Combustible Dust

Objectives

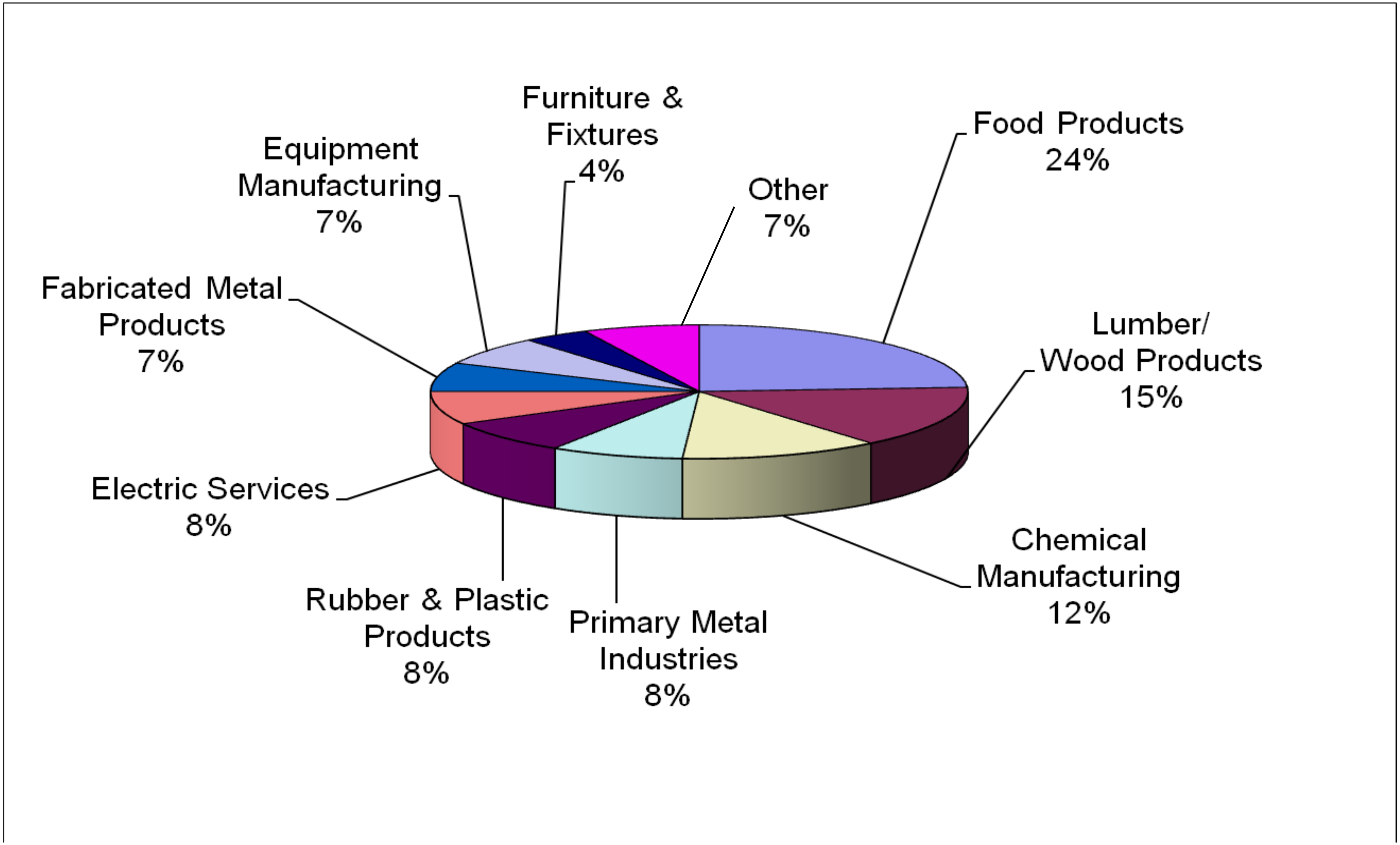
- In this course, we will cover:
  - Dust versus combustible dust
  - Industries with combustible dust
  - Management of combustible dust areas
  - Applicable occupational safety and health standards
  - Case studies

From 1980 to 2005

- 281 combustible dust fires and explosions in general industry
  - 44 different states affected
  - 119 workers killed
  - 718 injured
  - Seven of the explosions were catastrophic, involving multiple fatalities and a significant community economic impact

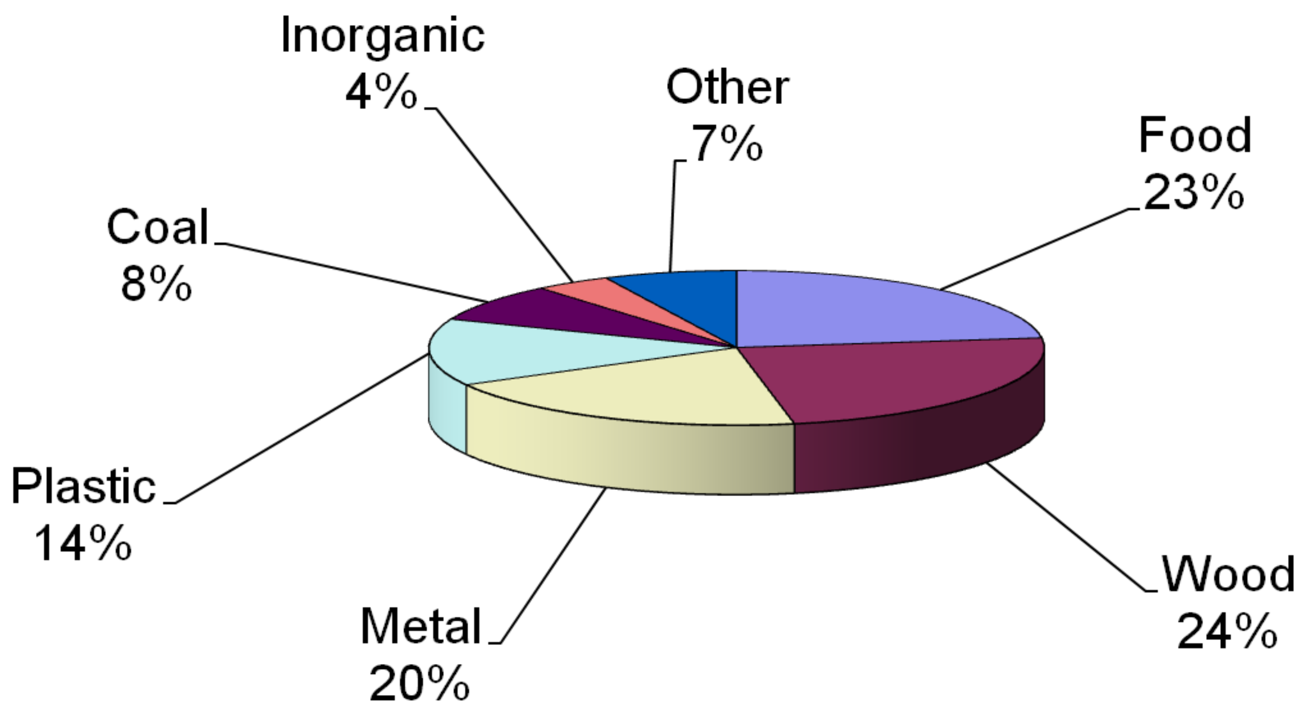
Source: CSB Report 2006-H-1

Industries Where Dust Incidents Occurred



Source: CSB Report 2006-H-1

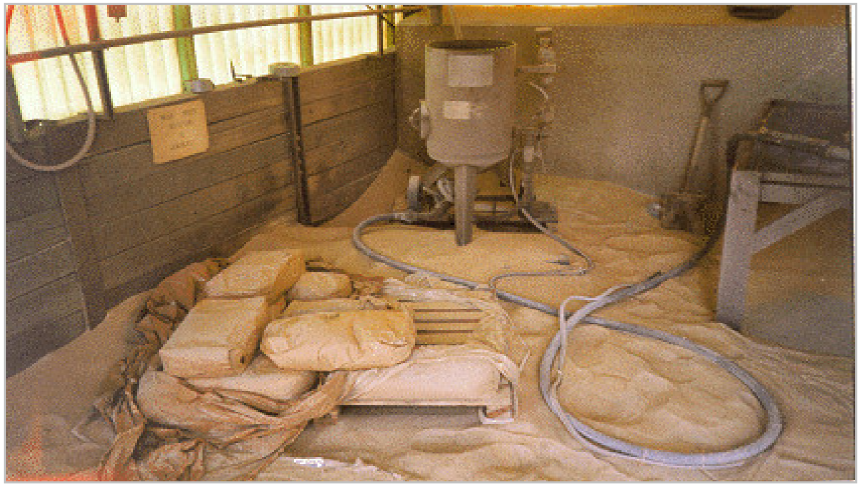
Types of Dust Involved in Incidents



Source: CSB Report 2006-H-1

Definition of Dust

- "Solid particles generated by handling, crushing, grinding, rapid impact, detonation, and decrepitation of organic or inorganic materials, such as rock, ore, metal, coal, wood, and grain."



Definition of Combustible Dust (NEP)

- "A combustible particulate solid that presents a fire or deflagration hazard when suspended in air or some other oxidizing medium over a range of concentrations, regardless of particle size or shape."

Definition of Combustible Dust (NFPA 654)

- “Any finely divided solid material that is 420 microns or smaller in diameter (material passing through a No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air.”

Common Types of Combustible Dust

Agricultural Products
Egg white
Milk, powdered
Milk, nonfat, dry
Soy flour
Starch, corn
Starch, rice
Starch, wheat
Sugar
Sugar, milk
Sugar, beet
Tapioca
Whey
Wood flour

Agricultural Dusts
Alfalfa
Apple
Beet root
Carrageen
Carrot
Cocoa bean dust
Cocoa powder
Coconut shell dust
Coffee dust
Corn meal
Cornstarch
Cotton
Cottonseed
Garlic powder
Gluten
Grass dust
Green coffee
Hops (malted)
Lemon peel dust
Lemon pulp
Linseed
Locust bean gum
Malt
Oat flour
Oat grain dust
Olive pellets
Onion powder
Parsley (dehydrated)
Peach
Peanut meal and skins
Peat
Potato
Potato flour
Potato starch
Raw yucca seed dust
Rice dust
Rice flour
Rice starch
Rye flour
Semolina
Soybean dust
Spice dust
Spice powder
Sugar (10x)
Sunflower
Sunflower seed dust
Tea
Tobacco blend
Tomato
Walnut dust
Wheat flour
Wheat grain dust
Wheat starch
Xanthan gum

Carbonaceous Dusts
Charcoal, activated
Charcoal, wood
Coal, bituminous
Coke, petroleum
Lampblack
Lignite
Peat, 22%H_20
Soot, pine
Cellulose
Cellulose pulp
Cork
Corn

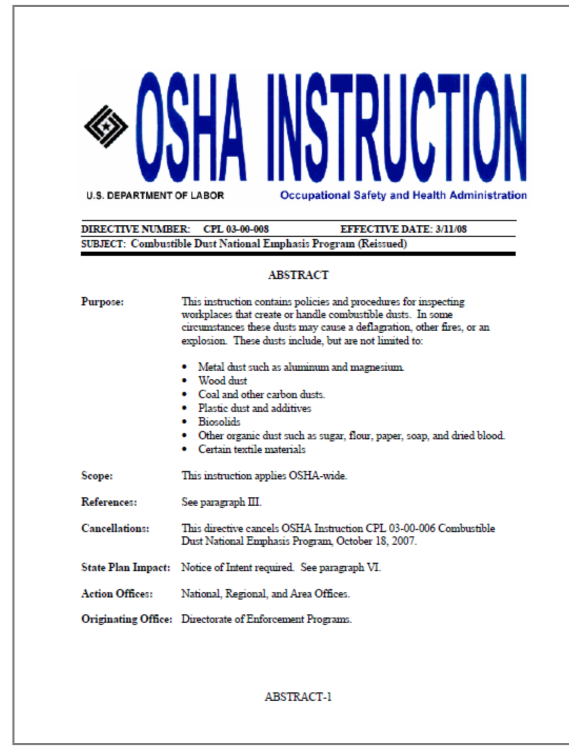
Chemical Dusts
Adipic acid
Anthraquinone
Ascorbic acid
Calcium acetate
Calcium stearate
Carboxy-methylcellulose
Dextrin
Lactose
Lead stearate
Methyl-cellulose
Paraformaldehyde
Sodium ascorbate
Sodium stearate
Sulfur

Metal Dusts
Aluminum
Bronze
Iron carbonyl
Magnesium
Zinc

Plastic Dusts
(poly) Acrylamide
(poly) Acrylonitrile
(poly) Ethylene
(low-pressure process)
Epoxy resin
Melamine resin
Melamine, molded
(phenol-cellulose)
Melamine, molded
(wood flour and
mineral filled phenol-
formaldehyde)
(poly) Methyl acrylate
(poly) Methyl acrylate,
emulsion polymer
Phenolic resin
(poly) Propylene
Terpene-phenol resin
Urea-formaldehyde/
cellulose, molded
(poly) Vinyl acetate/
ethylene copolymer
(poly) Vinyl alcohol
(poly) Vinyl butyral
(poly) Vinyl chloride/
ethylene/vinyl
acetylene suspension
copolymer
(poly) Vinyl chloride/
vinyl acetylene
emulsion
copolymer

Dust Identified in the NEP

- Dusts specifically identified in the NEP
  - Metal dusts such as aluminum and magnesium
  - Wood dust
  - Coal and other carbon dust
  - Plastic dust and additives
  - Biosolids
  - Other organic dust such as sugar, flour, paper, soap, and dried blood
  - Certain textile materials



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 (Reissued)

ABSTRACT

Purpose: This instruction contains policies and procedures for inspecting workplaces that create or handle combustible dusts. In some circumstances these dusts may cause a deflagration, other fires, or an explosion. These dusts include, but are not limited to:

- Metal dust such as aluminum and magnesium.
- Wood dust
- Coal and other carbon dusts.
- Plastic dust and additives
- Biosolids
- Other organic dust such as sugar, flour, paper, soap, and dried blood.
- Certain textile materials

Scope: This instruction applies OSHA-wide.

References: See paragraph III.

Cancellations: This directive cancels OSHA Instruction CPL 03-00-006 Combustible Dust National Emphasis Program, October 18, 2007.

State Plan Impact: Notice of Intent required. See paragraph VI.

Action Offices: National, Regional, and Area Offices.

Originating Office: Directorate of Enforcement Programs.

ABSTRACT-1

Size of Dust Particles

Common Materials	Size (Microns)
Talcum powder, fine silt, red blood cells, cocoa	5 to 10
Saw dust, ginger	25 to 600
Pollen, milled flour, coarse silt	44 to 74
Table salt	105 to 149
Coarse sand	297 to 1,000

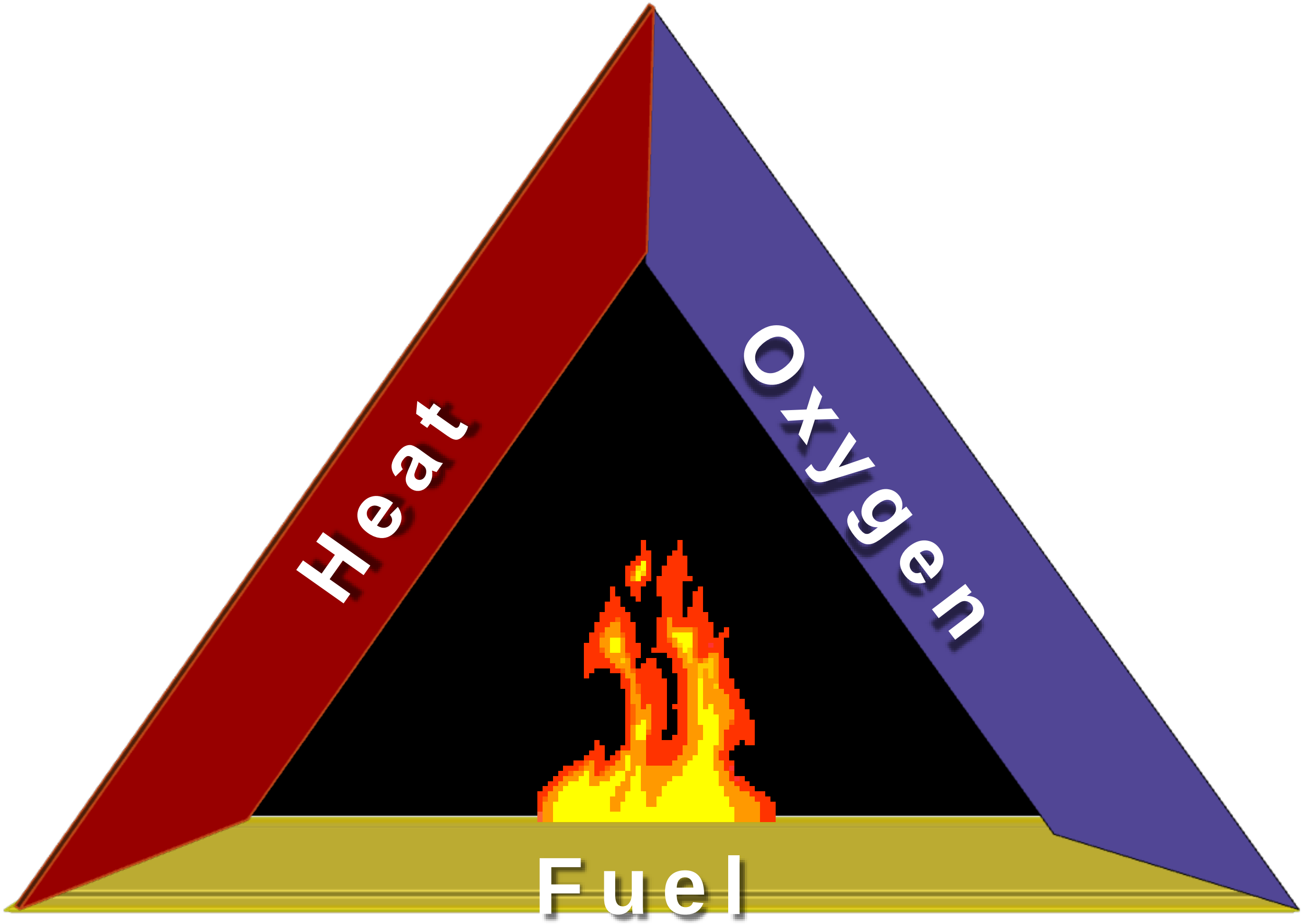
Particles may resemble: fibers, needles, flakes and sphere

Combustible Dust

- These very small particles become airborne and settle on surfaces and in crevices throughout the manufacturing area.
  - Lighting, pipes, dust collectors, other equipment

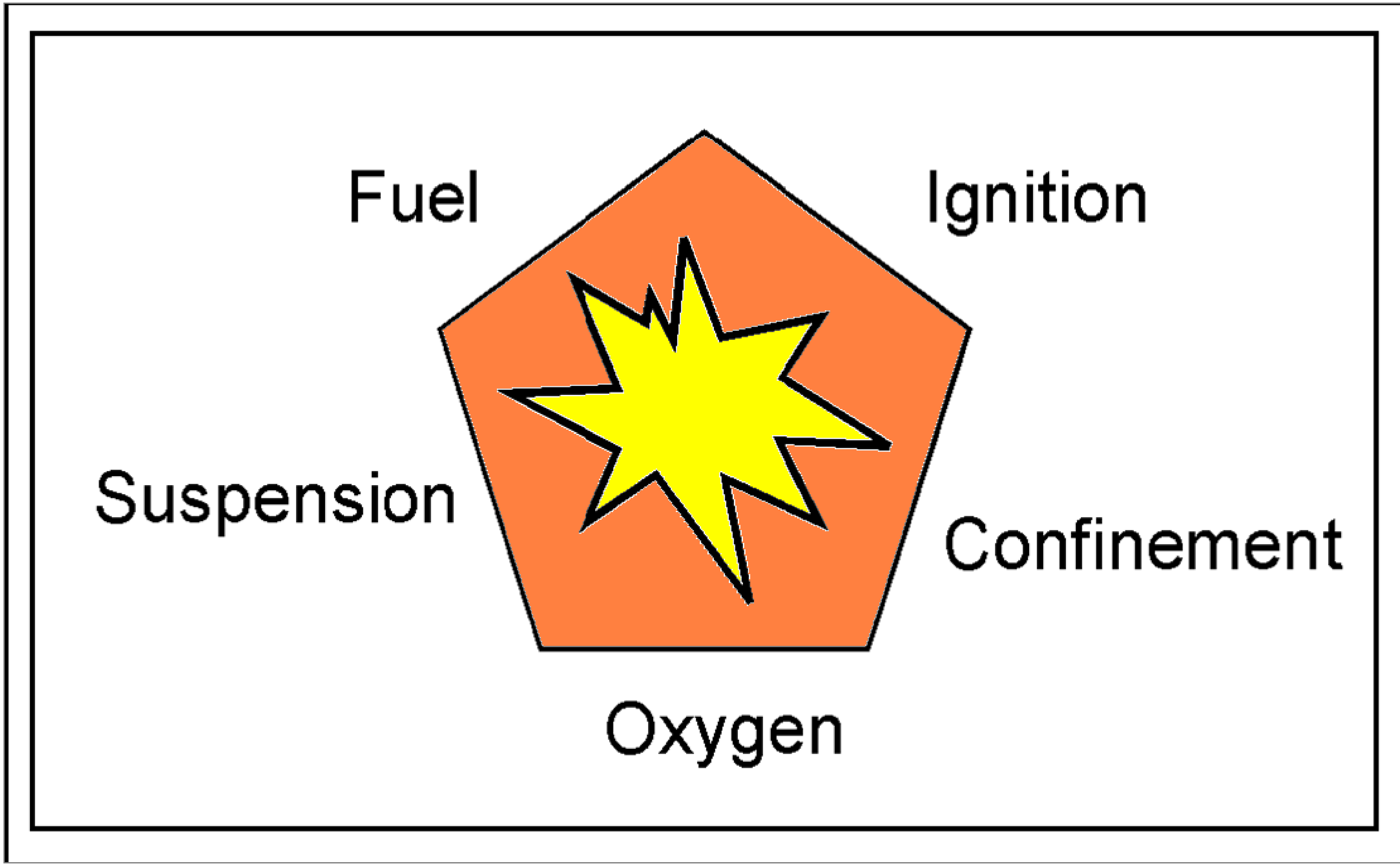
- When disturbed, they can generate potentially explosive dust clouds.

Fire Triangle



Which wood picture is likely to ignite first?

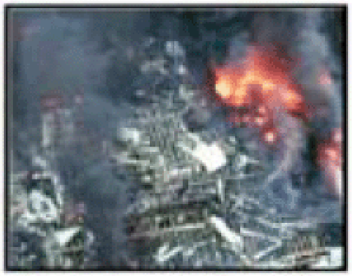
Dust Explosion Pentagon



Other NEP Definitions

- **Deflagration** – Propagation of a combustion zone at a speed that is less than the speed of sound in the un-reacted medium (vs. detonation).
  - Deflagration *isolation* and deflagration *suppression* are two associated terms.

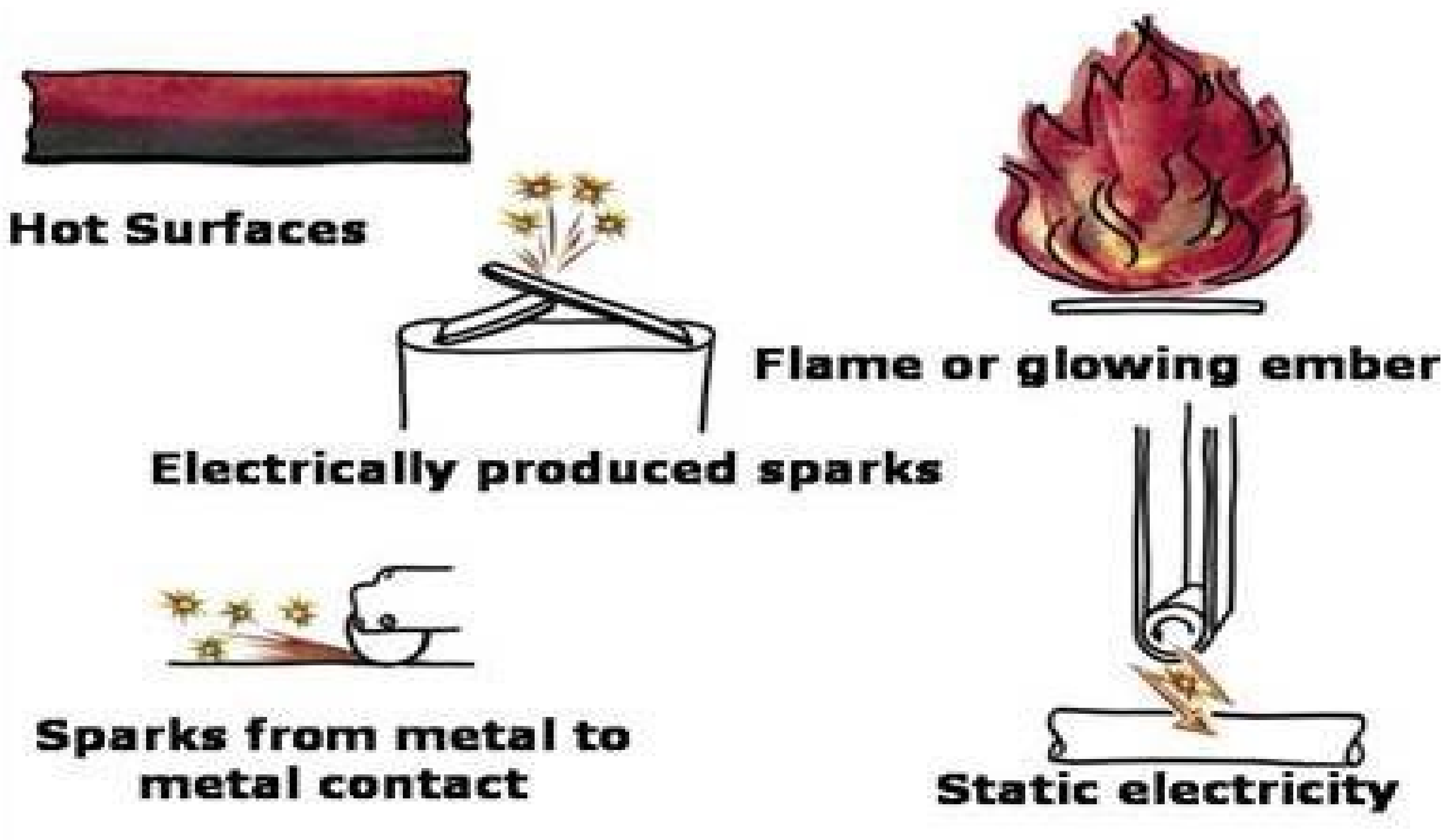
- **Explosion** – The bursting or rupture of an enclosure (including a room or building) or a container due to the development of internal pressure from deflagration.



Before a deflagration can occur ...

- Dust has to be combustible, ***and***
- Dust has to be dispersed in air or another oxidant AND the concentration must be > the minimum explosive concentration (MEC), ***and***
- There is an ignition source to ignite the mixture, such electrostatic discharge, spark, glowing ember, hot surface, friction heat, or a flame.

Ignition Sources

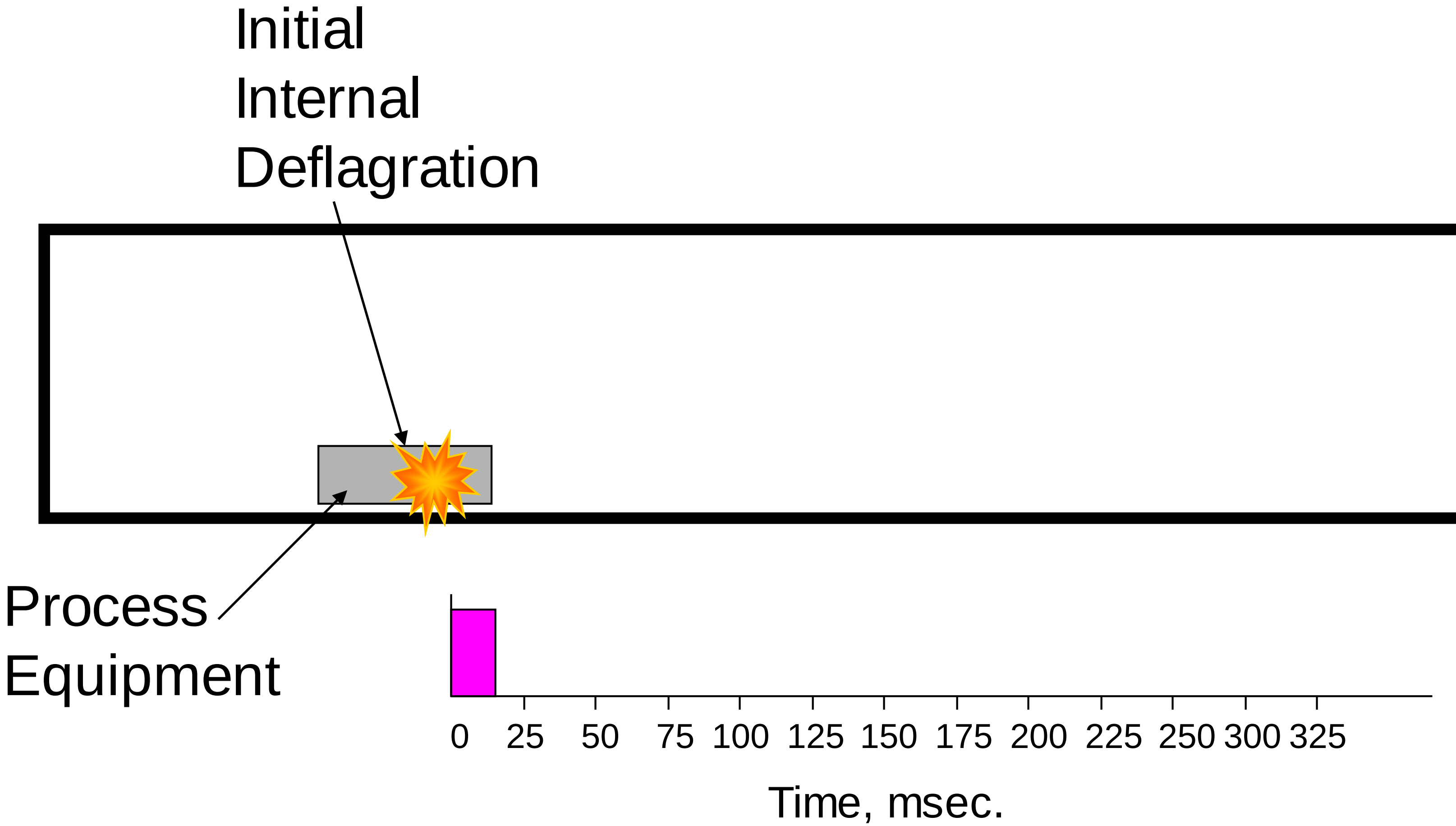


Explosion Types

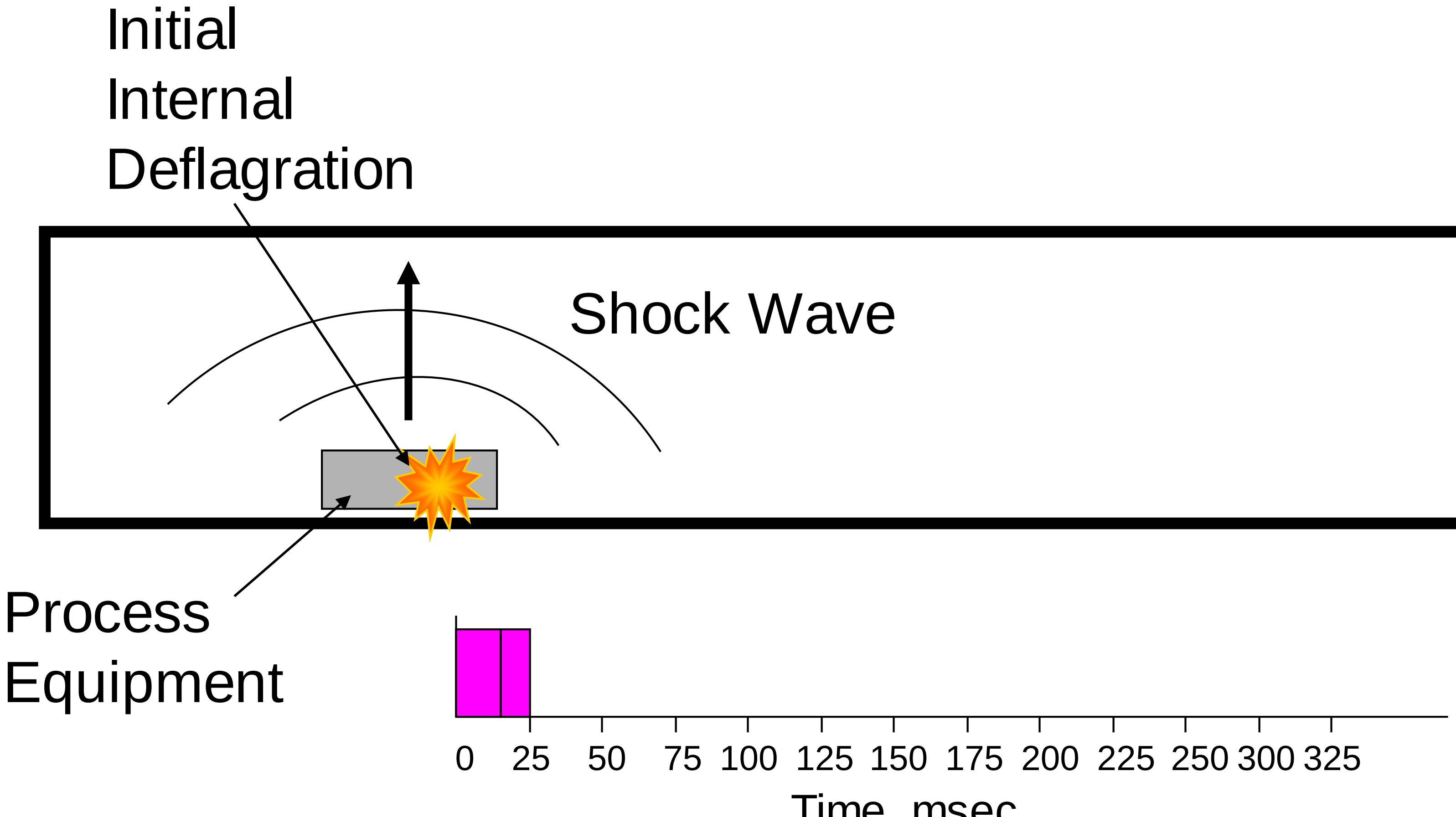
- Primary dust explosion occurs when dust suspension within container, room, or piece of equipment ignites and explodes

- Secondary dust explosion occurs when dust accumulated on floors or other surfaces is lifted into the air and ignites by primary explosion
  - Depending on the amount of dust in the area, a small deflagration or primary explosion may cause very powerful secondary dust explosions.
  - A secondary dust explosion may follow a primary non-dust explosion (e.g., natural gas or pressure vessel.)

The “Typical” Explosion Event



The "Typical" Explosion Event



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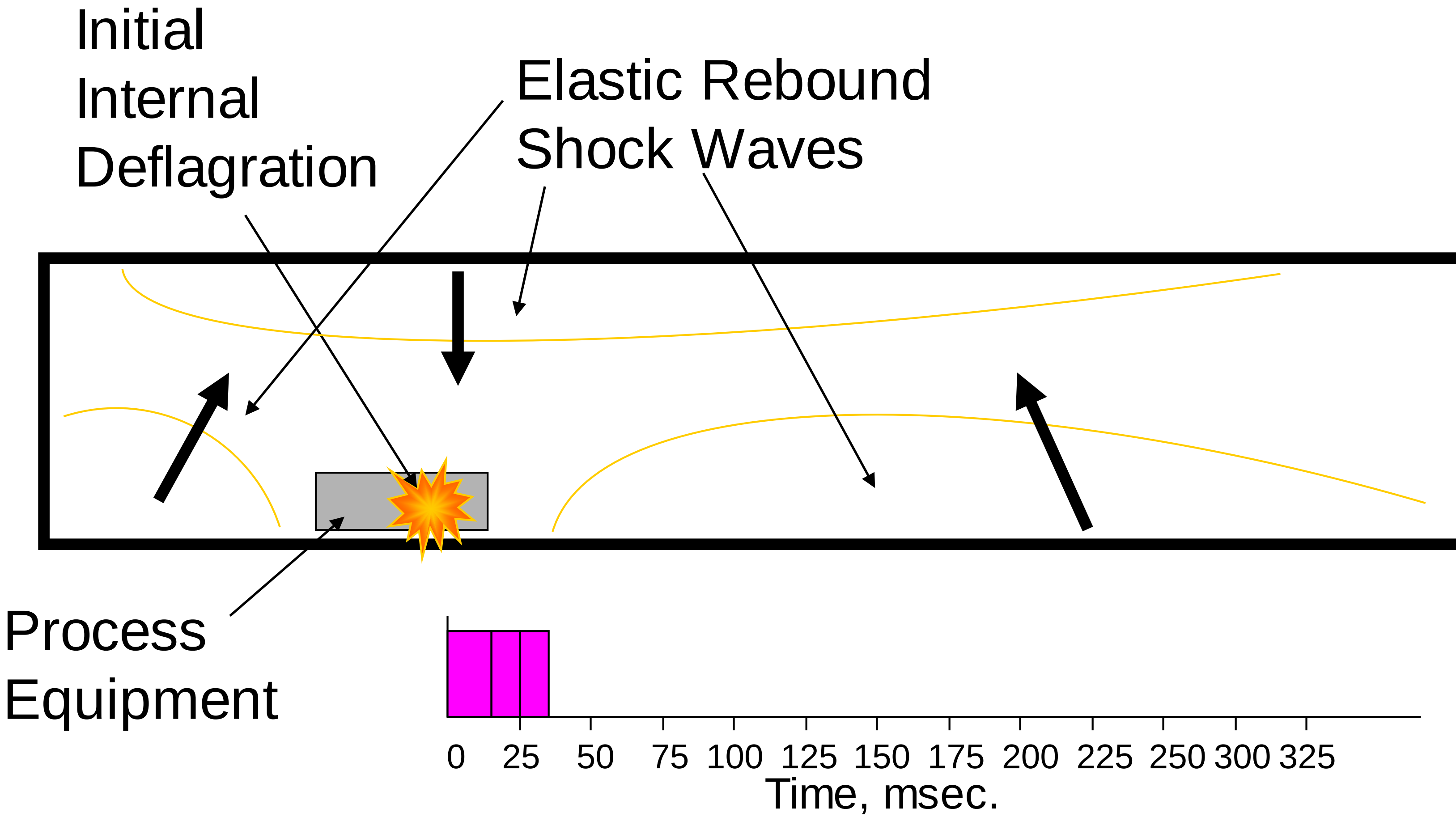

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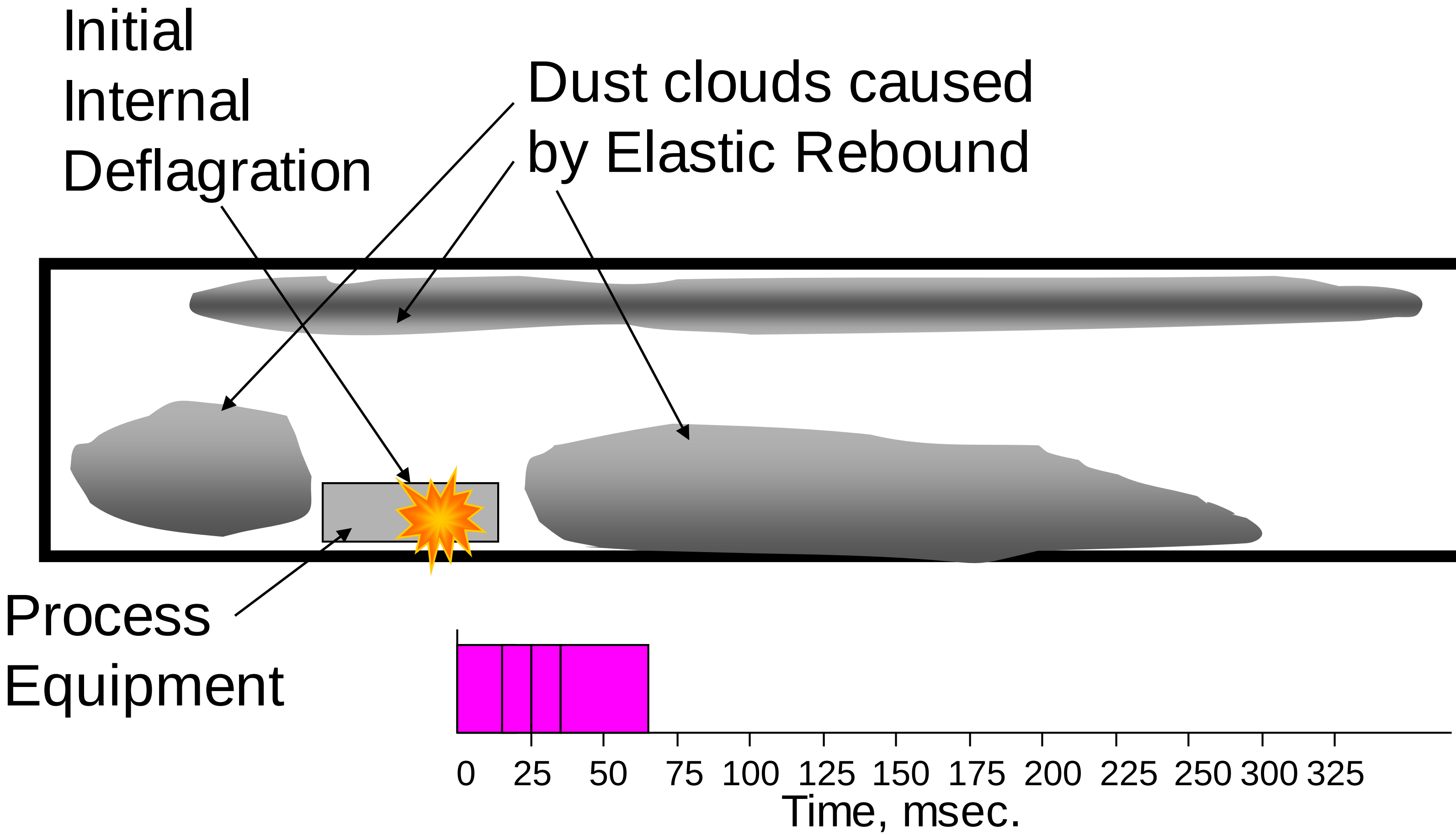
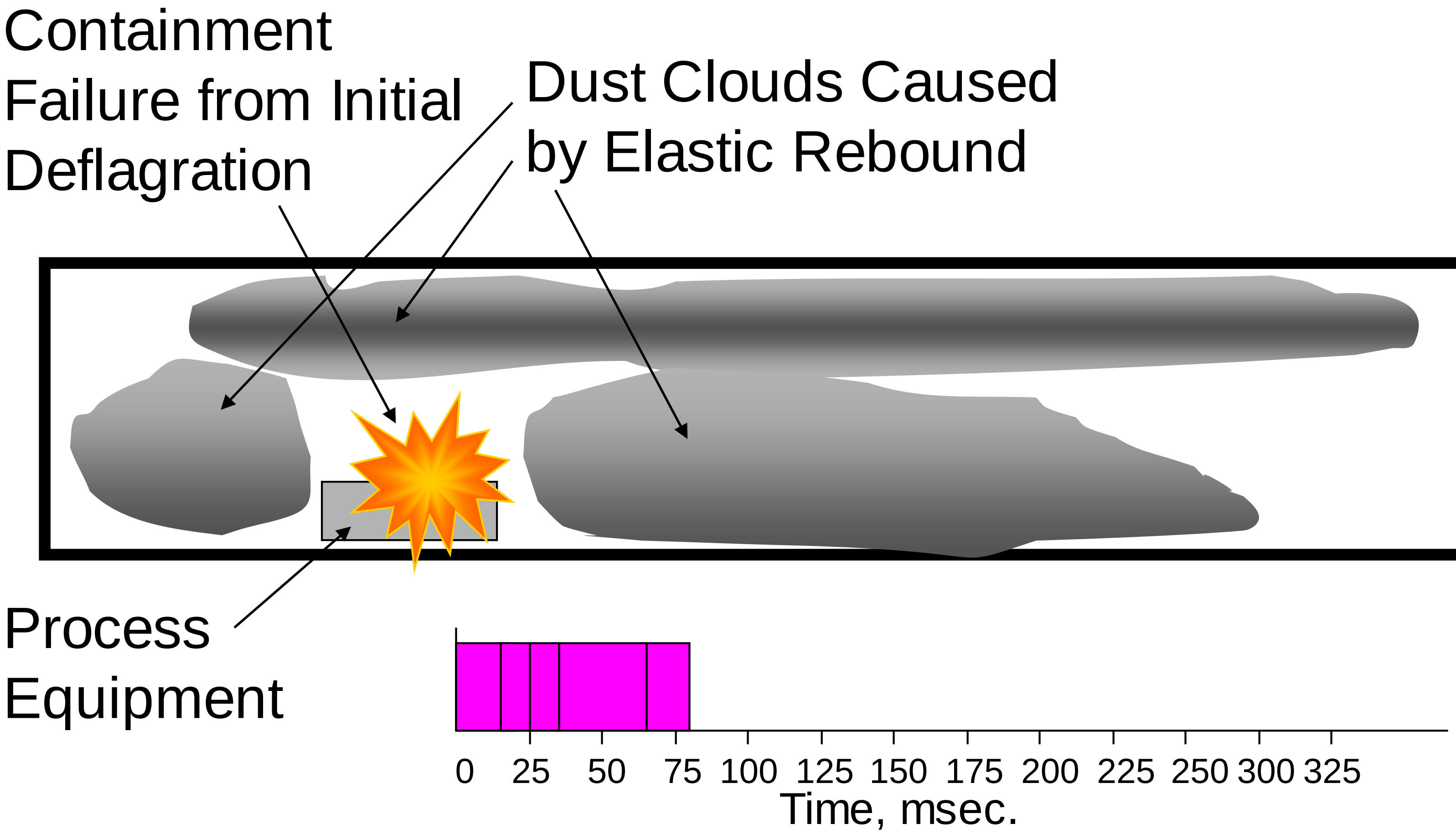
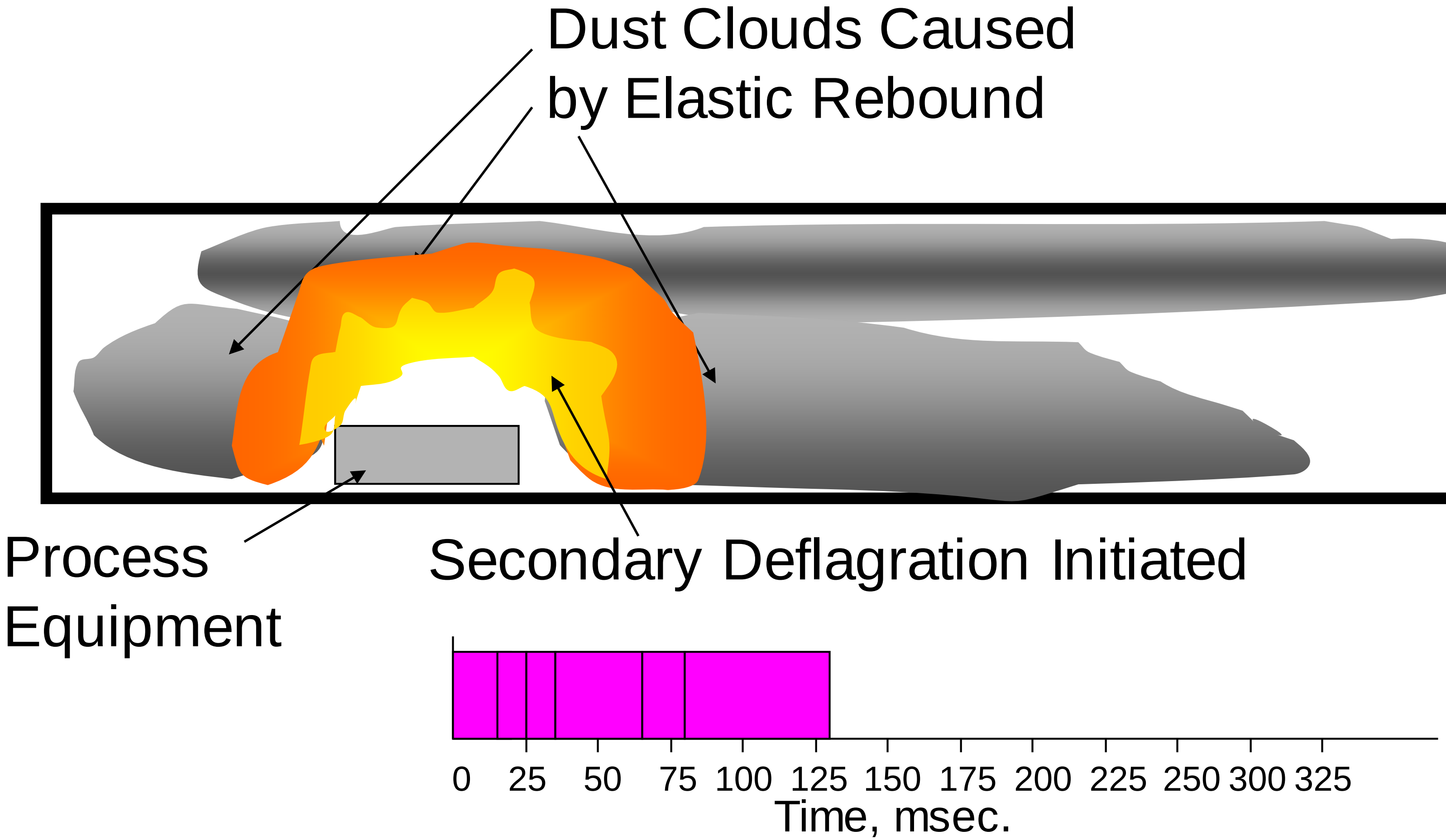


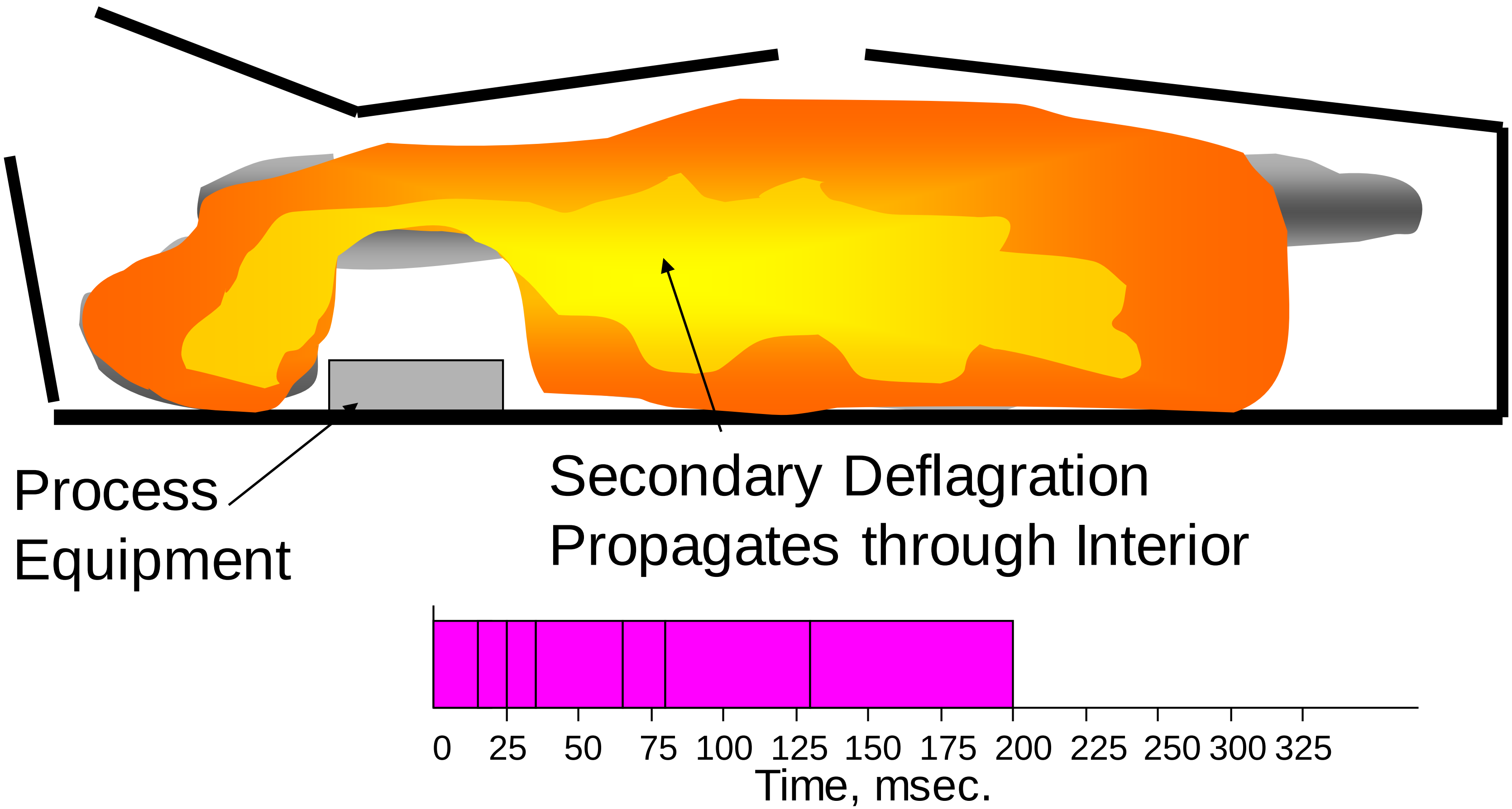
The "Typical" Explosion Event



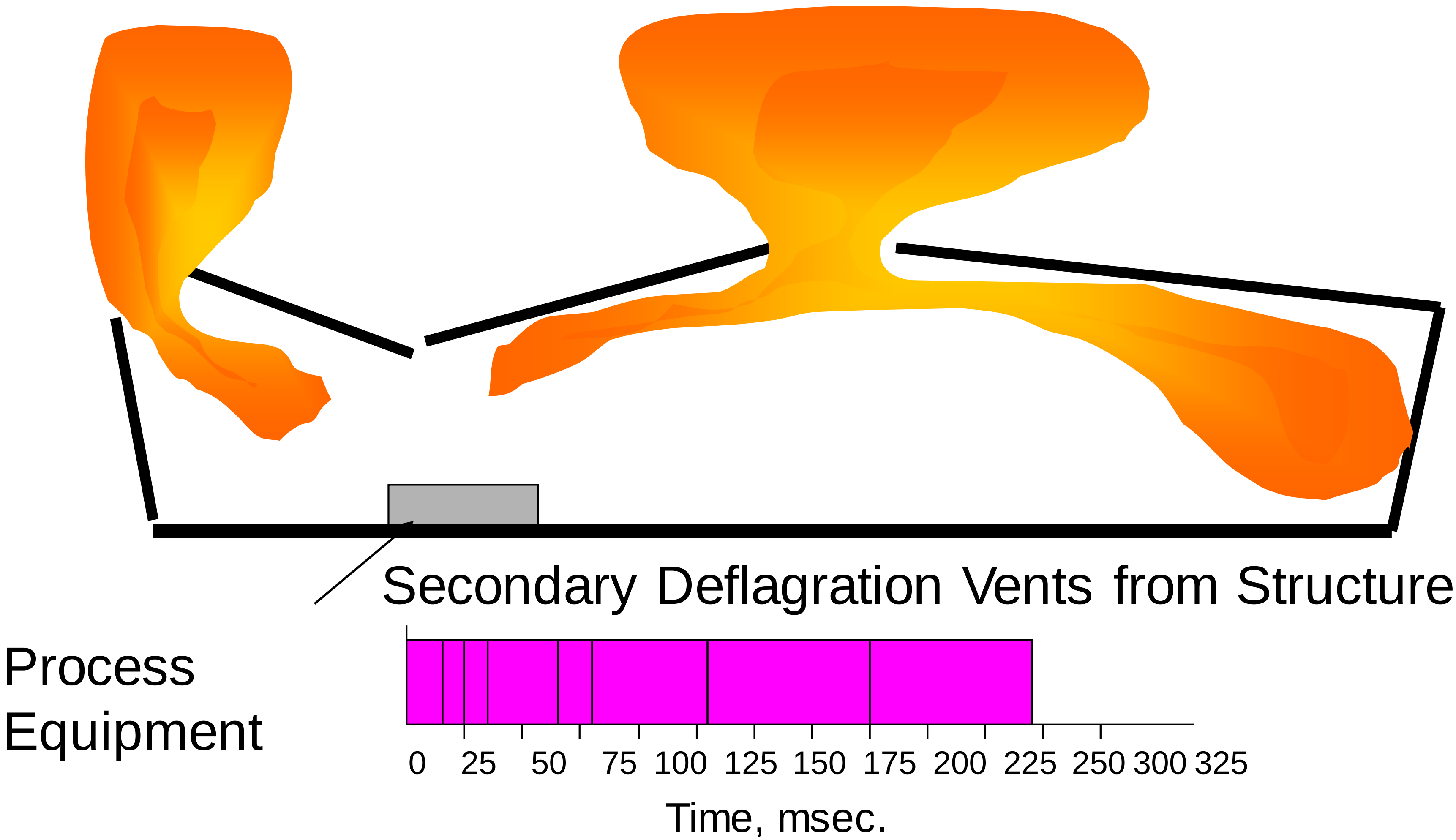
The “Typical” Explosion Event



The “Typical” Explosion Event

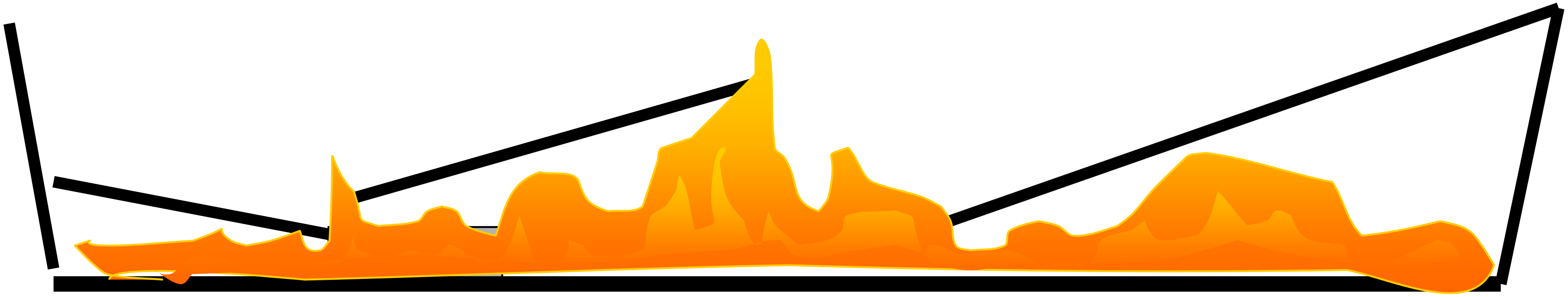


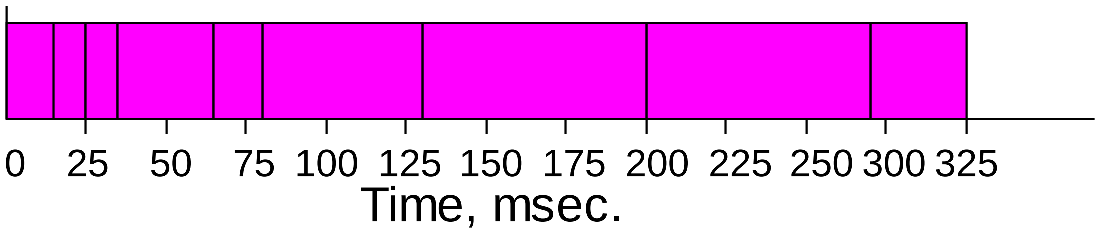
The “Typical” Explosion Event



The "Typical" Explosion Event

Secondary Deflagration
Causes Collapse and Residual Fires





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

Dust Control Measures

- Minimize escape of dust from process equipment or ventilation systems
- Use dust collection systems and filters
- Use surfaces that reduce dust accumulation
- Conduct regular inspections
- Clean dust residues at regular intervals

Dust Control Measures

- Use cleaning methods that do not generate dust clouds
- Use vacuum cleaners approved for combustible dust collection
- Locate relief valves away from dust hazard areas
- Develop and implement written program for hazardous dust inspection, housekeeping and control

Dust Layer Thickness Guidelines

- Grain handling standard - 1910.272
  - Exceeds 1/8″
- NFPA 654
  - 1/32 ″ over 5% of area
  - 5 % factor should not be used if floor area exceeds 20,000 ft^2
    - » Overhead beams and ledges should also be considered

Ignition Control Measures

- Electrically powered cleaning devices
  - Vacuum cleaners and electrical equipment approved for Class II locations
- Ignition control program
  - Grounding, bonding and other methods used for dissipating electrostatic charge
- Hot work permit program
- Cartridge activated tools used properly

Ignition Control Measures

- Posted “No Smoking” signs
- Duct systems, dust collectors, and dust-producing machinery bonded and grounded
- Industrial trucks approved for the combustible dust locations

Prevention Measures

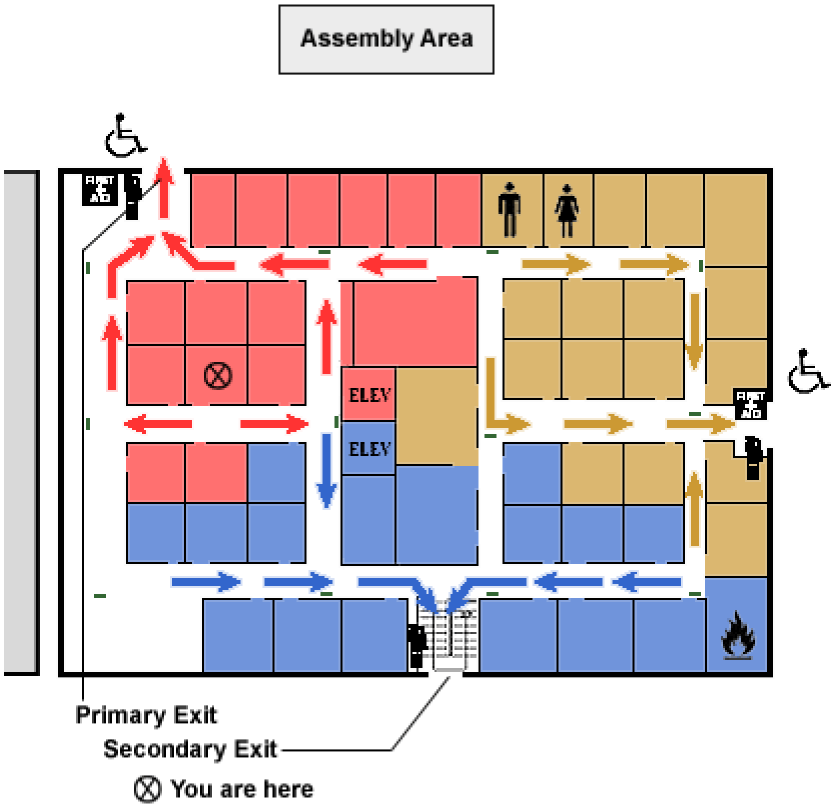
- Separator devices used to remove foreign materials capable of igniting combustible dusts
- MSDSs available for chemicals which could become combustible dust
- Employees trained on explosion hazards

Damage Control Measures

- Separation of the hazard
- Segregation of the hazard
- Deflagration venting of a building, room or area
- Pressure relief venting for equipment
- Spark detection and extinguishing systems
- Explosion protection systems
- Sprinkler systems

Protection Measures—Human

- Emergency Action Plan
  - Practice your plan
- Maintain emergency exit routes



Protection Measures—Physical

- Dust collectors not located inside buildings (exceptions)
- Rooms, buildings, or other enclosures (dust collectors) have explosion relief venting
- Explosion venting directed toward safe location away from employees
- Facility has isolation devices to prevent deflagration propagation between equipment connected by ductwork
- Spark detection and explosion/deflagration suppression systems in dust collector systems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2
3

General Industry Standards

- Housekeeping
  - 1910.22
- Means of Egress
  - 1910 Subpart E
- Ventilation
  - 1910.94
- Process Safety Management
  - 1910.119
- Warning Signs
  - 1910.145

General Industry Standards

- Permit-Required Confined Spaces
  - 1910.146
- Portable Fire Extinguishers
  - 1910.157
- Handling Materials
  - 1910.176
- Powered Industrial Trucks
  - 1910.178
- Welding, Cutting and Brazing
  - 1910.252

General Industry Standards

- Hazardous (Classified) Locations
  – 1910.307
- Hazard Communication
  – 1910.1200
- General Duty Clause
  – N.C. General Statute §95-129(1)

Special Industries—1910 Subpart R

- Bakery Equipment
  - 1910.263

- Sawmills
  - 1910.265
- Electric Power Generation, Transmission and Distribution
  - 1910.269

- Grain Handling Facilities
  - 1910.272

Applicable NFPA Standards

NFPA Number	Title	Current Edition
61	Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities	2008
68	Guide for Venting of Deflagrations	2007
69	Standard on Explosion Prevention Systems	2008
70	National Electrical Code	2008
77	Recommended Practice on Static Electricity	2007
85	Boiler and Combustion Systems Hazards Code	2007
86	Standard for Ovens and Furnaces	2007
91	Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids	2004
484	Standard for Combustible Metals	2006
499	Recommended Practice for the classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas	2008
654	Standard for the Prevention of Fire and Dust Explosions from the Manufacturing , Processing and Handling of Combustible Particulate Solids	2006
655	Standard for the Prevention of Sulfur Fires and Explosions	2007
664	Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities	2007

Catastrophic Combustible Dust Incidents Since 1995

Malden Mills, Methuen, MA

- December 11, 1995
- 37 injured
- Nylon fiber
  - Polartec fleece fibers

Ford River Rouge, Dearborn, MI

- February 1, 1999
- 6 killed
- 36 injured
- Initial event was natural gas explosion
- Secondary coal dust explosion

Jahn Foundry, Springfield, MA

- February 26, 1999
- 3 killed
- 9 injured
- Phenolic resin dust

Rouse Polymerics, Vicksburg, MS

- May 16, 2002
- 5 killed
- 7 injured
- Rubber dust

CTA Acoustics, Inc., Corbin, KY

- February 20, 2003
- 7 killed
- 37 injured
- Series of dust explosions
- Facility destroyed

CTA Acoustics, Inc.

- Phenolic resin powder was deposited onto a fiberglass web.

- In the mat-former, air-suction dispersed the phenolic resin powder throughout the web to create a resin-impregnated fiberglass mat.
  - Suction air with resin and fiberglass traveled to a 40K cfm pulse-jet baghouse.

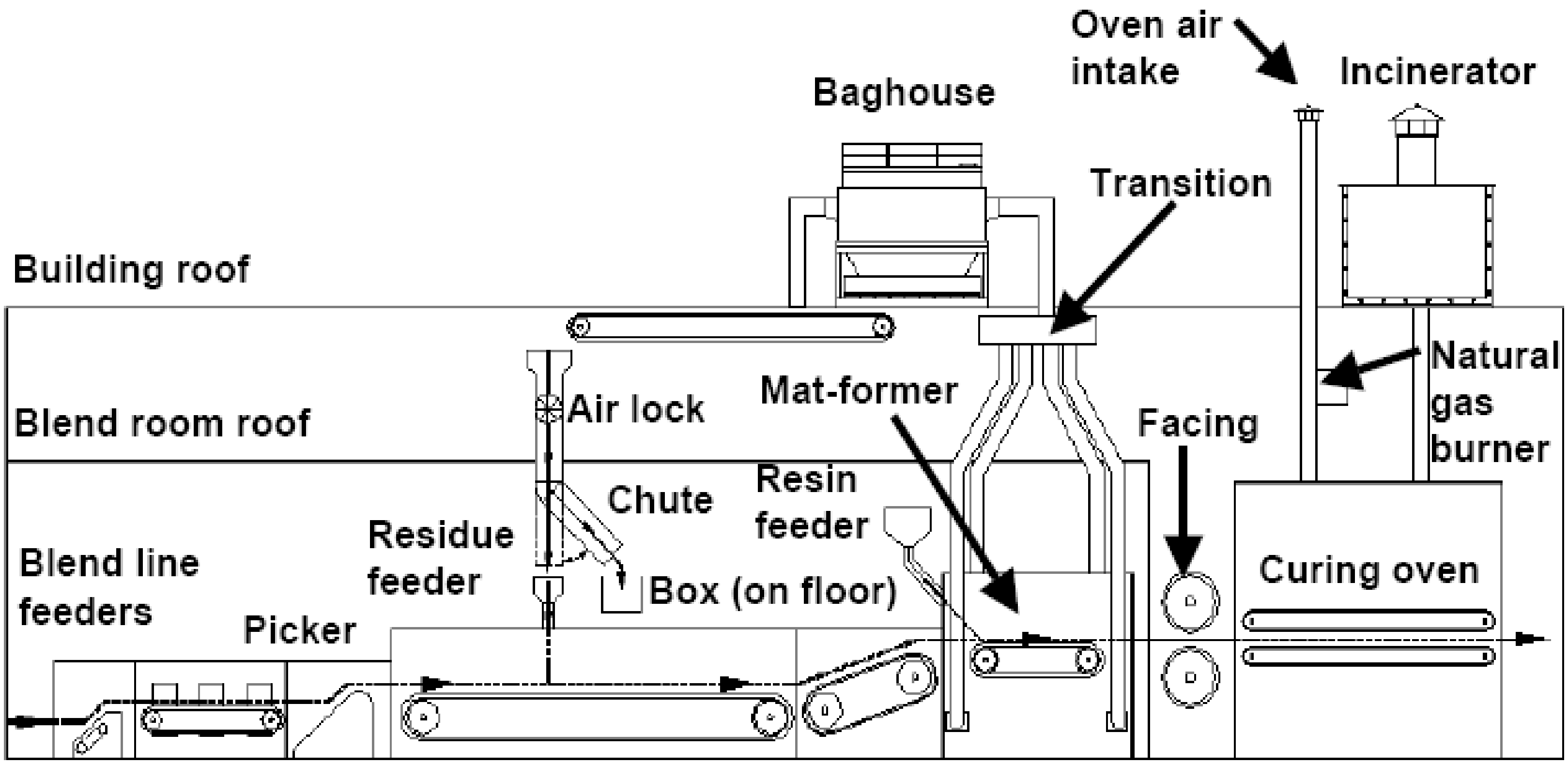


Figure 3. Line 405 process flow.

Source: CSB Report 2003-09-I-KY

CTA Acoustics, Inc.

- Line 405 oven temperature controller stopped working four days before incident
  - Oven running too hot
  - Controls switched to manual by line operators
  - Oven temperature controlled by opening and closing doors on east/west side of oven

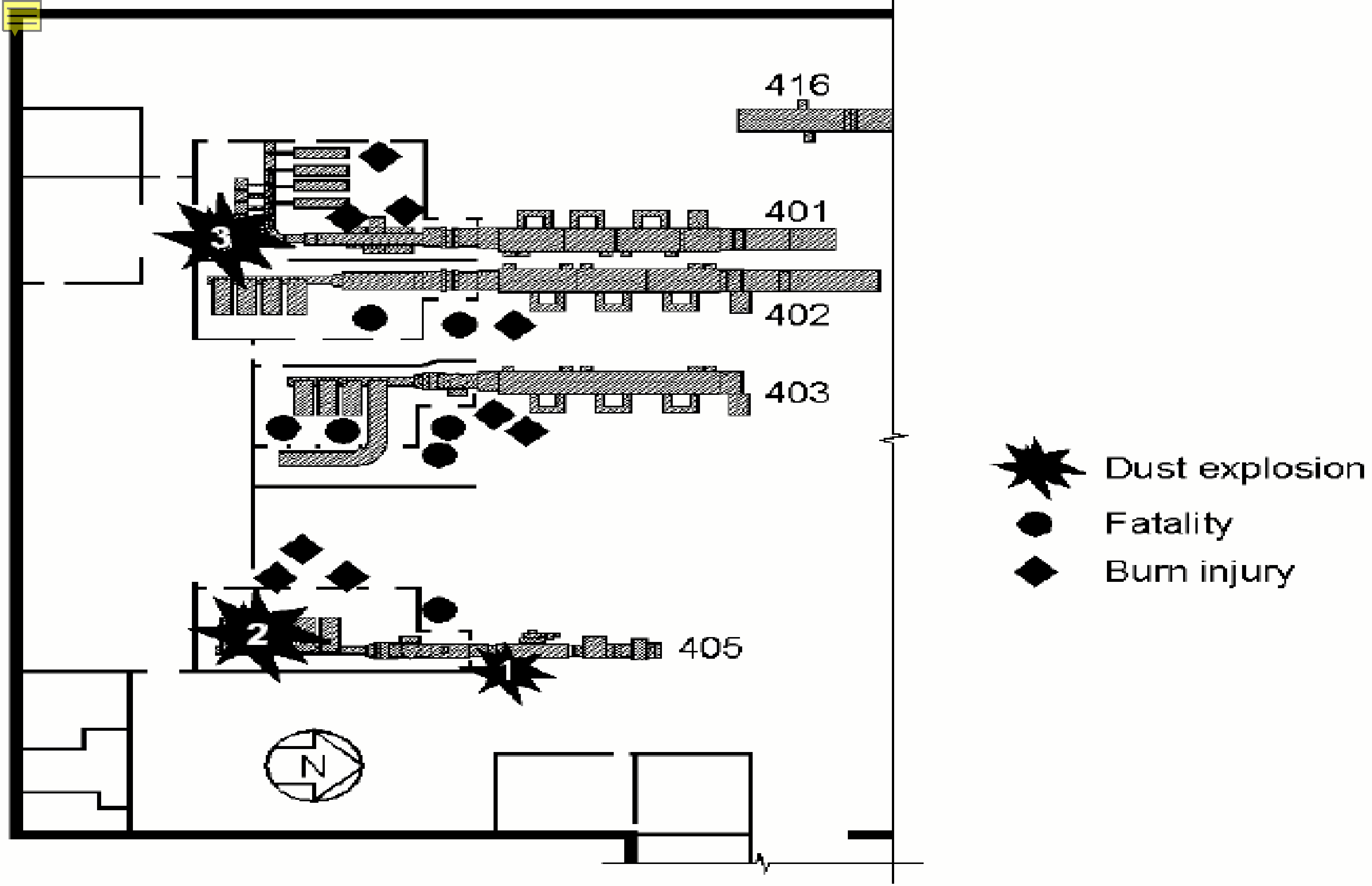
- Line 405 oven had history of fires
  - Accumulated phenolic resin/fiberglass materials ignited
  - Extinguished with a garden hose or portable fire extinguisher
  - Seven fires in six months preceding the incident. Five of those seven originated inside line 405 oven
    - » Sparks from the oven flight chain were listed as most frequent source of ignition

CTA Acoustics, Inc.

- Crew was cleaning the baghouse for line 405 at 7 a.m.
  - Transition leading to the baghouse was plugged
  - Compressed air lance used to blow material out of transition – which fell back into the production area
  - Cloud of combustible dust was generated in the plant around line 405

CSB determined that air currents probably transported the dust cloud (from bag house cleaning) to the Line 405 oven, where it likely ignited.

Collapsed firewall and metal panels – south end of line 405 blend room



Source: CSB Report 2003-09-I-KY

Hayes-Lemmerz International, Huntington, IN

- October 29, 2003
- 1 killed
- 6 injured
- Aluminum dust explosion
- Fireball that erupted from furnace sidewell was likely result of an aluminum dust explosion in dust collector system


1 / 32
INCHES
1
1/16

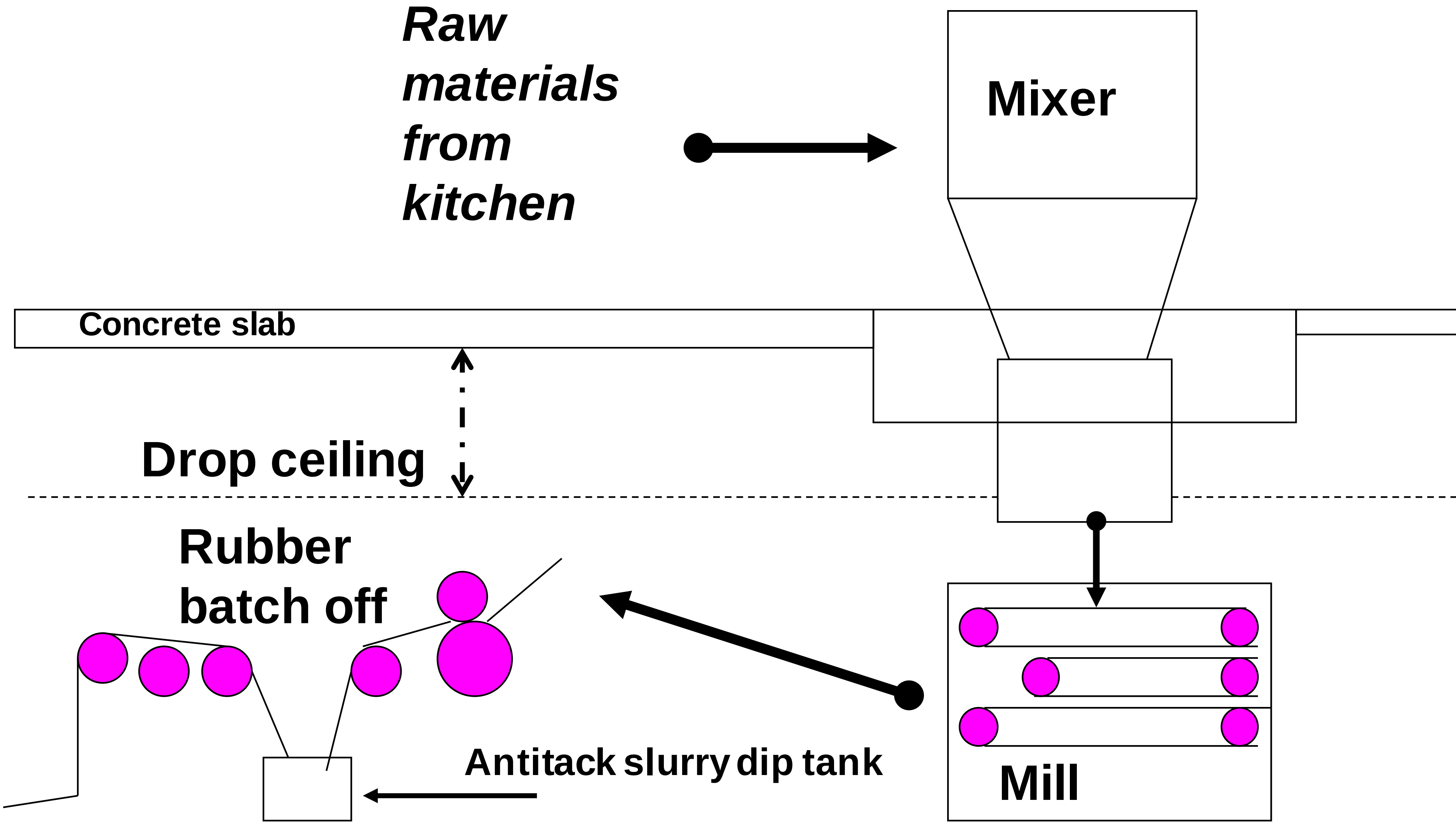
West Pharmaceuticals, Kinston, NC

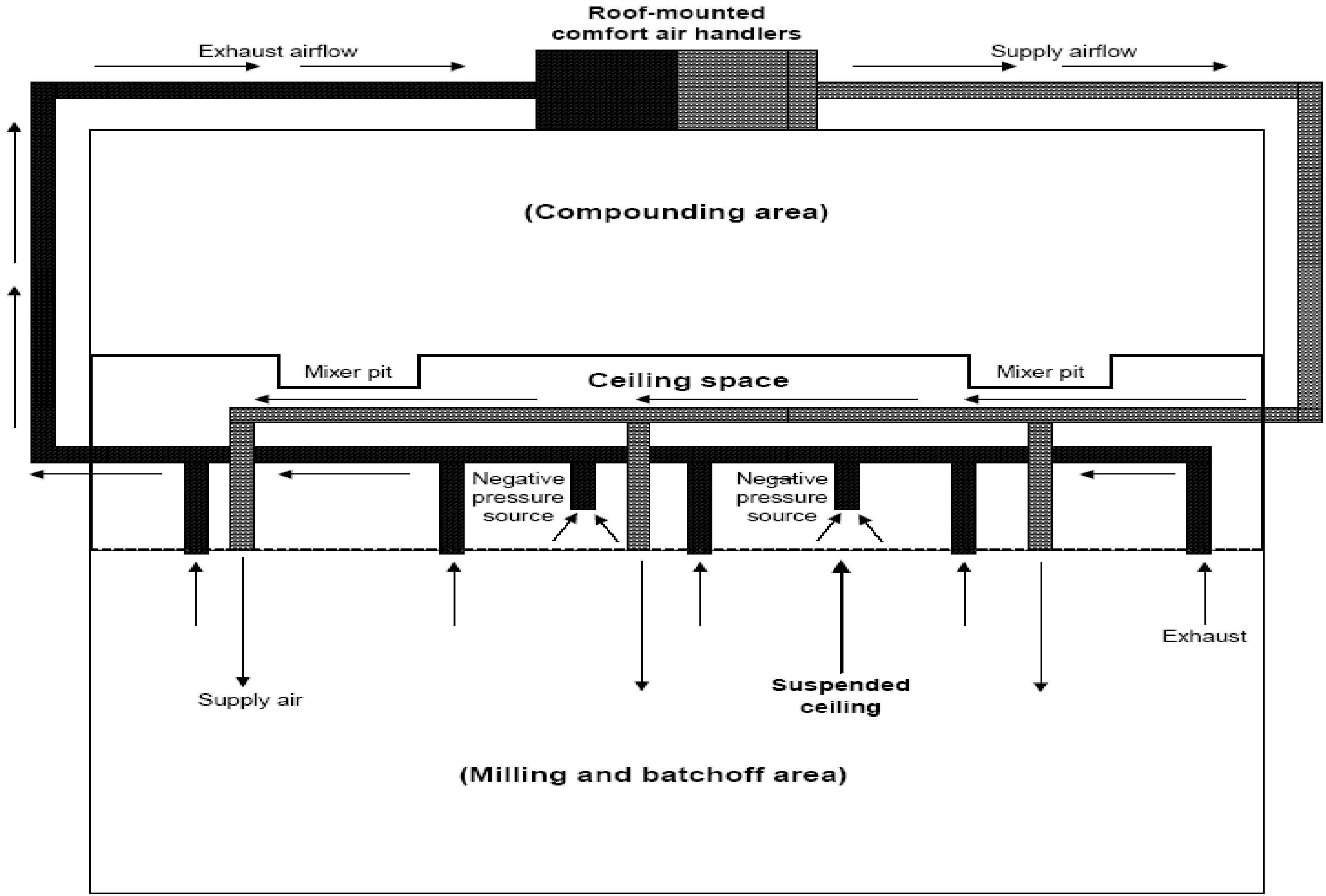
- January 29, 2003
- 6 killed
- 38 injured including two firefighters
- Facility manufactured rubber drug delivery components

West Pharmaceuticals

- Production process included use of finely powdered (12 microns) grade of polyethylene as an antitack agent
  – Zinc stearate had been used as antitack agent until 1996
- Small amounts of dried powder that did not remain on the folded rubber likely became airborne

Simplified Automated Rubber Compounding System Process





Source: CSB Report 2003-07-I-NC


Due to the amount of damage, investigators were not able to establish what dispersed the dust or what ignited it.

What Caused Initial Explosion?

- Not known for sure, but several theories:
  - Deflagration of vapors emitted by decomposing rubber
  - Ignition of dust:
    - » By overheated electrical ballast or fixture
    - » By an electrical spark, ***or***
    - » In a motor cooling duct

CSB Recommendations to OSHA

- Issue a standard designed to prevent combustible dust fires and explosions in general industry

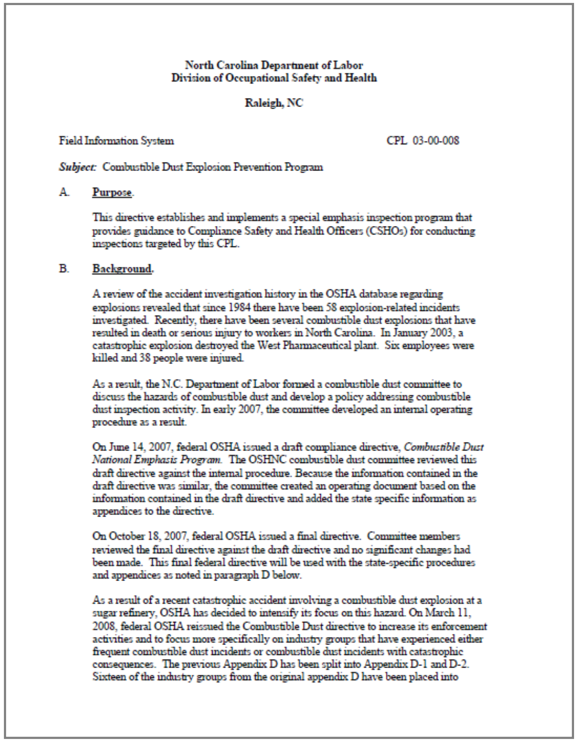
- Revise the Hazard Communication Standard (HCS) (1910.1200) to clarify that the HCS covers combustible dusts

- Communicate to the United Nations Economic Commission (UNECE) the need to amend the Globally Harmonized System (GHS) to address combustible dust hazards

CSB Recommendations to OSHA

- Provide training through the OSHA Training Institute (OTI) on recognizing and preventing combustible dust explosions

- While a standard is being developed, implement a National Special Emphasis Program (SEP) on combustible dust hazards in general industry



North Carolina Department of Labor
Division of Occupational Safety and Health

Raleigh, NC

Field Information System CPL 03-00-008

Subject: Combustible Dust Explosion Prevention Program

A. Purpose.

This directive establishes and implements a special emphasis inspection program that provides guidance to Compliance Safety and Health Officers (CSHOs) for conducting inspections targeted by this CPL.

B. Background.

A review of the accident investigation history in the OSHA database regarding explosions revealed that since 1984 there have been 58 explosion-related incidents investigated. Recently, there have been several combustible dust explosions that have resulted in death or serious injury to workers in North Carolina. In January 2003, a catastrophic explosion destroyed the West Pharmaceutical plant. Six employees were killed and 38 people were injured.

As a result, the N.C. Department of Labor formed a combustible dust committee to discuss the hazards of combustible dust and develop a policy addressing combustible dust inspection activity. In early 2007, the committee developed an internal operating procedure as a result.

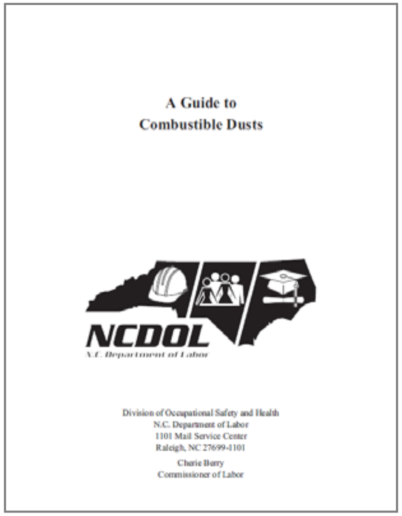
On June 14, 2007, federal OSHA issued a draft compliance directive, *Combustible Dust National Emphasis Program*. The OSHNC combustible dust committee reviewed this draft directive against the internal procedure. Because the information contained in the draft directive was similar, the committee created an operating document based on the information contained in the draft directive and added the state specific information as appendices to the directive.

On October 18, 2007, federal OSHA issued a final directive. Committee members reviewed the final directive against the draft directive and no significant changes had been made. This final federal directive will be used with the state-specific procedures and appendices as noted in paragraph D below.

As a result of a recent catastrophic accident involving a combustible dust explosion at a sugar refinery, OSHA has decided to intensify its focus on this hazard. On March 11, 2008, federal OSHA reissued the Combustible Dust directive to increase its enforcement activities and to focus more specifically on industry groups that have experienced either frequent combustible dust incidents or combustible dust incidents with catastrophic consequences. The previous Appendix D has been split into Appendix D-1 and D-2. Sixteen of the industry groups from the original appendix D have been placed into

NCDOL Resources

- Combustible Dust Industry Guide
- Combustible Dust Alerts
- Training Calendar and Newsletter
- A-Z Topics on Combustible Dust
- Combustible Dust Compliance Directive



A Guide to
Combustible Dusts

NCDOL
N.C. Department of Labor

Division of Occupational Safety and Health
N.C. Department of Labor
1101 Mail Service Center
Raleigh, NC 27699-1101
Cherie Berry
Commissioner of Labor

Summary

- Dust versus combustible dust
- Industries with combustible dust
- Management of combustible dust areas
- Applicable occupational safety and health standards
- Case Studies

Thank You For Attending!

Final Questions?

Handouts

Appendix B of CPL 03-00-008

Sample questions CSHOs may use during the course of an inspection.
(CSHOs may refer to appropriate NFPA standards in developing additional questions.)

What types of combustible dust does the facility have?
(Note: Please see Table 4.5.2 of NFPA 499 and Table 1 in NMAB 353-3 for additional information on the various types of dust along with their properties)

Does the facility have a housekeeping program with regular cleaning frequencies established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility? Under the housekeeping program, is the dust on floors, structural members, and other surfaces removed concurrently with operations? Is there dust accumulation of 1/32 inch thick, or greater? For housekeeping violations, what are the dimensions of the room and the dimensions of the area covered with the dust?

Are the dust-containing systems (ducts and dust collectors) designed in a manner that fugitive dusts are not allowed to accumulate in the work area?

Are dust collectors greater than 8 cubic feet in volume located inside of buildings?

If dust explosion hazards exist in rooms, buildings, or other enclosures, do such areas have explosion relief venting distributed over the exterior walls of buildings and enclosures? Is such venting directed to a safe location away from employees?

Does the facility have isolation devices to prevent deflagration propagation between pieces of equipment connected by ductwork?

Does the facility have an ignition control program, such as grounding and bonding and other methods, for dissipating any electrostatic charge that could be generated while transporting the dust through the ductwork?

Does the facility have separator devices to remove foreign materials capable of igniting combustible dusts?

Are electrically- powered cleaning devices, such as sweepers or vacuum cleaners used in dusty areas, approved for the hazard classification, as required under 1910.307(b)?

Is smoking permitted only in safe designated areas?

Are areas where smoking is prohibited posted with “No Smoking” signs?

Is the exhaust from the dust collectors recycled?

Does the dust collector system have spark detection and explosion/deflagration suppression systems? (There are other alternative measures.)

Are all components of the dust collection system constructed of noncombustible materials?

Are ducts designed to maintain sufficient velocity to ensure the transport of both coarse and fine particles?

Are duct systems, dust collectors, and dust-producing machinery bonded and grounded to minimize accumulation of static electrical charge?

Is metal ductwork used?

In areas where a hazardous quantity of dust accumulates or is present in suspension in the air, does all electrical wiring and equipment comply with 1910.307(b) requirements?

Does the facility allow hot work only in safe, designated areas?

Are bulk storage containers constructed of noncombustible materials?

Does the company use methods to dissipate static electricity, such as by bonding and grounding?

Are employees who are involved in operating, maintaining, and supervising facilities that handle combustible dust trained in the hazards of the combustible dust?

Are MSDSs for the chemicals which could become combustible dust under normal operations available to employees?