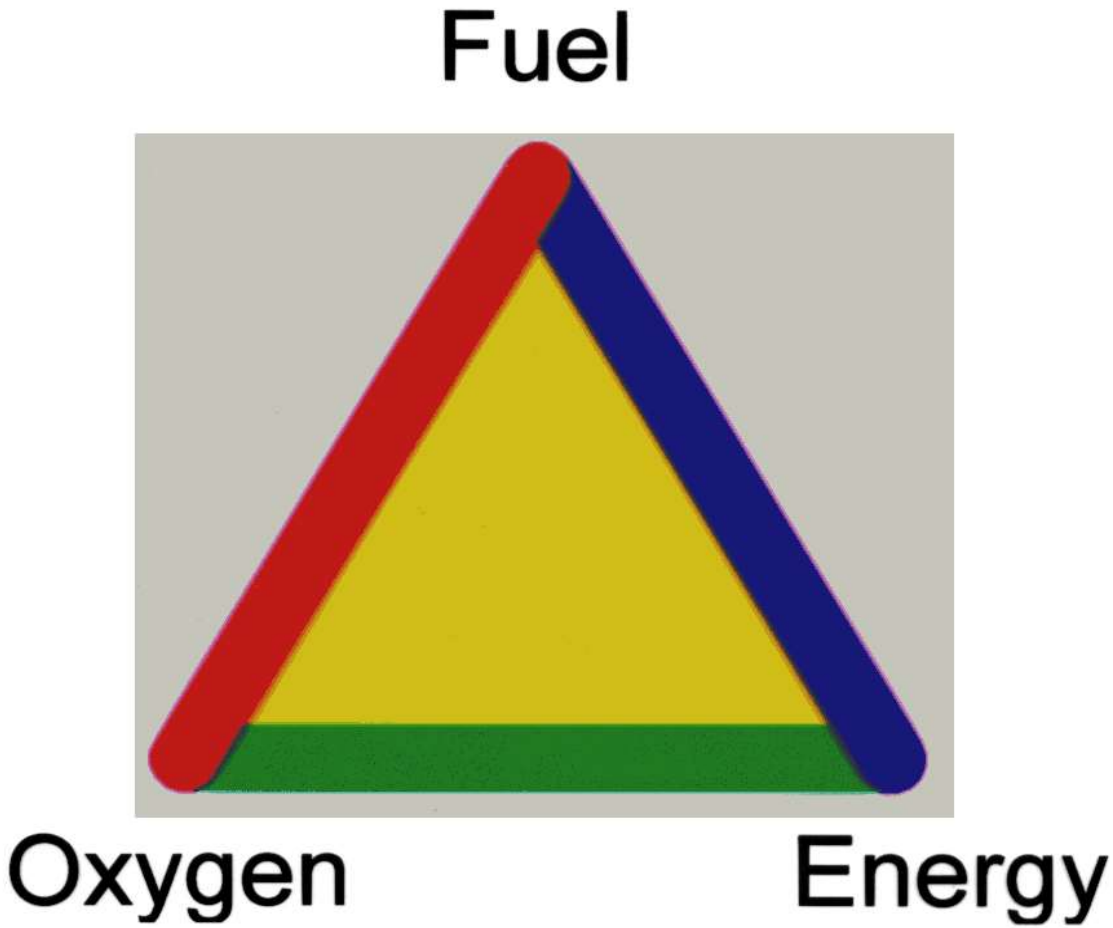
- This chapter details requirements for written Operations and Maintenance procedures, Equipment Manuals, and Maintenance of Fire Protection Equipment.

Tank Farm Safety General

Properties and Safety Issues of Flammable Liquefied Gases

- Flammable
- Gases Liquefied Under Pressure
- Sudden Release of Pressure
- Low Boiling Points
- High Expansion Ratios
- Heavier Than Air
- Vapors are Colorless and Odorless
- BLEVE (Boiling Liquid Expanding Vapor Explosion)

The Fire Triangle



General Safety Practices

- Proper Pressure Ratings for Storage Tanks and Equipment
- Storage Tanks must be fitted with safety relief valves set to discharge at container design pressure
- Storage Tanks must have liquid level, pressure and temperature gauges
- Container openings for Liquid and Vapor service must be fitted with internal safety valves, excess flow, Emergency shutoff valves, or backflow check valves as appropriate

General Safety Practices

- Hydrostatic relief valves must be present between isolation valves where liquid could be trapped in the piping.
- There must be emergency shut-off valves and protective bulkheads at transport loading and unloading stations.
- At least one 20 lb. BC type portable fire extinguisher should be located at the storage area.
- Adequate Fire Protection must be provided for storage tanks.

General Safety Practices

- Electrical Equipment and connections must be explosion proof (NEC Class I, Division I or II, Groups C & D). Note: Group D for Hydrocarbons and HFCs; Group C for Dimethyl Ether (DME).
- There must be adequate clearances between storage containers, other groups of storage containers, buildings, and flammable liquid storage areas. See NFPA 58 for details.
- Security Fencing with at least two separate access gates should be present around storage tanks or around the entire facility.

Regulations

- Title V - Clean Air Act Operating Permits
- OSHA PSM - Process Safety Management
- EPA RMP - Risk Management/Worst Case Scenario
- Yearly Emission Reporting
- Hazard Communications (Right-to-Know) Procedures and Reporting
- Documented Employee Training Program
- Written Fire Safety Analysis