

TO 12: Describe requirements in 29 CFR 1910 Subpart H standards to protect workers from common hazards associated with hazardous materials.

EO 12.1: Describe common hazards associated with hazardous materials.

EO 12.2: Describe the requirements for compressed gas cylinders.

EO 12.3: Describe requirements for flammable and combustible liquid hazards.

EO 12.4: Explain basic requirements associated with process safety management.

# Subpart H Hazardous Materials

John Newquist



Draft 9 10 2023



- New York cosmetics factory left 30 to 35 people injured, including seven firefighters caught in the second blast, officials said Monday.
- "A deceased male employee was recovered from the plant fire at approximately 7:40 p.m.
- Police said the first explosion occurred around 10:15 a.m. Monday at the Verla International cosmetics factory in New Windsor, about an hour's drive from New York City. Firefighters who responded were inside when the second explosion occurred around 10:40 a.m.

# Nov 2017



# January 2014

- According to OSHA records, it was first shift workers acting under supervision, who loaded the fateful batch of carbon and graphite parts, coated in a highly flammable alcohol and iodine solution.
- The oven, unequipped to handle combustibles, exploded roughly 15 minutes later.
- OSHA said the force ripped the oven's door from its hinges, causing the heavy metal object to strike a group of three workers on a tour of the facility, 15 to 20 feet away.
- The result is listed as “death and broken bones.”



The “event” oven – a Despatch-brand electric oven — had reportedly been purchased by the company to cure water-based calcium treatments roughly four years earlier.

# Hydrogen

- January 8, 2007 OHIO
- The truck driver was delivering hydrogen gas to fill two 6500 cubic feet storage cylinders at the plant.
- The hydrogen gas was used to cool the generator at the power plant.
- At this time witnesses heard a loud noise, like high pressure gas venting through a relief valve, and within 15 to 20 seconds, the hydrogen gas exploded, killing the employee and injuring eight AEP coworkers.
- The investigation revealed that the hydrogen gas over pressurized a rupture disk attached to one of the hydrogen cylinders.



As the set pressure of the rupture disk was between 3500 and 4000 psi, and the maximum pressure that could have been put on the system during filling was 2600 psi, the rupture disk failed well below its designed pressure.

# Cont.

OSHA - \$8500

On or about January 8, 2007, employees were exposed to a fire and/or explosion hazard from the ignition of hydrogen gas during the filling of hydrogen storage cylinders at Unit 5 of AEP's Muskingum River Plant.

Precautions were not taken to prevent the ignition due to,

- Failure to use non-sparking tools (crescent wrench) to open the hydrogen tube trailer main valve; and
- Failure to shut off the engine of the tractor delivering the tube trailer.
- A feasible and acceptable method of abatement would be to remove all potential ignition sources while transferring hydrogen gas from trailers to customer storage cylinders, including:



1. Use non-sparking tools while working on hydrogen gas equipment; and
2. Shut down the engine of the tractor before initiating the transfer of hydrogen gas from the tube trailer to the storage cylinders.

# Cont.

\$7 million to Truck driver Family  
Mr. Brown explained the inner workings of hydrogen storage systems at power plants and noted specifically the inherent dangers in the defendant's roof above its hydrogen system and its use of weak copper relief stacks.

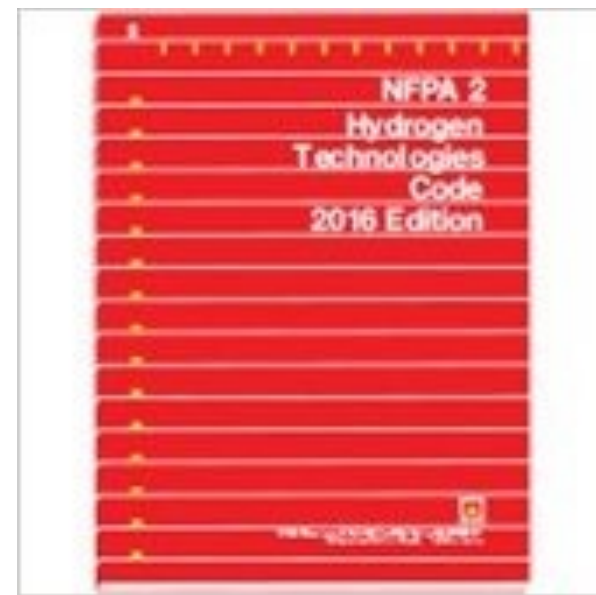
He also described a similar explosion that occurred in December 2005 at a plant in Moundsville, West Virginia, which prompted safety recommendations that were not acted upon by either defendant.



Simply stated, to become a fire hazard, hydrogen must first be confined; however, because hydrogen is the lightest element in the universe, it is very difficult to confine. Industry takes these properties into account when designing structures in which hydrogen will be used.

The designs help hydrogen escape up and away from the user in case of an unexpected release

# NFPA 2 - 2016



- Hydrogen Technology Code
- 5.1.8 – operation and maintenance manual
- 5.1.11 – annual certification
- 5.1.12.2 PHA
- 5.2.2.2 Explosion Protection
- 5.4.3.1 H2 vessel burst scenario
- 5.4.3.2 H2 deflagration scenario
- 5.4.3.3 Hydrogen detonation scenario
- 6.4 Quantity Thresholds
- 6.8 Employee Alarm
- 6.12 H2 detection
- 6.13 approved lighting
- 6.17 Ventilation
- 6.19.3 Fire Protection
- 7.1.4.1.6 Container inspection
- 8.1.4 pressure relief

See also **CGA G 5.3:2017**  
Commodity Specification For Hydrogen



# October 2023

- OSHA finds RM Palmer did not evacuate West Reading candy plant before gas leak explosion fatally injured 7 workers



# Citation

abatement obligations: Develop and implement an evacuation plan to be used in the event of a gas leak that complies with Pennsylvania Fire Code (IFC 2018) section 404.2; NFPA 54: NFPA 715 Installation of Fuel Gases Detection and Warning Equipment 2023; ANSI Z223.1–2021 National Fuel Gas Code, 2021 Edition - Annex D and includes the following:

- \* Evacuate the facility in the event of a gas leak
- \* Install gas leak detection
- \* Use portable gas detectors when investigating potential leaks.
- \* Define the levels at which evacuation should occur
- \* Provide training on “the plan” that includes among other things, information on what natural gas smells like.

## **ABATEMENT DOCUMENTATION REQUIRED FOR THIS ITEM**

Date By Which Violation Must be Abated:

October 03, 2023

Proposed Penalty:

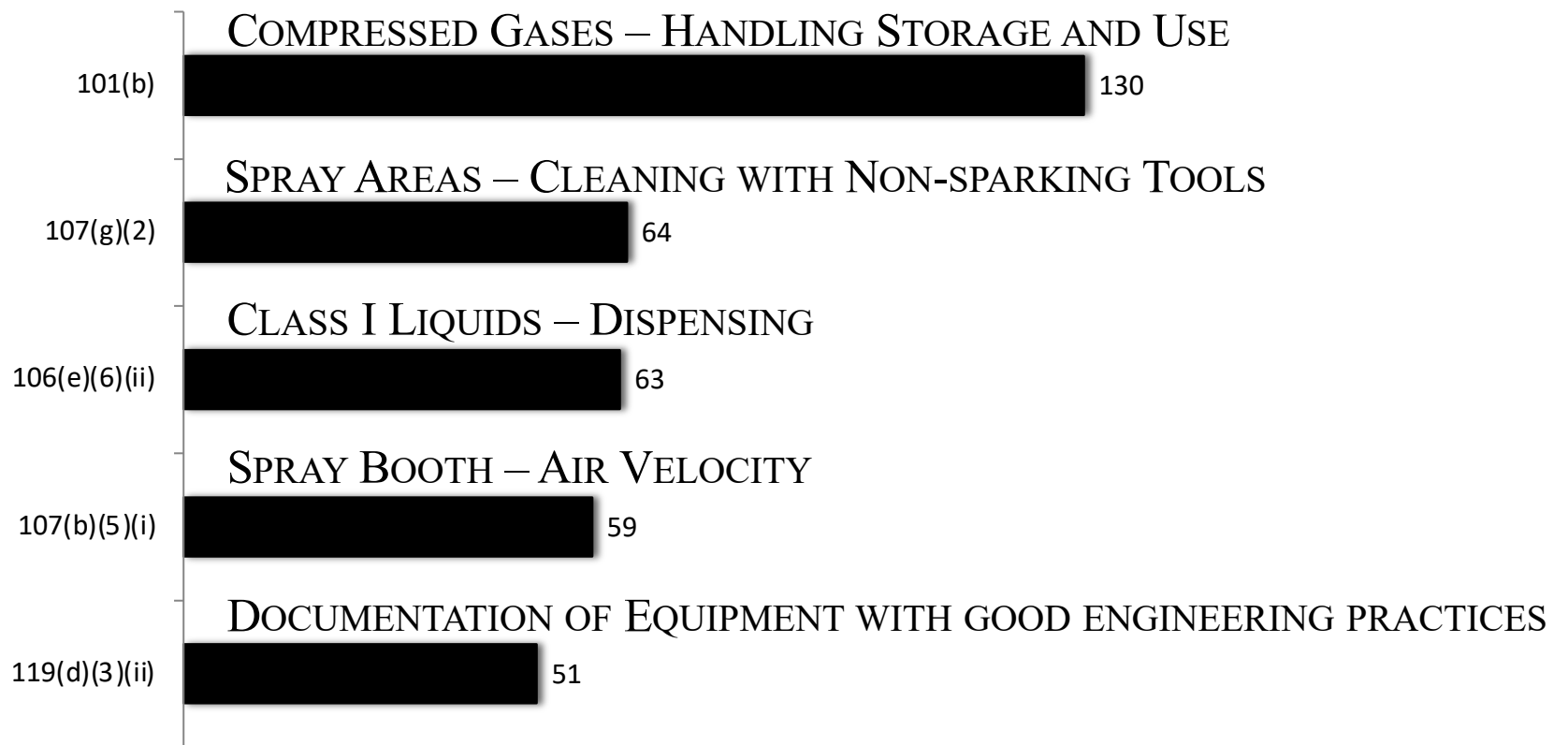
\$15,625.00

# Buffalo Rock

- 1988
- 4 dead
- Bullet filling machine misfires.
- Housekeeping
- Electrical



# Hazardous Materials [1910.101 – .126]



# 1910.101(b)

- "**Compressed gases.**" The in-plant handling, storage, and utilization of all compressed gases in cylinders, portable tanks, rail tank cars, or motor vehicle cargo tanks shall be in accordance with **Compressed Gas Association Pamphlet P-1-1965**, which is incorporated by reference as specified in Sec. 1910.6.



Citation 1 Item 4 Type of Violation: **Serious**

29 CFR 1910.101(b): The in-plant handling, storage, and utilization of all compressed gases in cylinders, portable tanks, rail tankcars, or motor vehicle cargo tanks shall be in accordance with Compressed Gas Association Pamphlet P-1-1965, which is incorporated by reference as specified in Sec. 1910.6:

On or about March 2, 2012, and times prior thereto:

- a) In the Fabrication Shop beside the door leading into the Welding Shop, argon cylinders are stored unchained exposing employees to struck-by hazards.
- b) In the Fabrication Shop beside the door leading into the room where the rollers, shear, strippet and circular shear, argon cylinders are stored unchained exposing employees to struck-by hazards.
- c) In the Welding Shop by each welding station, argon cylinders are not secured to prevent them from falling over when in use exposing employees to struck-by hazards.

Pursuant to 29 C.F.R. 1903.19, within ten (10) calendar days of the abatement date, the employer must submit documentation showing that it is in compliance with the standard, including describing the steps that it is taking to ensure that cylinders of compressed gas are properly stored.

**\*\*\*Abatement Certification and Documentation Required\*\*\***

Date By Which Violation Must be Abated:	09/05/2012
Proposed Penalty:	\$ 2310.00

Citation 1 Item 4 Type of Violation: **Serious**

29 CFR 1910.101(b): The in-plant handling, storage, and utilization of all compressed gases in cylinders, portable tanks, rail tankcars, or motor vehicle cargo tanks were not in accordance with Compressed Gas Association Pamphlet P-1-1965, which is incorporated by reference as specified in CFR 1910.6:

Employees were exposed to injury from fire and explosion or a projectile hazard. Compressed gas cylinders, that were not in use, were not secured to prevent damage in accordance as required by Compressed Gas Association Pamphlet P-1-1965 in the following locations:

- a) The white cylinder with a yellow cap located outside, west side of the building, right end of end of the propane storage rack.
- b) Two propane compressed gas cylinders located outside, west side of the building, left end of the propane storage rack.
- c) Two compressed gas cylinders of acetylene located inside, southeast corner of the production area in the compressed gas cylinder storage area. The chain provided is not low enough to secure the small acetylene cylinders.
- d) Three compressed gas cylinders of oxygen located inside, southeast corner of the production area in the compressed gas cylinder storage area. The chain provided is not low enough to secure the small oxygen cylinders.

29 CFR 1903.19(c)(1) requires certification that the abatement of the above violation is complete.

Date By Which Violation Must be Abated:

04/20/2015

Proposed Penalty:

\$4500.00

Citation 1 Item 4 a Type of Violation: **Serious**

29 CFR 1910.101(b): The in-plant handling, storage, and utilization of all compressed gases in cylinders, portable tanks, rail tankcars, or motor vehicle cargo tanks were not in accordance with Compressed Gas Association Pamphlet P-1-1965, which is incorporated by reference as specified in CFR 1910.6:

On or about 5/14/14 at 200 McIntyre Drive, Hartwell, GA, in the cylinder storage area on the pad:

- a. powered industrial trucks are driven within approximately three feet of stored full cylinders of compressed oxygen, argon, acetylene, and empty cylinders of oxygen and argon, to perform propane tank changes and fillings on a daily basis. The compressed gas cylinders are not protected from damage.
- b. an empty argon cylinder was stored without a cap.

In accordance with 29 CFR 1903.19(d), abatement certification is required for this violation (using the CERTIFICATION OF CORRECTIVE ACTION WORKSHEET), and in addition, documentation demonstrating that abatement is complete must be included with your certification. This documentation may include, but is not limited to, evidence of the purchase or repair of the equipment, photographic or video evidence of abatement, or other written records.

**ABATEMENT DOCUMENTATION REQUIRED FOR THIS ITEM**

Date By Which Violation Must be Abated:

12/03/2014

Proposed Penalty:

\$7000.00



Citation 1 Item 1 Type of Violation: **Repeat**

29 CFR 1910.101(b): The in-plant handling, storage, and utilization of all compressed gases in cylinders, portable tanks, rail tank cars, or motor vehicle cargo tanks were not in accordance with Compressed Gas Association Pamphlet P-1-1965, which is incorporated by reference as specified in CFR 1910.6:

(a) Receiving Area: Employees are exposed to struck by hazards while stacking freight in and around two unsecured helium bottles. This condition was most recently observed on March 12, 2014 and at times prior thereto.

DOLLAR TREE STORES INC., WAS PREVIOUSLY CITED FOR A VIOLATION OF THIS OCCUPATIONAL SAFETY AND HEALTH STANDARD WHICH WAS CONTAINED IN OSHA INSPECTION NUMBER 314238429 CIITATION NUMBER 02, ITEM NUMBER 002 AND WAS AFFIRMED AS A FINAL ORDER ON MAY 10, 2010, WITH RESPECT TO A WORKPLACE LOCATED AT 2357 LINCOLN HIGHWAY EAST, LANCASTER, PA 17602.

Pursuant to 29 C.F.R. 1903.19, within ten (10) calendar days of the date of this citation, the employer must submit documentation showing that it is in compliance with the standard, including describing the steps that it is taking to ensure that all compressed gas cylinders are stored and secured correctly in accordance with Compressed Gas Association Pamphlet P-1-1965.

**ABATEMENT DOCUMENTATION REQUIRED FOR THIS ITEM**

Date By Which Violation Must be Abated:

06/30/2014

Proposed Penalty:

\$33000.00

# Knowledge Check 28

- Which industry standard has OSHA incorporated by reference for handling, use and storage of compressed gases?

# Knowledge Check 28

- Which industry standard has OSHA incorporated by reference for handling, use and storage of compressed gases?
- **CGA Pamphlet P-1**

# 1910.107(g)(2)

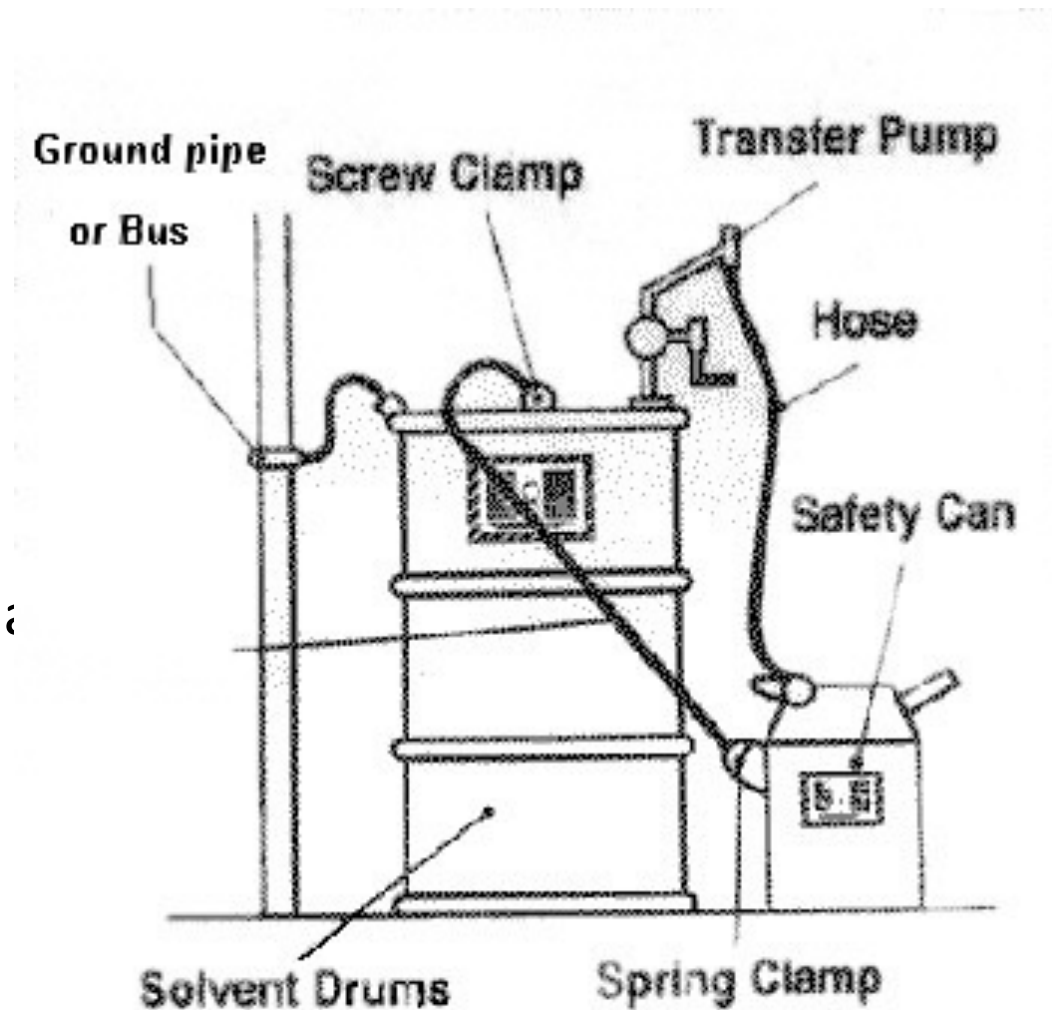
- Cleaning.
- All spraying areas shall be kept as free from the accumulation of deposits of combustible residues as practical, with cleaning conducted daily if necessary.
- Scrapers, spuds, or other such tools used for cleaning purposes shall be of nonsparking material.



What could be the weaknesses in citing this?

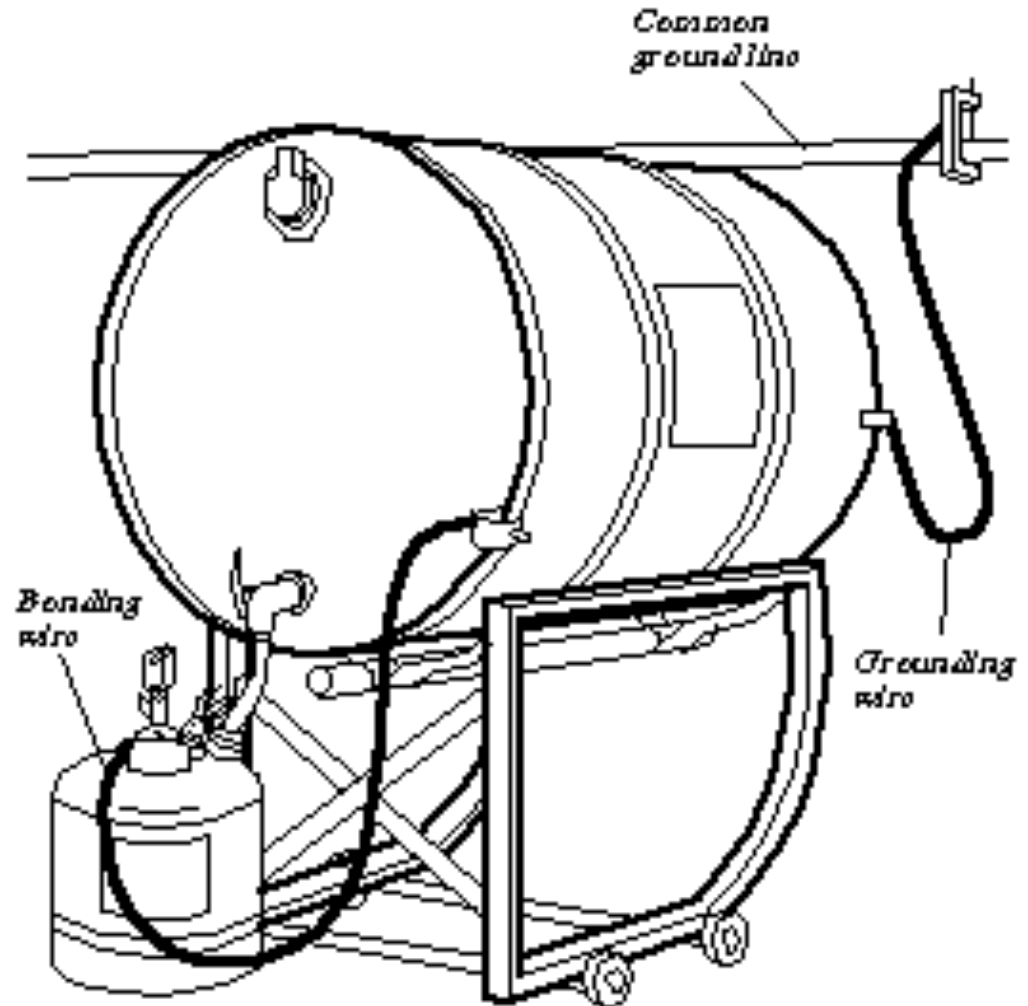
# 1910.106(e)(2)(iv)(d)

- Flammable liquids shall be drawn from or transferred into vessels, containers, or portable tanks within a building only through a closed piping system, from safety cans, by means of a device drawing through the top, or from a container or portable tanks by gravity through an approved self-closing valve.
- Transferring by means of air pressure on the container or portable tanks shall be prohibited.



# Bonding and Grounding

- OSHA's flammable liquids standard, 29 CFR 1910.106, requires electrical interconnection when dispensing Category 1 or 2 flammable liquids or:
  - Dispensing Category 3 flammable liquids with a flashpoint below 100 degrees F



# September 2014



2017





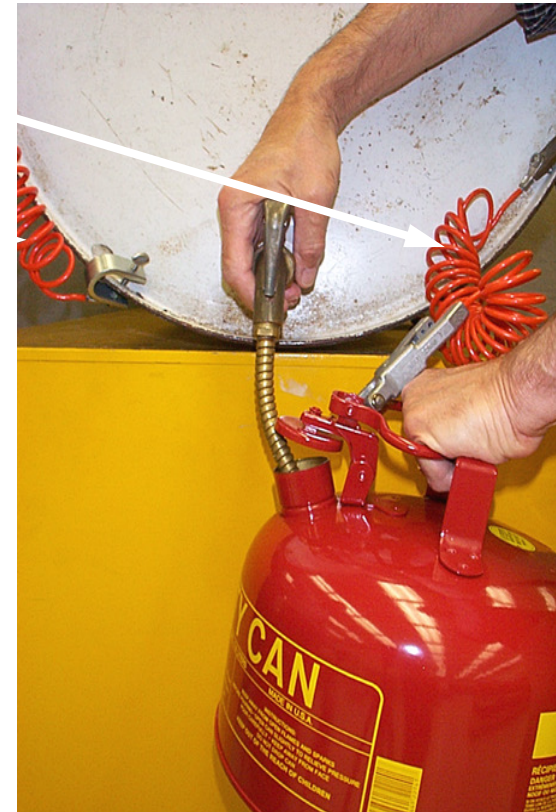
# Ether accident

- Drop filling
- Worker sees sparks in funnel
- Next thing he knows he is on fire with invisible flames



# Self-Closing Safety Faucet

- Bonding wire between drum and container
- Grounding wire between drum and ground
- Safety vent in drum



# Safety Pump

- Faster and safer than using a faucet
- Spills less likely
- No separate safety vents in drum required
- Installed directly in drum bung opening
- Some pump hoses have integral bonding wires



# Knowledge Check 26

- OSHA's flammable liquids standard, 29 CFR 1910.106, requires electrical interconnection when dispensing Category 1 or 2 flammable liquids or:
- Storing flammable liquids for more than one shift
- Dispensing Category 3 flammable liquids with a flashpoint below 100 degrees F

# Knowledge Check 26

1. The lower flammable limit of a flammable gas or vapor is the:
  - a. Highest concentration of the gas or vapor in air, expressed as a percentage, that can be ignited
  - b. Lowest concentration of the gas or vapor in air, expressed as a percentage, that can be ignited

# Knowledge Check 26

1. The lower flammable limit of a flammable gas or vapor is the:
  - a. Highest concentration of the gas or vapor in air, expressed as a percentage, that can be ignited
  - b. **Lowest concentration of the gas or vapor in air, expressed as a percentage, that can be ignited**

# 1910.107(b)(5)(i)

- The spraying operations except electrostatic spraying operations shall be so designed, installed and maintained that the average air velocity over the open face of the booth (or booth cross section during spraying operations) shall be not less than 100 linear feet per minute.



# 1910.119(d)(3)(ii)

- The employer shall document that equipment complies with recognized and generally accepted good engineering practices.





# 1910.119(d)(3)(ii)

- Ammonia  
Compressor Room
- Photo Bryan  
Haywood



# 1910.119(d)(3)(ii)

- OSHA considered, but rejected, publishing a list of RAGAGEP providers
- The employer (not OSHA!) selects the applicable and protective RAGAGEP it will use / comply with!



# Potential Sources of RAGAGEP

## Ammonia - IIAR (International Institute of Ammonia Refrigeration)

Bulletin 107 - Guidelines for: Suggested Safety and Operating Procedures when Making Refrigeration Plant Tie-Ins

Bulletin 108 - Guidelines for: Water Contamination in Ammonia Refrigeration System

Bulletin 109 - Guidelines for: IIAR Minimum Safety Criteria for a Safe Ammonia Refrigeration System

Bulletin 110 - Guidelines for: Start-Up, Inspection and Maintenance of Ammonia Mechanical Refrigerating Systems



# Potential Sources of RAGAGEP

## Ammonia - IIAR

Bulletin 111 - Guidelines for:  
Ammonia Machinery Room  
Ventilation

Bulletin 112 - Guidelines for:  
Ammonia Machinery Room  
Design

Bulletin 114 - Guidelines for:  
Identification of Ammonia  
Refrigeration Piping and  
System Components

Bulletin 116 - Guidelines for:  
Avoiding Component Failure in  
Industrial Refrigeration  
Systems Caused by Abnormal  
Pressure or Shock



# Potential Sources of RAGAGEP

## The Chlorine Institute

Numerous Standards for:

Chlorine

Sodium hypochlorite

Hydrogen Chloride

Hydrochloric Acid

Many pamphlets  
available for free  
download

– [www.chlorineinstitute.org](http://www.chlorineinstitute.org)



# Chlorine

- I hope the basement has the proper ventilation and if it does, install a green/red light at the entrance to the stairs.
- Green we have glow/red no flow means no entry.
- Over 1.0 ppm (STEL) requires APR;
- 5.0 ppm (1/2 the IDLH) requires SAR.
- No entry at 10 ppm (IDLH)



# Knowledge check 14

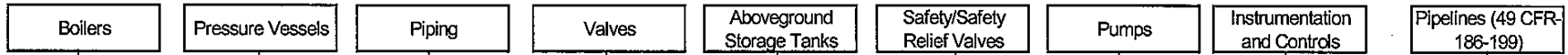
1. The Process Safety Management (PSM) Standards require refresher training at least every\_\_\_\_\_ years.
  - a. 2
  - b. 3
  - c. 4
  - d. 5

# Knowledge check 14

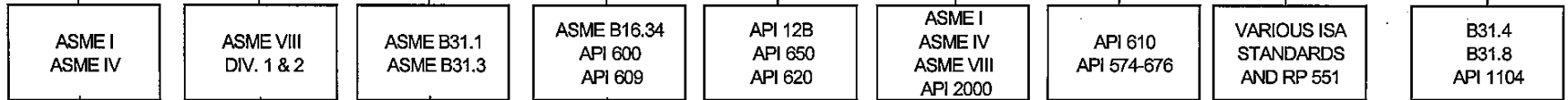
1. The Process Safety Management (PSM) Standards require refresher training at least every\_\_\_\_\_ years.
  - a. 3



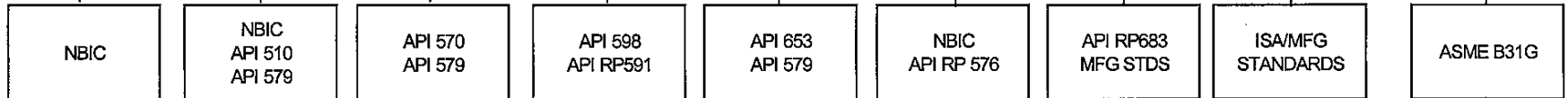
**1. ITEMS:**



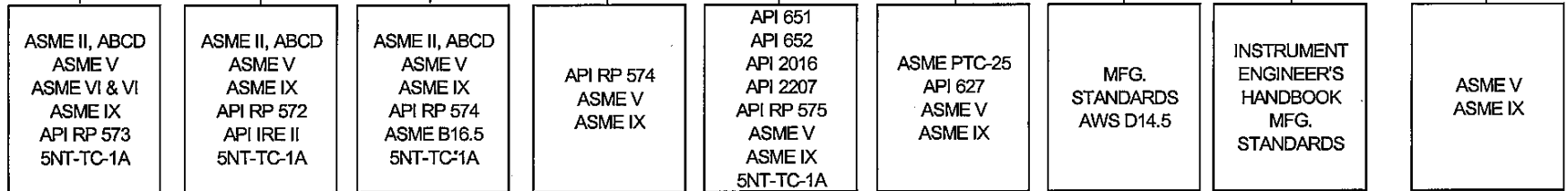
**2. DESIGN OR CONSTRUCTION CODES:**



**3. INSPECTION, REPAIR, ALTERATION, RERATING, OR FITNESS FOR SERVICE CODES:**



**4. "SUPPORT" OR "REFERENCED" CODES OR PUBLICATIONS:**



**Common RAGAGEPs**

Source: CCPS  
Guidelines for Mechanical Integrity Systems  
AIChE, 2006

# Potential Sources of RAGAGEP

API – American Petroleum Institute

ASME – American Society of  
Mechanical Engineers

NBIC – National Board Inspection  
Code, The National Board of Boiler  
and Pressure Vessel Inspectors

CCPS – American Institute of  
Chemical Engineers, Center for  
Chemical Process Safety

NFPA – National Fire Protection  
Association



Boiler leak

# Potential Sources of RAGAGEP

ANSI – American National Standards Institute

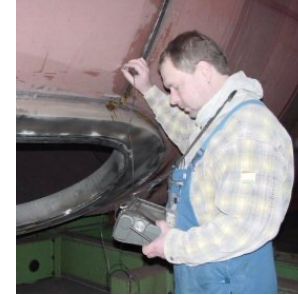
NIOSH – National Institute for Occupational Safety and Health

ASNT – American Society for Non-Destructive Testing

ISA – International Society of Automation

ISA-TR84.00.04 – Safety Instrumented Systems

EPRI – Electric Power and Research Institute



# Nitrogen

- Oxygen alarms
- Ventilation
- Signs for isolation valves
- Procedures: startup, shutdown and emergency shutdown,
- Respirator when uncertain air quality
- Nitrogen vessel inspected and certified

Cryogenic Food Freezing



- Nitrogen offloading and fill connection are 10 feet from building exits.
- Secure equipment from damage.



# Nitrogen

- The presence of nitrogen cylinders and containers requires a focus on safety.
- Liquid Nitrogen rapidly vaporizes to gas at about 700 times the liquid volume.
- By displacing air the gas may kill by asphyxiation.
- When the oxygen concentration in air is sufficiently low, a person can become unconscious without any warning symptoms.
- Fixed oxygen detector
- Handheld oxygen detector



# Linebreaking

- “Plant is down for a few days so doing a few bottom blowdown valve replacements.”
- What issues?
- Photo – Richard Clinton



# Definitions

- Flammable liquid means any liquid having a flashpoint at or below 199.4 °F (93 °C).
- The lower flammable limit of a flammable gas or vapor is the:
  - **Lowest concentration of the gas or vapor in air, expressed as a percentage, that can be ignited**



NFPA 30 3.3.33.2\* Flammable Liquid. Any liquid that has a closed cup flash point below 100°F (37.8°C)  
Class IA Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C)

# Flammable Liquid Storage

Flammable storage cabinet capacities:

- 25 gallons of Category I  
120 gallons of Category 2, 3, 4





# Let's count

- Cabinet or no cabinet?



# Storage Room Capacity

- Reference Table H-13 in 1910.106(d)(4)
- Capacity is dependent on:
  - room size
  - fire resistant rating
  - if fire protection is available

(gals/cubic feet/floor area)



Electrical lighting of this type and windows not allowed

# Knowledge Check 27

1. OSHA has incorporated by reference industry standard \_\_\_\_\_ for the handling, use, and storage of compressed gases.
  - a. CGA Pamphlet P-1
  - b. NFPA Publication 30

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# Electrical

- Electrical installations (lighting, receptacles, etc) for Class I liquids must meet Class I, Division 2 Hazardous location requirements in Subpart S
- Electrical for Class II and III is approved for **general use**



# Ventilation

- Gravity or mechanical
- Six air changes/hour
- Locate switch outside of room – wired with lighting



# LPG Storage

- Quantity of LP-Gas stored within buildings not frequented by the public, such as industrial buildings, must not exceed 300 pounds
- Typical tank for forklift is 33 pounds. So nine inside.



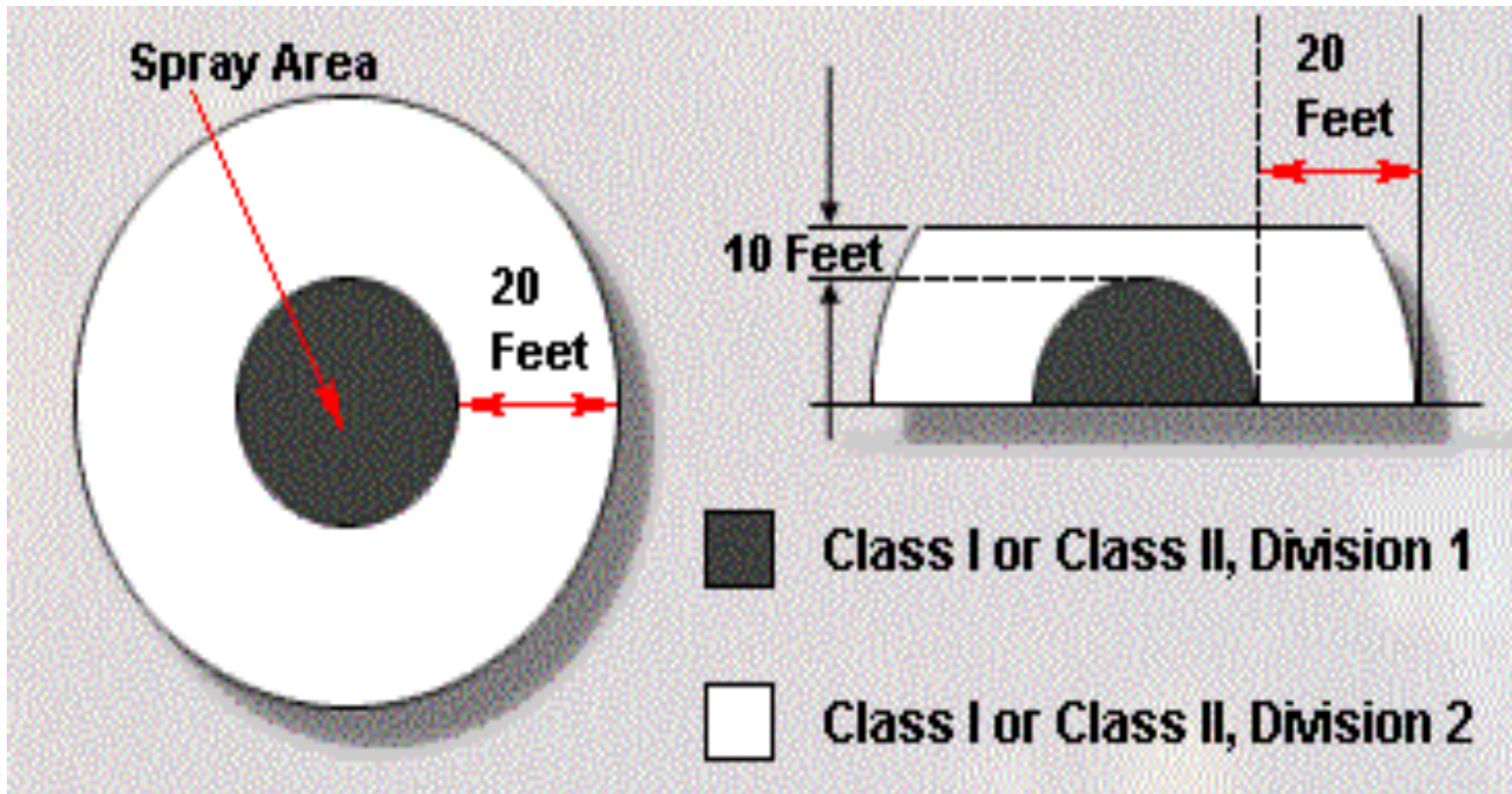
# Propane Storage

- NFPA 58
- The storage of propane in buildings is limited:
- Buildings frequented by the public are limited to cylinders with a propane capacity of 1 pound.
- The total quantity stored is limited to 200 pounds of propane.
- Buildings not frequented by the public are limited to a maximum quantity of 300 pounds of propane.
- The cylinder size is not restricted.





# Open Spraying Locations



# Combustible Dust Safety

Optional



# Coal Dust

- Throughout a twenty-five year (1980-2005) study of PRB coal-fired power plants, there were an average of **11 fires or explosions**, 29 injuries, and 5 deaths per year.
- Another study conducted by the United States Department of Labor during the 1996-2009 time period noted 437 workplace coal power-related deaths, averaging 33 deaths per year in the United States..



Will County Power Plant  
Crusher Building Explosion

# May 2017



- On May 31 at approximately 11 p.m., an explosion occurred at our milling operations located in Cambria, Wisconsin.
- The cause of the explosion is not known
- Corn milling
- 5 dead

# Apr 2017

- Dust collection systems must be installed which will safely capture potentially explosive aluminum fines.



Metallic dusts from grinding, sawing or cutting should be picked up by one collection system, while dusts from buffing and polishing should be picked up by a different system.

This will prevent the mixing of explosive and flammable dusts.



March 2017



# May 2017

NFPA requires that an **explosion isolation device** be installed on all suction side ducts that transport material with a KST value above zero.

KST values are used to measure the speed at which pressure rises during a standard explosion severity test.

**EcoMAXX™ No Return Valve**



# Imperial Sugar - 2008

- Feb 7, 2008
- 14 died
- 60 injured
- \$180-220 million dollar est. loss
- \$7,700,000 Fine – OSHA







# Chemical Safety Board

- From 2008 to 2012, our board documented, 50 combustible dust accidents that led to 29 fatalities and 161 injuries.



# Typical 5(a)(1) Violations

- Systems were not provided to prevent deflagration propagation from dust collectors to other parts of the plant.



**October 29, 2003 - Hayes Lemmerz  
Manufacturing Plant, IN  
Shawn Boone, 33, died in the  
Aluminum Dust explosion**

# Typical 5(a)(1) Violations

- No explosion relief venting distributed over the exterior walls and roofs of the buildings.

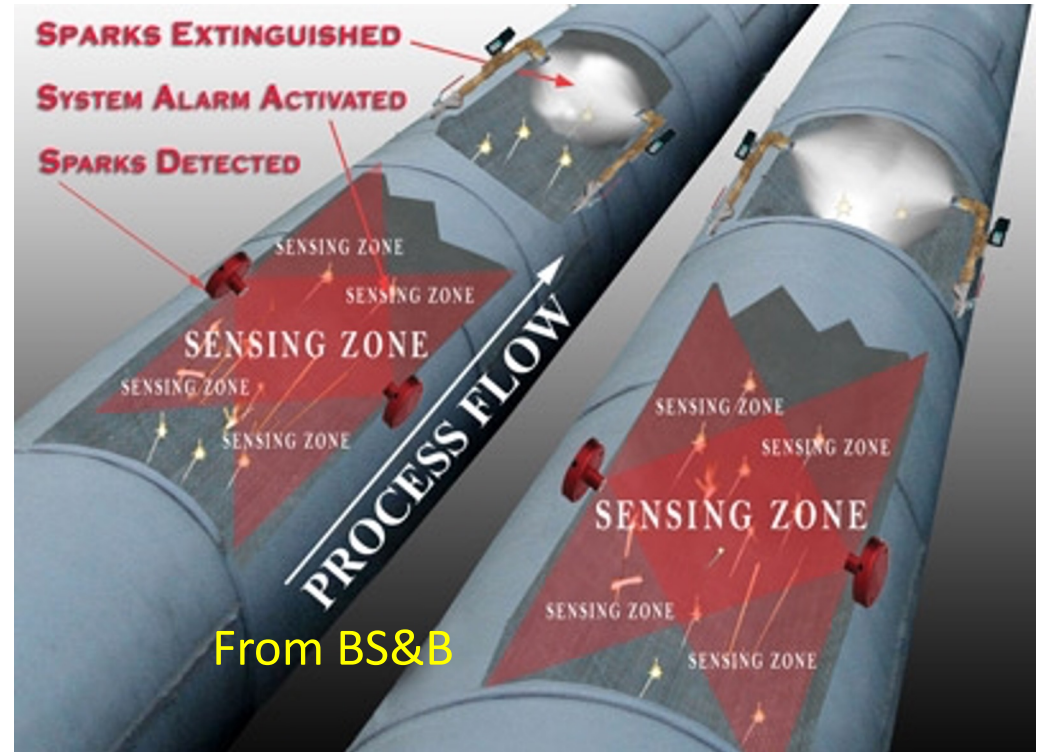


CTA Acoustics 2003 – 7 dead

Fiberglass fibers and excess phenolic resin powder probably went to the oven while workers were using compressed air and lance to break up a clogged bag house filter

# Typical 5(a)(1) Violations

- Dust Collector and ducts do not prevent propagation to other parts of the plant



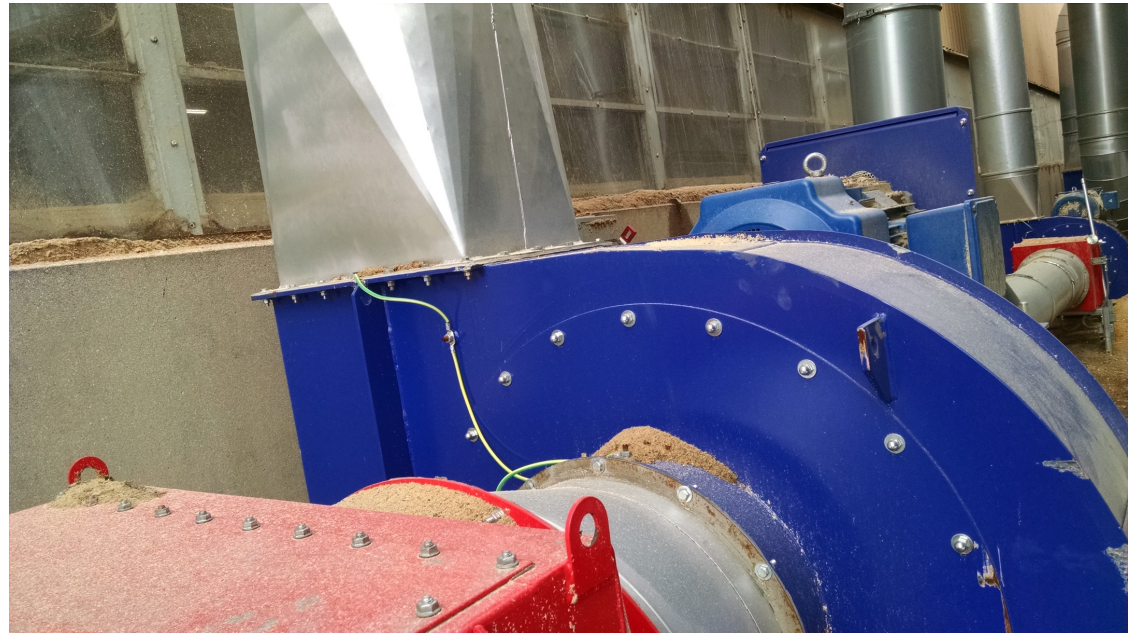
# Typical 5(a)(1) Violations

- Ducts and system were not grounded



# Grounding

All equipment used in the dust generating process must be thoroughly grounded to remove static electricity. “Recommended Practice on Static Electricity,” NFPA 77, should be followed.



Inspection and cleaning of all electrical equipment must be done regularly and frequently (at least weekly). Ground connections should be checked visually on a daily basis by the operators.

# Typical 5(a)(1) Violations

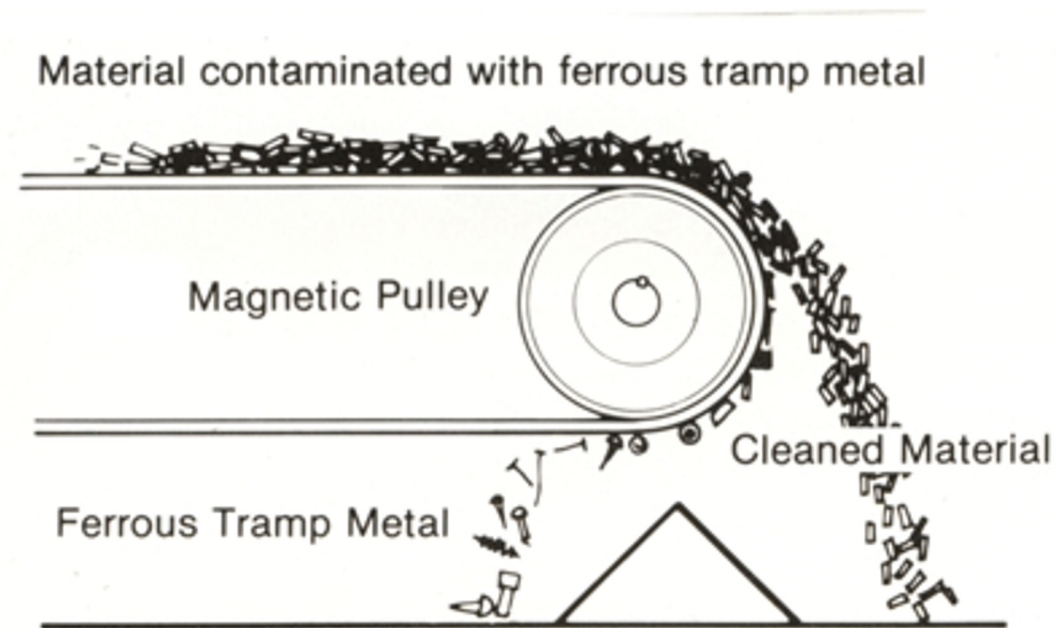
- Airborne fugitive **dust**





# Typical 5(a)(1) Violations

- A means of tramp metal protection was not provided to keep any unwanted metal fragments out of the air-material separators



From Duramag

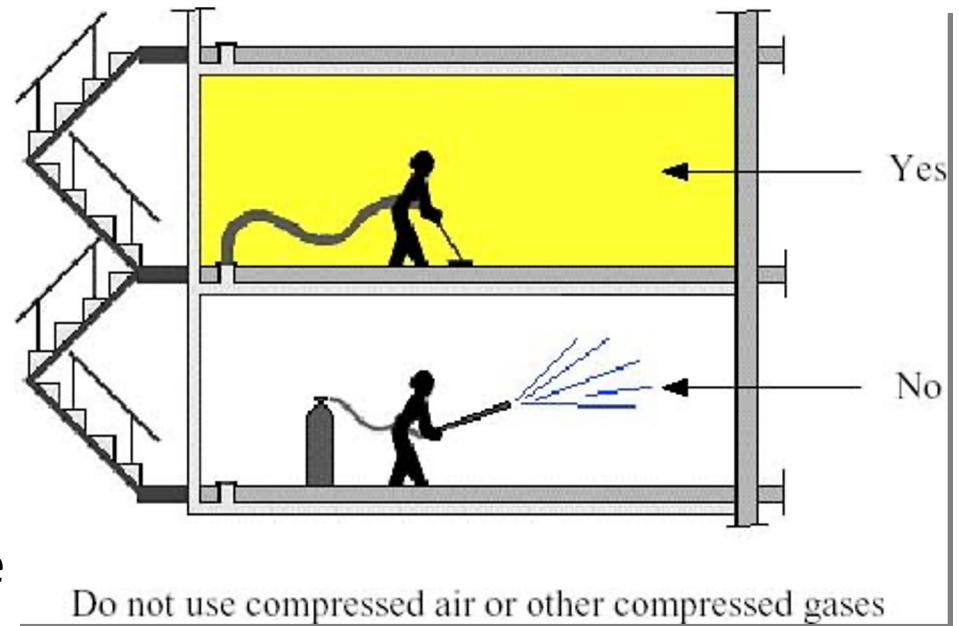
# Typical 5(a)(1) Violations

- Excessive dust
- Not cleaning per the appropriate NFPA Standard



# Typical 5(a)(1) Violations

- Compressed Air was used for cleaning
- Tip: Clean fugitive dust
  - Regular program
  - Access to hidden areas
  - Safe cleaning methods
  - Maintain dust free as possible
  - No blow down unless **All electrical** power and processes have been shutdown and other means cannot work.
- See NFPA



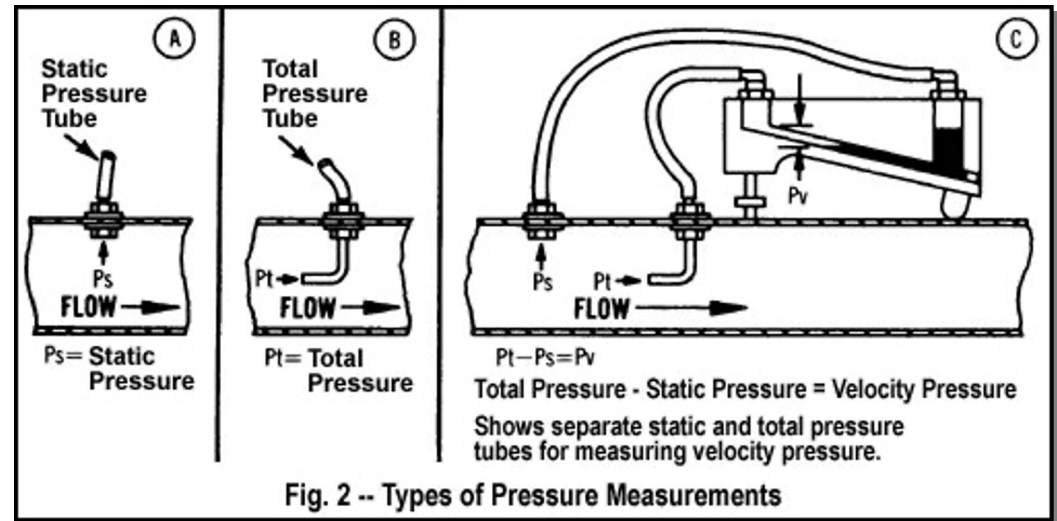
# Typical 5(a)(1) Violations

- No PVC or nonconductive ducts



# Typical 5(a)(1) Violations

- Not maintaining duct velocity
- Aluminum Conveyor velocity might be 4500 ft/min for pneumatic conveyors



# How Much Dust is too Much?

Reference	Thickness and Caveats
NFPA-654	1/32" @ 75 lb/ft <sup>3</sup> , Adjusted for Lower Bulk Density
NFPA-664	1/8", Assumes 20 lb/ft <sup>3</sup> Bulk Density
NFPA-484	Does Not Allow Accumulation, Infers Daily Cleaning Schedule
NFPA-61	Remove Concurrently with Operations, Refers to 654; OSHA 1910.272 for grain handling facilities used 1/8"
OSHA Grain Dust	1/8"
OSHA Dust NEP	1/32"

- **Current allowances are based on layer thickness**

$$\text{Allowable Thickness (in.)} = \frac{(1/32") \left( 75 \text{ lb/ft}^3 \right)}{\text{bulk density (lb/ft}^3)}$$

- **Layer thickness is not the primary parameter**
- **Explosible Cloud mass decides the consequences**

# NFPA References

- 654 General
- 664 Wood
- 61 Agriculture
- 484 Metal
- 850 Coal Power Plants
- 70 National Electric Code
- 499 Classification of Combustible Dust
- 68 Deflagration Venting Systems
- 69 Explosion Prevention Systems
- 91 Exhaust Systems
- 2113 Flame Resistant Clothing