OSC | 10
Ohio Safety Congress & Expo

Combustible dust hazards and OSHA's National Emphasis Program

133

Howard Eberts and Tom Kling

Thursday, April 1, 2010 10:30 to 11:30 a.m.

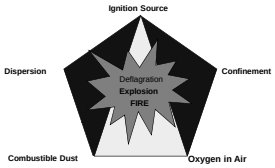
Continuing Nursing Education Disclosures

- **Goal:** To educate conference attendees on specific aspects of accident prevention and Ohio's workers' compensation system
- **Learning objectives:**
  - Identify hazards associated with combustible dust in the workplace.
  - Identify methods to mitigate the hazards associated with combustible dust in the workplace. .
  - Indentify the basic components of OSHA's combustible dust enforcements initiative and the results to date.
- **Criteria for Successful Completion:** Attend the entire event and complete a session evaluation.
- **Conflict of Interest:** The planners and faculty have no conflict of interest.
- **Commercial Support:** There is no commercial support for this event.
- **Continuing Education:** Awarded 0.1 IACET general CEUs and 1.0 RN* contact hour.

**The Ohio BWC (OH-188/01-01-2013) is an approved provider of continuing nursing education by the Ohio Nurses Association (OBN-001-91), an accredited approver by the American Nurses Credentialing Center's Commission on Accreditation.*

Combustible Dust Hazards

OSHA's National Emphasis Program



BWC Safety Congress – April 1, 2010

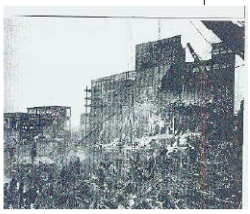
Tom Kling – Corrosion Fluid Products Corp.

Howie Eberts – OSHA Columbus Area Office

Catastrophic Combustible Dust Incidents

Corn Products Explosion

- Jan 3 1924
- 42 died
- Starch Dust
- Pekin IL
- Explosion in starch packing house.
- Dumping buggies of starch
- Low moisture due to cold.



Brach's Candy

- Sep 7, 1948
- 18 died
- Spark from electrical equipment ignited suspended starch dust
- Open storage of starch.

1970's

- Westwego, LA Grain Elevator Explosion, Dec 1977
- Spark ignited grain dust.
- The explosion killed 36 people.

Combustible Dust Explosions History

- Ford River Rouge:
- Secondary
- Coal Dust Explosion
- February 1, 1999
- Killed six workers and injured 36

Combustible Dust Explosions History

Jahn Foundry
Springfield, MA
February 26, 1999
3 dead
9 Injured
Phenolic resin dust

Combustible Dust Explosions History

May 16, 2002
Rouse Polymerics
Vicksburg, MS
5 dead, 7 injured
Rubber Dust

Combustible Dust Explosions History

- January 29, 2003 - West Pharmaceutical Services, Kinston, NC
  - Six deaths, dozens of injuries
  - Plastic powder accumulated above suspended ceiling ignited

West Pharmaceutical facility destroyed by polyethylene dust

Combustible Dust Explosions History

- February 20, 2003 – CTA Acoustics Corbin, KY
  - Seven Workers died
  - Facility produced fiberglass insulation for automotive industry
  - Resin accumulated in production area and was ignited

Imperial Sugar – Savannah, GA February 7, 2008

- **National News Release: 08-1018-NAT**
  July 25, 2008
  Contact: Office of Communications
  Phone: 202-693-1999

- **Federal OSHA issues third largest fine in history following sugar refinery explosion**
- **SAVANNAH, Ga.** -- The Occupational Safety and Health Administration (OSHA) today issued citations proposing penalties totaling **$8,777,500** against the Imperial Sugar Co. and its two affiliates alleging violations at their plants in Port Wentworth, Ga., and Gramercy, La. OSHA initiated the inspections following an explosion and fire on Feb. 7, 2008, at the Port Wentworth refinery that claimed the lives of 13 employees and hospitalized 40 others. Three employees still remain hospitalized. The proposed penalties against Imperial Sugar represent the third largest fine in the history of OSHA.

- **National News Release: 08-1018-NAT**
  July 25, 2008
  (cont.)

- OSHA's inspections of both facilities found that there were large accumulations of combustible sugar dust in workrooms, on electrical motors and on other equipment. The investigation also determined that officials at the company were well aware of these conditions, but they took no action reasonably directed at reducing the obvious hazards.

Dust Incidents, Injuries & Fatalities 1980 - 2005

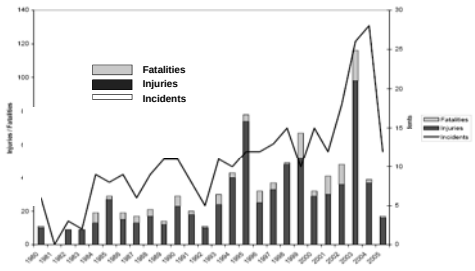


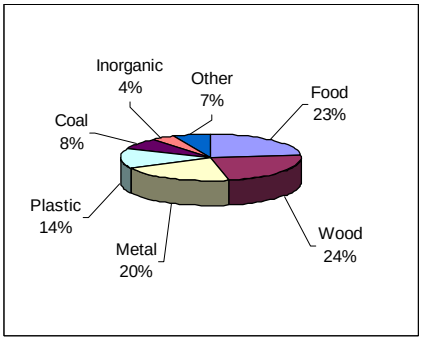
Figure 11. Dust incidents, injuries, and fatalities, 1980-2005

Source: CSB

CSB Recommendations To OSHA

1) Issue a standard
2) Clarify that the HCS covers combustible dusts
3) Amend the Globally Harmonized System (GHS) to address combustible dust hazards
4) Provide training on recognizing and preventing combustible dust explosions.
5) Implement a National Special Emphasis Program (SEP) on combustible dust hazards in general industry

Types of Dust Involved in incidents



19

Equipment Involved in Dust Explosions

Material	US (1985 – 1995)		UK (1979 – 1988)		Germany (1965 – 1980)	
	Number of Incidents	%	Number of Incidents	%	Number of Incidents	%
Dust Collectors	156	42	55	18	73	17
Grinders	35	9	51	17	56	13
Silos/Bunkers	27	7	19	6	86	13
Conveying Systems	32	9	33	11	43	10
Dryer/Oven	22	6	43	14	34	8
Mixers/Blenders	>12	>3	7	2	20	5
Other or Unknown	84	23	95	31	114	27
Total	**372**	**100**	**303**	**100**	**426**	**100**

Source: Guidelines for Safe Handling of Powders and Bulk Solids, CCPS, AICHE

OSHA NEP


OSHA INSTRUCTION

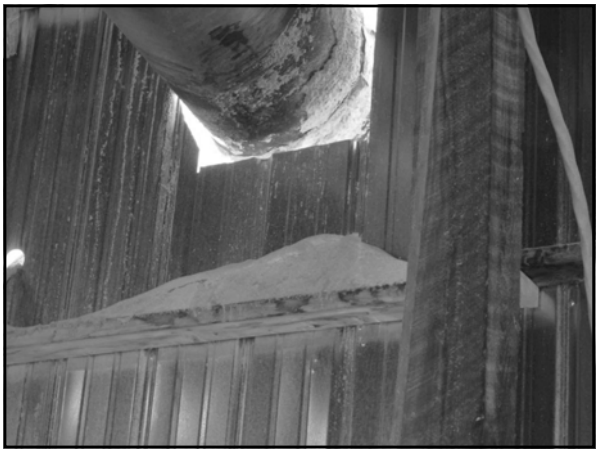
U.S. DEPARTMENT OF LABOR Occupational Safety and Health Administration

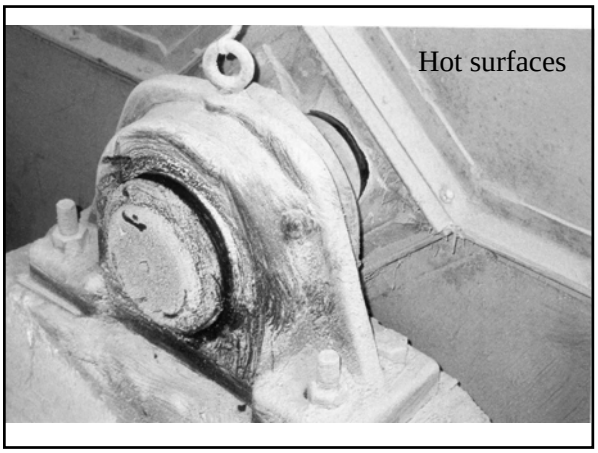
DIRECTIVE NUMBER: CPL 03-00-008 EFFECTIVE DATE: 3/11/08

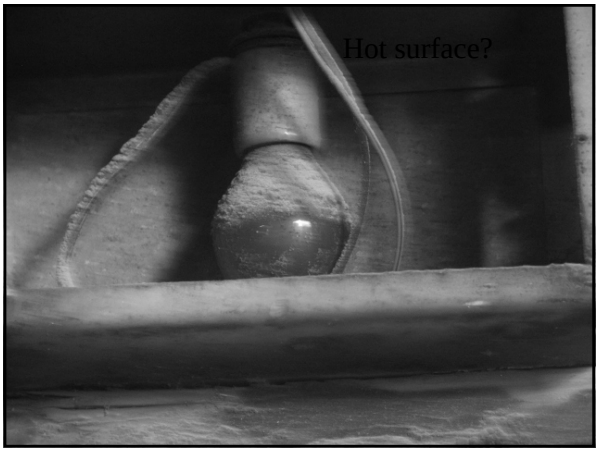
SUBJECT: Combustible Dust National Emphasis Program (Retroed)

ABSTRACT

Sometimes we can't see the forest for the trees







NEP/ Industry Application

- Food products
- Agriculture
- Chemicals
- Textiles
- Forest and furniture products
- Metal processing
- Tire and rubber manufacturing plants
- Paper products
- Pharmaceuticals
- Wastewater treatment
- Recycling operations (metal, paper, and plastic)
- Coal dust in coal handling and processing facilities

Inspections Conducted

- **446 Inspections**
- **300+ planned for next year**
- **Over 6.6 violations per Inspection**
- **78% Serious**
- **$1116 penalty per Serious**

Primary Applicable OSHA Standards

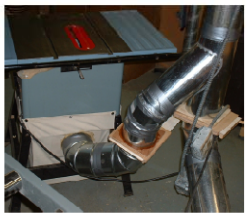
- 1910.22 General – Housekeeping
- 1910.307 Hazardous (Classified) Locations
- 1910.178 Powered Industrial Trucks
- 1910.263 Bakery Equipment
- 1910.265 Sawmills
- 1910.272 Grain Handling
- General Duty Clause

Combustible Dust Violations

- Housekeeping violations
- 5(a)(1) Violations
- Electrical Violations

Typical 5(a)(1) Violations

- Dust collectors inside
- No proper explosion protection systems such as explosion venting or explosion suppression systems.



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
Two severely burned (one of the victims died)

Typical 5(a)(1) Violations

- Excessive dust accumulations in Rooms
- 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 cogged 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

Typical 5(a)(1) Violations

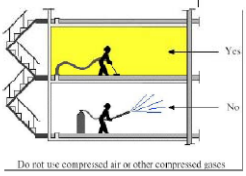
- Airborne fugitive **dust**

Typical 5(a)(1) Violations

- Excessive dust

Typical 5(a)(1) Violations

- Compressed Air for cleaning



Typical 5(a)(1) Violations

- No PVC or nonconductive ducts

The Future

- 300+ Inspection
- MSDS revisions
- Less explosions
- More eyes and awareness – insurance, S&H professionals, media,
- Debate on a standard
- More Employer Self-assessment

Hazard Mitigation

- Dust control
- Ignition source control
- Damage control

Dust Layer Thickness Guidelines

- 1/8” in grain standard
- Rule of thumb in NFPA 654
  - 1/32” over 5% of area
  - Bar joist surface area equals about 5% of floor area
  - Max 20,000 SF
  - Idealized
- Consider point in cleaning cycle

Housekeeping

- Maintain dust free as possible
- No blow down *unless* **All** electrical power and processes have been shutdown.
- No welding, cutting or grinding *unless* under hot-work permit
- Comfort heating equipment shall obtain combustion air from clean outside source.

Ignition Source Control

- Electrical equipment
- Static electricity control
- Mechanical sparks & friction
- Open flame control
- Design of heating systems & heated surfaces
- Use of tools, & vehicles
- Maintenance

Ignition Source Control

- Electrical equipment
  - Class II, Division 1 and 2
  - Class I and Class III may also be an issue
  - Consider equipment both inside dust handling equipment and outside

Ignition Source Control

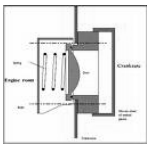
- Static electricity control
  - Grounding and Bonding are key
  - Inspection of ground and bonding means
  - Vibrating equipment (e.g., sifters) may cause fatigue failure in straps

Ignition Source Control

- Mechanical sparks & friction
- Open flame control
- Use of tools & vehicles
- Maintenance
- All require effective control of Hot Work
  - Look for permit systems

Damage Control Construction

- Detachment (outside or other bldg.)
- Separation (distance within same room)
- Segregation (barrier)
- Pressure resistant construction
- Pressure relieving construction
- Pressure Venting
- Relief valves
- Maintenance



Damage Control Systems

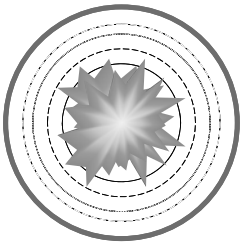
- Specialized detection systems
- Specialized suppression systems
- Explosion prevention systems
- Maintenance

What is an Explosion?

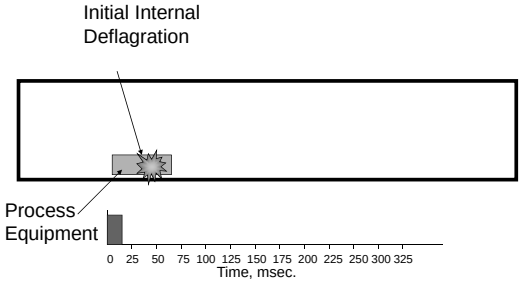
Industry Definitions

Explosion Characteristics

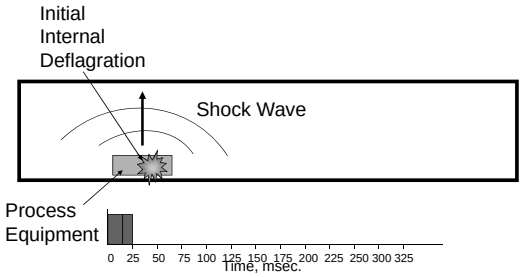
Flame and Pressure Waves (2 Components)



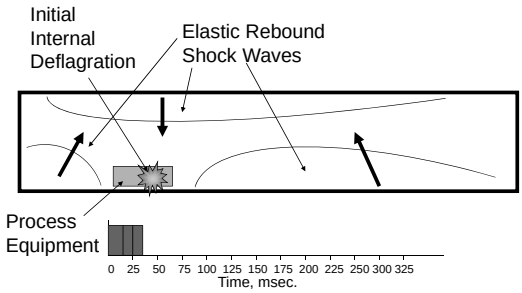
The "Typical" Explosion Event



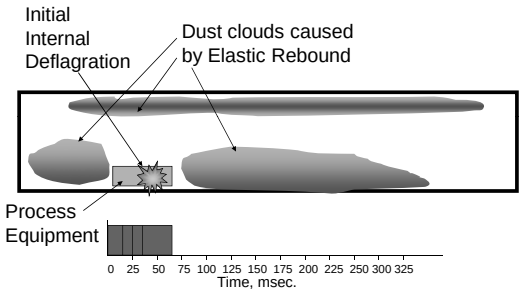
The “Typical” Explosion Event



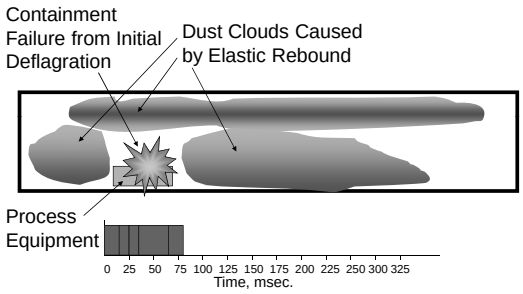
The “Typical” Explosion Event



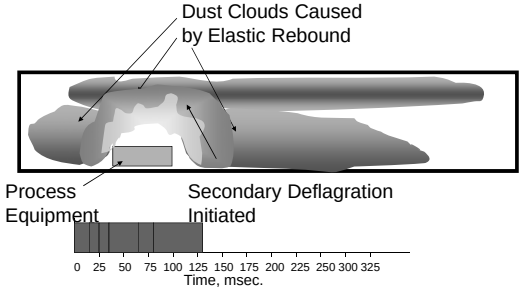
The “Typical” Explosion Event



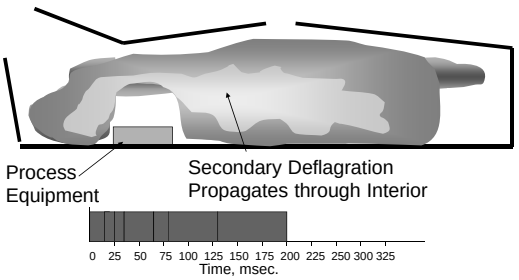
The “Typical” Explosion Event



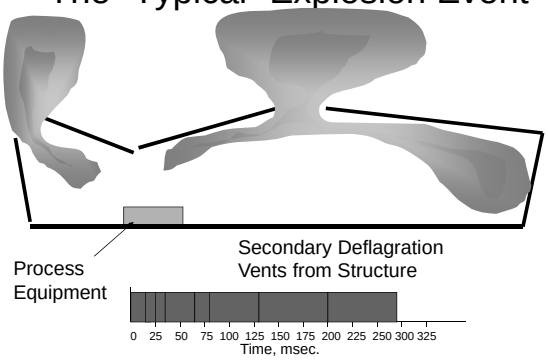
The “Typical” Explosion Event



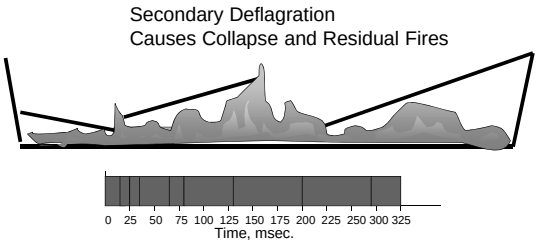
The “Typical” Explosion Event



The “Typical” Explosion Event



The “Typical” Explosion Event



Diagrams Courtesy of John M. Cholin, P.E., FSFPE, J.M. Cholin Consultants, Inc.

Explosion Ingredients

Top identified Explosion Ignition Sources

Per FM 7-76 2006

What kind of stuff explodes?

Gases & vapours **Dusts**

TESTING

NFPA 68

Chapter 6 Fundamentals of Venting of Deflagrations.

6.1.2 For dusts Kst and Pmax shall be determined in approximately spherical calibrated test vessels of at least 20 L capacity per ASTM E1226, *Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dusts.*

Chapter 8 Venting of Deflagrations of Dust and Hybrid Mixtures

8.1.2.2 When the actual material is available, the Kst shall be verified by testing.

Current NFPA Documents

- NFPA-654 **2006** Standard for the Prevention of Fire & Dust Explosions from the Manufacturing, Processing & Handling of Combustible Particulate Solids
- NFPA-61 **2008** Standard for the Prevention of Fires and Dust Explosions in the Agricultural and Food Processing Industries
- NFPA-664 **2007** Prevention of Fires and Explosions in Wood Processing and Woodworking Industries

Explosivity Index or Deflagration Index for Dust

Kst = bar – m/sec

1bar-m/sec = 47.6 psi - ft/sec

Calculation of Kst

$K = (dP/dt)_{max} \times V^{1/3}$

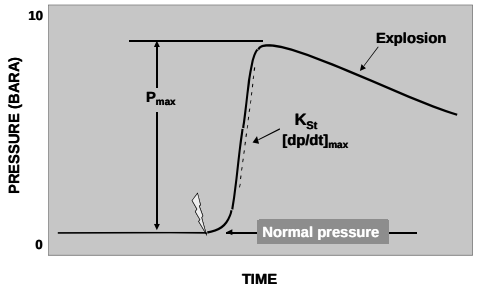
Maximum Pressure

P_{max} (bar)

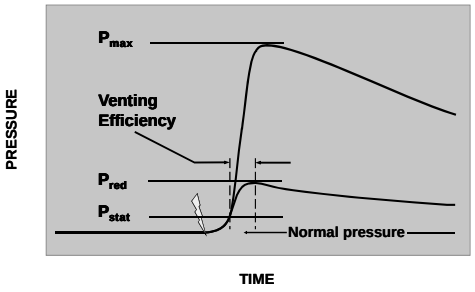
The maximum pressure developed in a confined deflagration of an optimum mixture.

(maximum explosion pressure)

Explosion Pressure Curve



Vented Explosion



Explosion Protection

- Containment
- Explosion Vents
- Explosion Suppression
- Explosion Isolation

Containment

- If the vessel is capable of withstanding the pressure generated, P_{max} during a deflagration, it is perfectly fine to contain the explosion. Attention must be paid to the spread of the explosion, however.

Explosion Venting

- Venting is the most widely used form of explosion protection, it is relatively inexpensive and requires almost no maintenance.

Caution!

The sizing requirements have been recalculated in the newest NFPA 68.

Many if not most, dust collectors purchased used are not fitted with the proper size vents!

A Different Look at Venting

Explosion Vent in Slow Motion

Flame Front

Flame discharge length

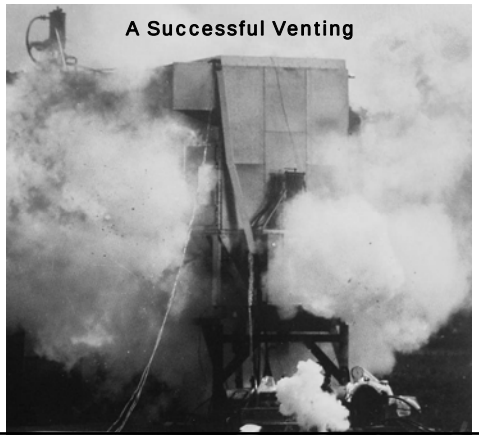
(Assuming 1 vent, agricultural dust)

- $D=K \times (V/n)^{1/3}$

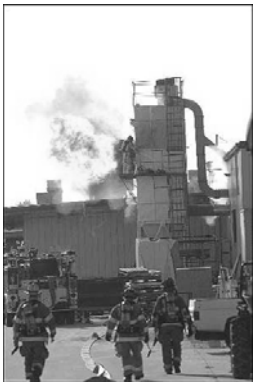
- 1 m3 vessel = 8 m (26 ft)
- 2 m3 vessel = 10 m (33 ft)
- 5 m3 vessel = 13.68 m (45 ft)
- 25 m3 vessel = 23.36 m (76 ft)

Where 'K' = 10 for metal dusts, and 8 for chemical or agricultural dusts, and 'n' = number of evenly distributed Explosion Vents.

D is limited to 60 m max.



Expect a serious fire after venting



VENTING SUMMARY

ADVANTAGES

- Relatively inexpensive
- Easy to install or replace
- Low or no maintenance
- Passive system

CONSIDERATIONS

- Releasing pressure does not put out the flame. Flame, pressure and unburned products will exit through the vent and may cause further damage or injury.
- Toxic products may be dispersed into the atmosphere.
- Flame and Pressure propagation through connecting lines ***should be expected***
- A serious fire afterwards ***should be expected***

Explosion Isolation

Reminder ……

From 1979 to 1981, the (NAS) **Panel on Causes and Prevention of Grain Elevator Explosions** investigated **14** grain elevator explosions in USA.

of the 14 primary explosions… ***12***

were followed by ***secondary explosions*** - which generally caused most of the resulting damage.

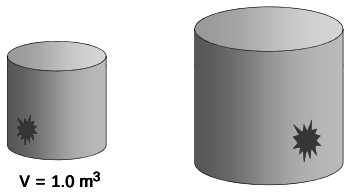
NFPA-68 2007
Annex A.8.10

Without successful isolation or venting of the interconnection, vent areas calculated…can be inadequate. can give insufficient vent area

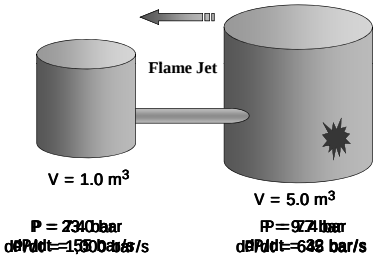
NFPA-69 2002
Para 9-1.1

- 9-1.1) The technique for deflagration isolation shall be permitted for interruption or mitigation of flame, deflagration pressures, pressure piling, and flame jet ignition between equipment interconnected by pipes or ducts.

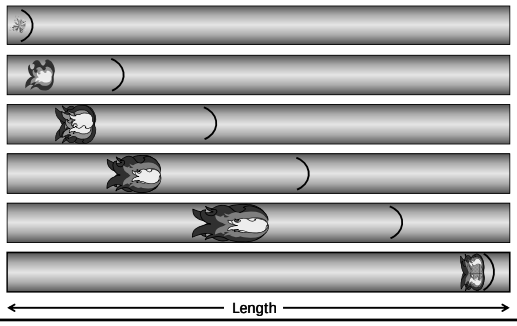
Explosions in Interconnected Enclosures



Explosions in Interconnected Enclosures



Deflagration to Detonation
Pipeline Propagation



- ..\Explosion Videos\Flame Propigation in Pipe.MOV
- ..\Explosion Videos\Flame in Pipe Turbulance.MOV

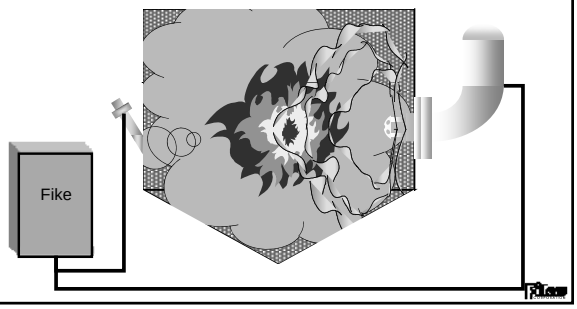
Propagation

Explosion Suppression

INSTEAD OF **Venting**…

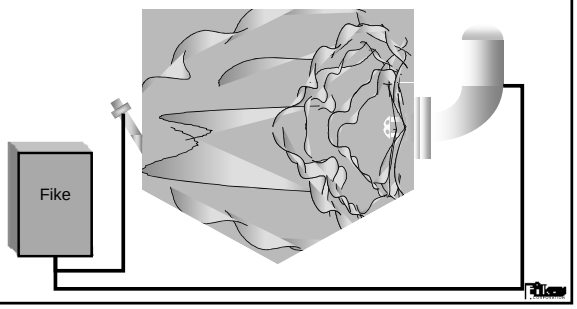
Injection

Suppression agent released through dispersion nozzle.



Suppression

Container continues to release agent. Explosion is suppressed.
Response time is measured in Milliseconds

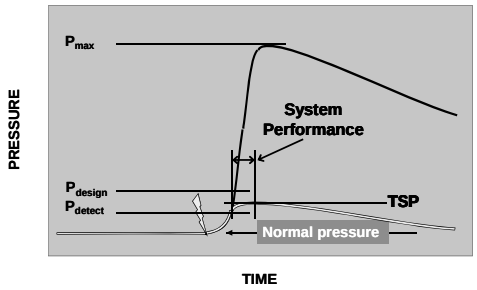


Suppression Concept

- The heat of combustion develops pressure.
- Upon pressure detection, sufficient suppressant agent is dispersed into the protected volume.
- Flame is quenched which prevents any further pressure increase.
- Flame, pressure and unburned mixture are contained inside the vessel

Suppression

Suppressed Explosion



Definition of **"TSP"** *(Total Suppressed Pressure)*

TSP is the sum of:

Most Fike Suppression Systems involve TSP's of about <u>3.0</u> psig

Explosion Suppression

ADVANTAGES

- Process media is contained
- Chemical Isolation prevents secondary explosions
- Can be used inside buildings - near personnel -
- Almost eliminates possibility of ensuing fire (after initial deflagration)
- Can provide automatic process shutdown

CONSIDERATIONS

- Active system
- Requires regular maintenance

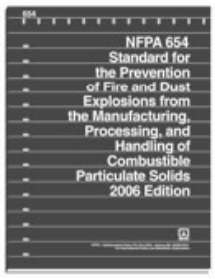
Resources

Safety and Health Information Bulletin

- Purpose
- Background
- Elements of a Dust Explosion
- Facility Dust Hazard Assessment
- Dust Control
- Ignition Control
- Damage Control
- Training
- References

NFPA Standards – Dust Hazards

- 654 General
- 664 Wood
- 61 Agriculture
- 484 Metal



NFPA Standards – Electrical & Systems

- 70 National Electric Code
- 499 Classification of Combustible Dust
- 68 Deflagration Venting Systems
- 69 Explosion Prevention Systems
- 91 Exhaust Systems