COMBUSTIBLE Dust

SAFETY WORKSHOP

Navigating the Combustible Dust Explosion &
Fire Risk Mitigation Journey

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Lewellyn
TECHNOLOGY

Jason Reason

- Education & Certifications
  - B.S. Industrial Hygiene – Purdue University
  - MBA – University of Indianapolis
  - CIH, CSP, CHMM
- Experience
  - 12.5 years as OSHA Compliance Officer
  - Performed over 50 combustible dust inspections
  - Assisted Federal OSHA & State Plan OSHAs on numerous combustible dust inspections and issues
  - Instructor for OSHA Combustible Dust Course at OTI

Jason Reason

- NFPA Technical Committees
  - Chair of Committee for Wood & Cellulosic Materials (NFPA 664)
  - Principle Member of Committee for Handling & Conveying of Dusts, Vapors and Gases (NFPA 91, 654 & 655)
  - Principle Member of Committee for Fundamentals of Combustible Dusts (NFPA 652)
  - Principle Member of Flash Fire Protective Garment Committee (NFPA 2112 & 2113)
  - Member of Correlating Committee for Combustible Dusts (Over all NFPA combustible dust committees)

Overview

- Hazard Identification
  - Dust Explosion History
  - Definition & Description of Combustible Dusts
  - Hazards Associated with Combustible Dusts
  - Combustible Dust Testing
  - Combustible Dust Standards
- Hazard Assessment
  - Dust Hazard Analysis (DHA)

Overview

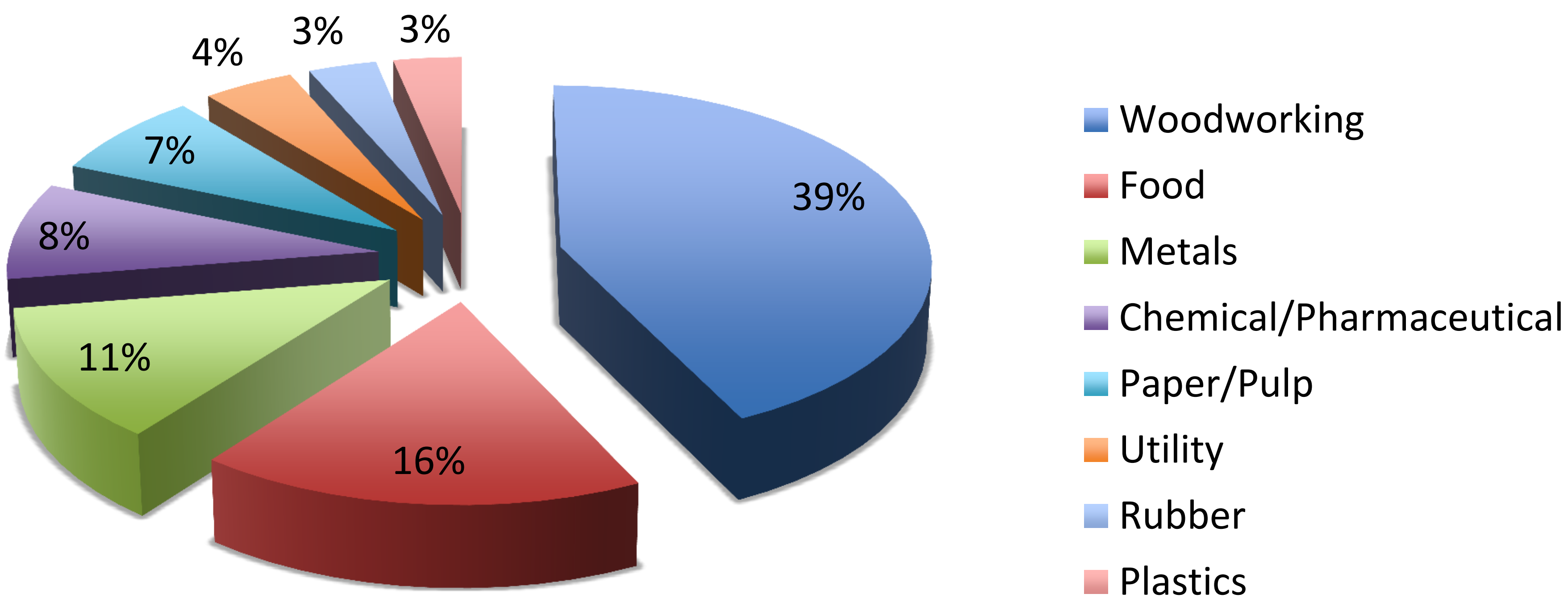
- Hazard Mitigation and Prevention
  - Engineering Controls
    - Explosion Protection Systems
    - Electrical Area Classification
  - Administrative Controls
    - Housekeeping
    - Cleaning Methods

A HUGE Problem

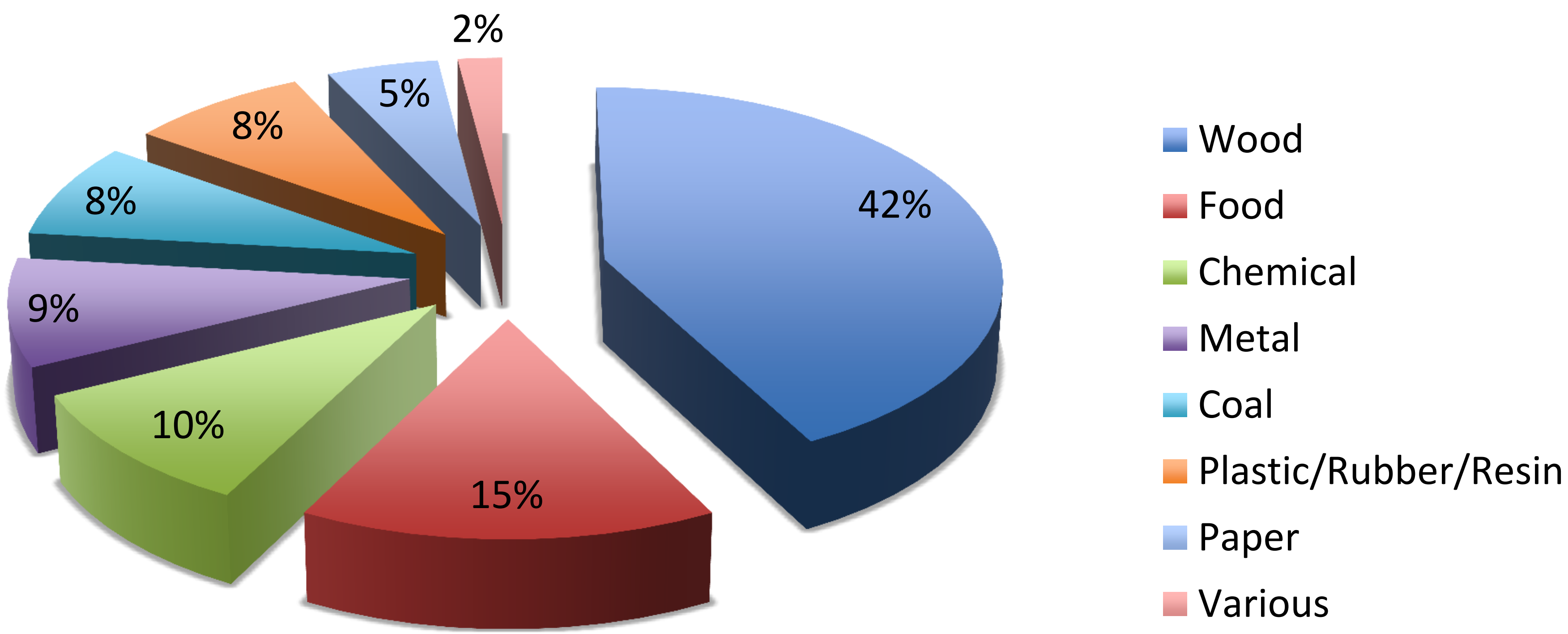
- Between 1982 and 2007, there were 281 dust fires and explosions
- Between 2009 and 2013, there were 57 dust fire and explosions

Paarl Print Factory (South Africa)

FM Global Loss Data by Industry



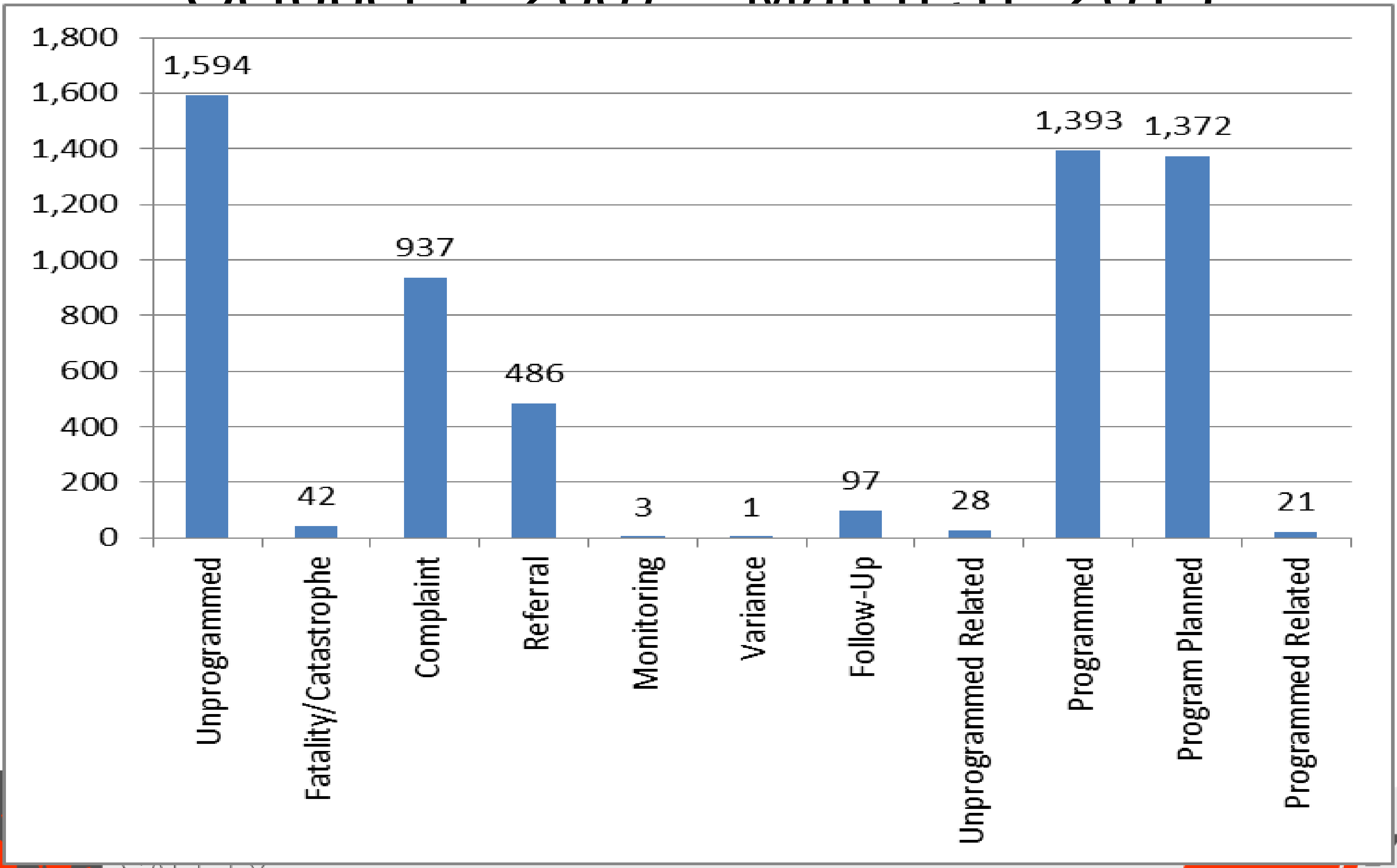
FM Global Loss Data by Dust Group



Key Factors Contributing to Incidents

- Dust collectors were inadequately designed or maintained to minimize explosions (> 40% of incidents
- Process changes were made without adequately reviewing them for the introduction of new potential hazards
- Outside parties inspecting the facilities failed to identify dust explosion hazards:
  - **Government enforcement**
  - **Insurance underwriters**
  - **Health and safety professionals**

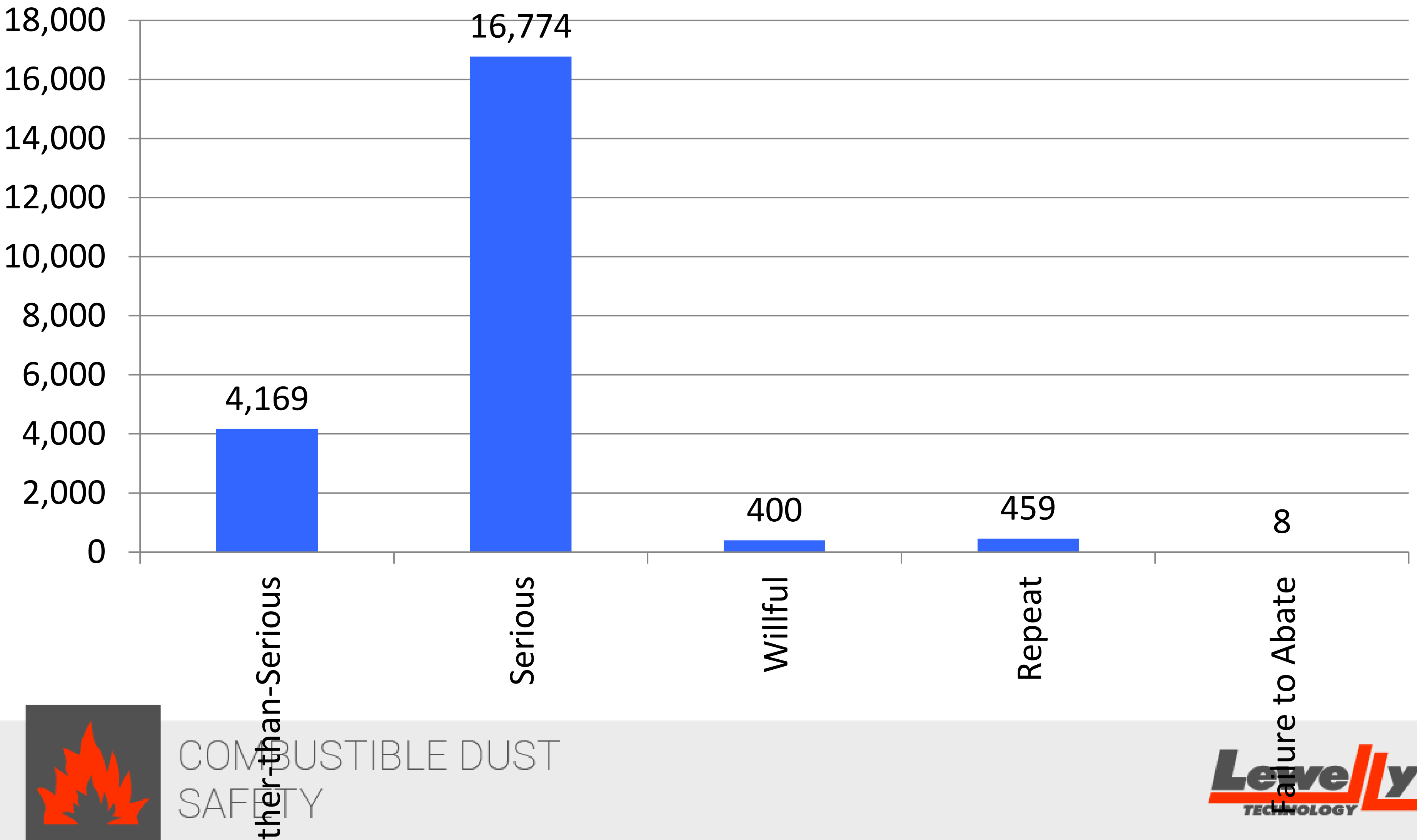
Combustible Dust Inspections (Federal OSHA)
October 1, 2007 – March 31, 2015



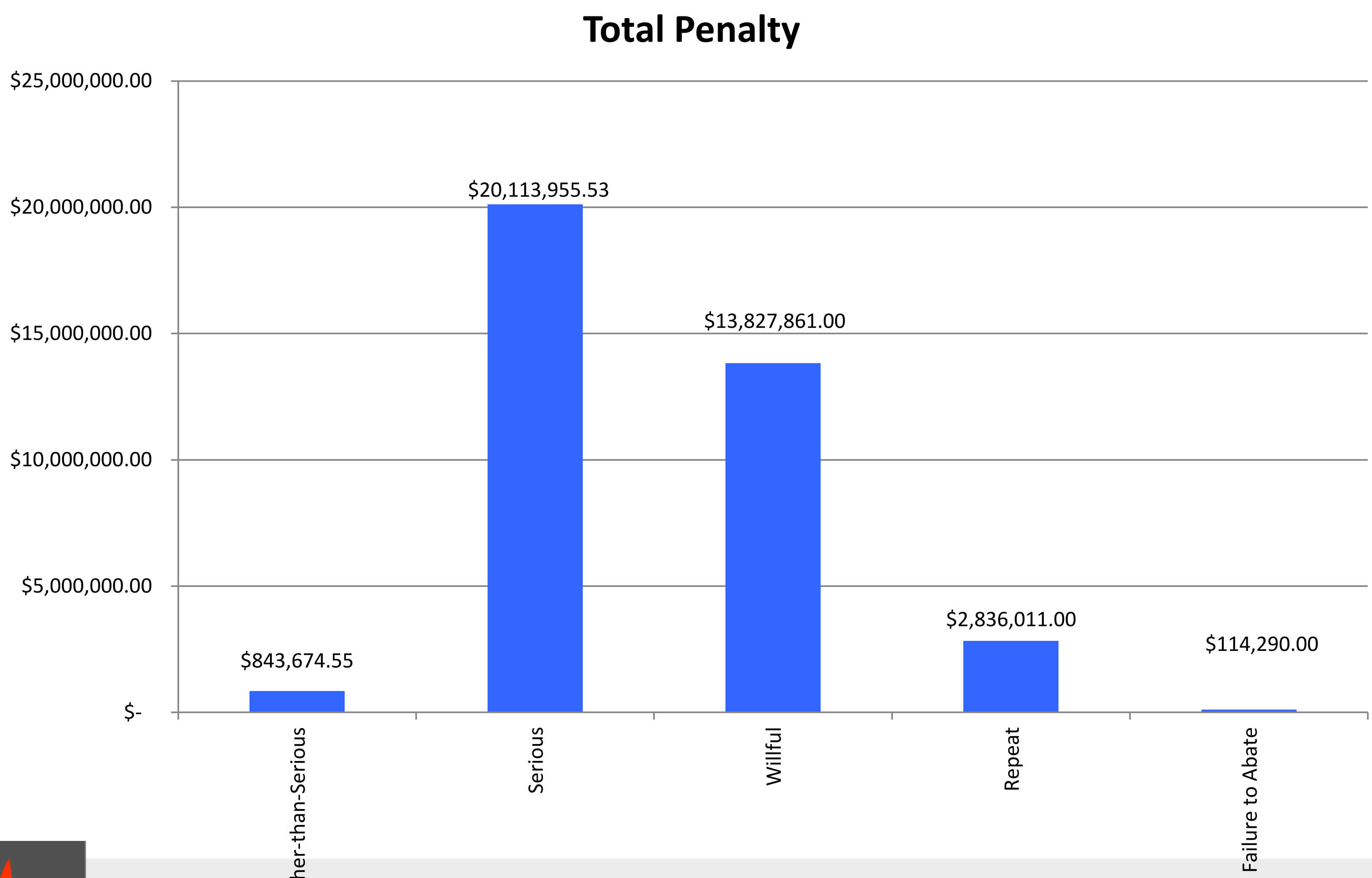
SAFETY

TECHNOLOGY

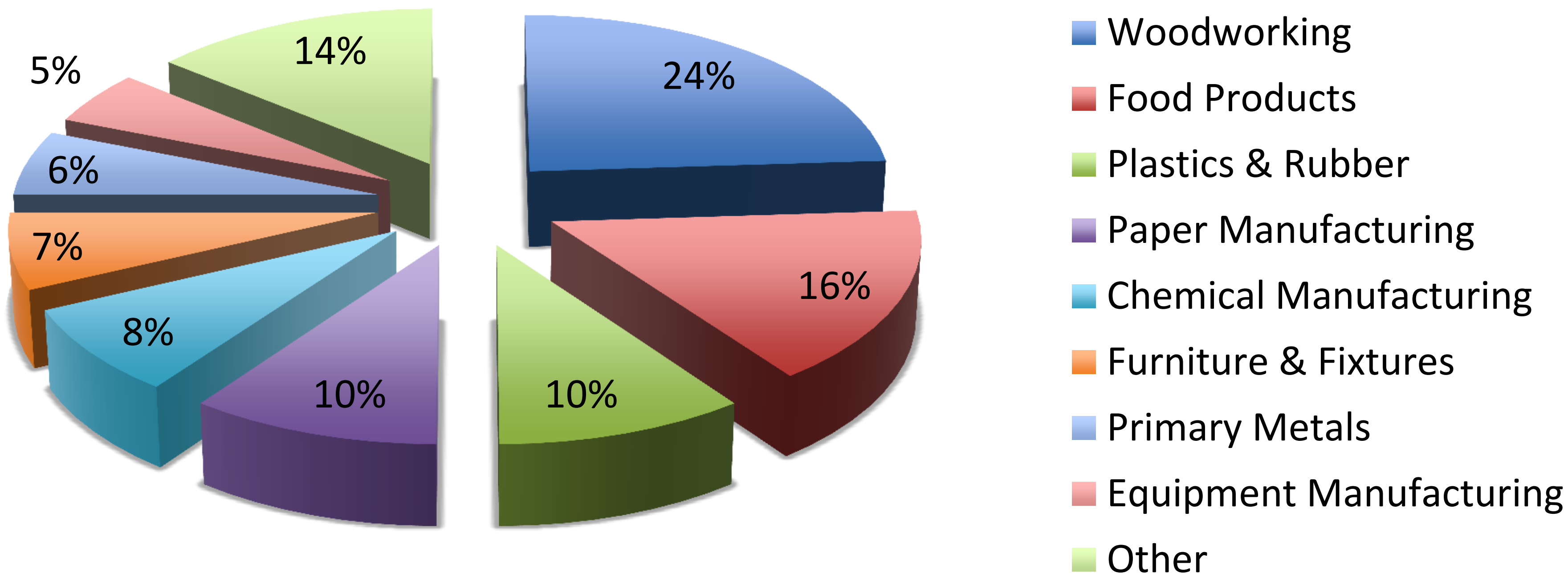
Number of OSHA Citations



Current Penalties Under The NEP



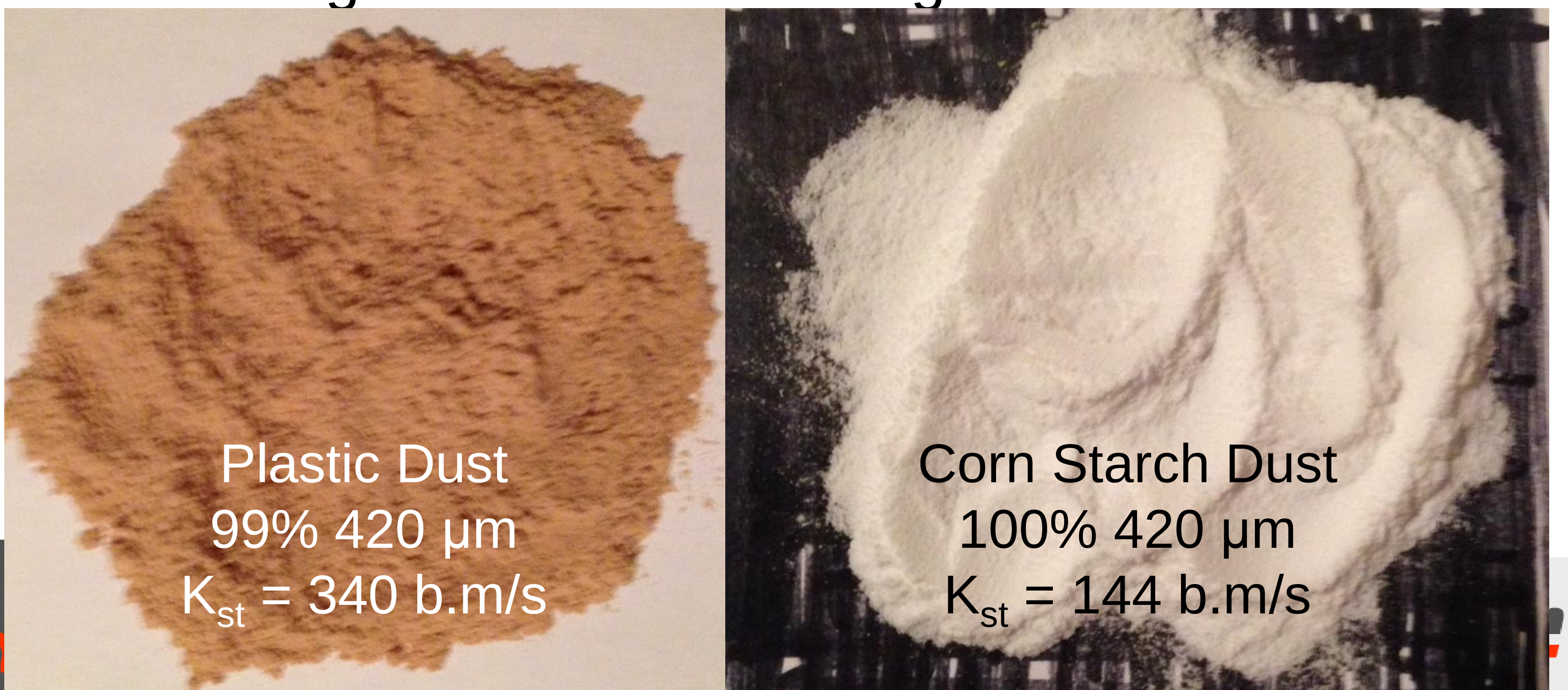
Types of Industries Inspected by OSHA



How Do Combustible Dust Fires and Explosions Occur?

Combustible Dust

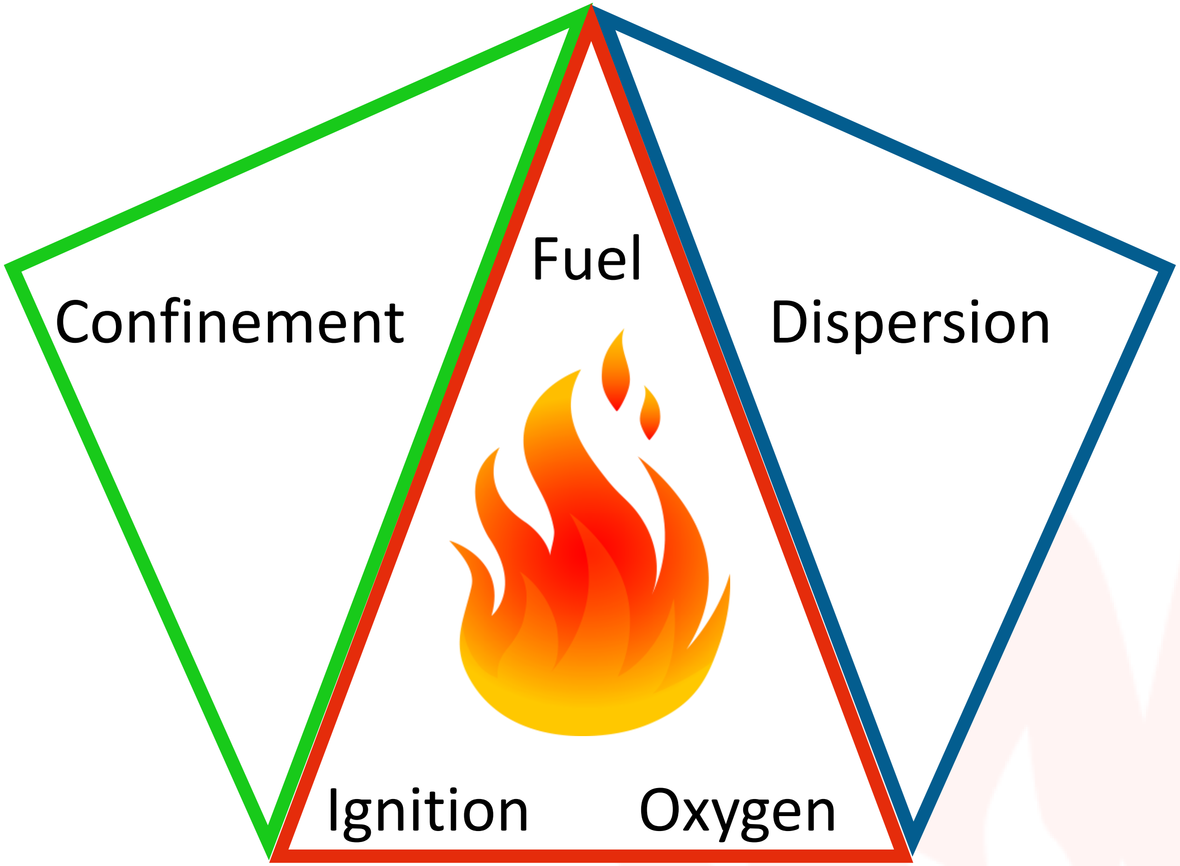
- A finely divided combustible particulate solid that presents a flash fire hazard or explosion hazard when suspended in air or the process-specific oxidizing medium over a range of concentrations



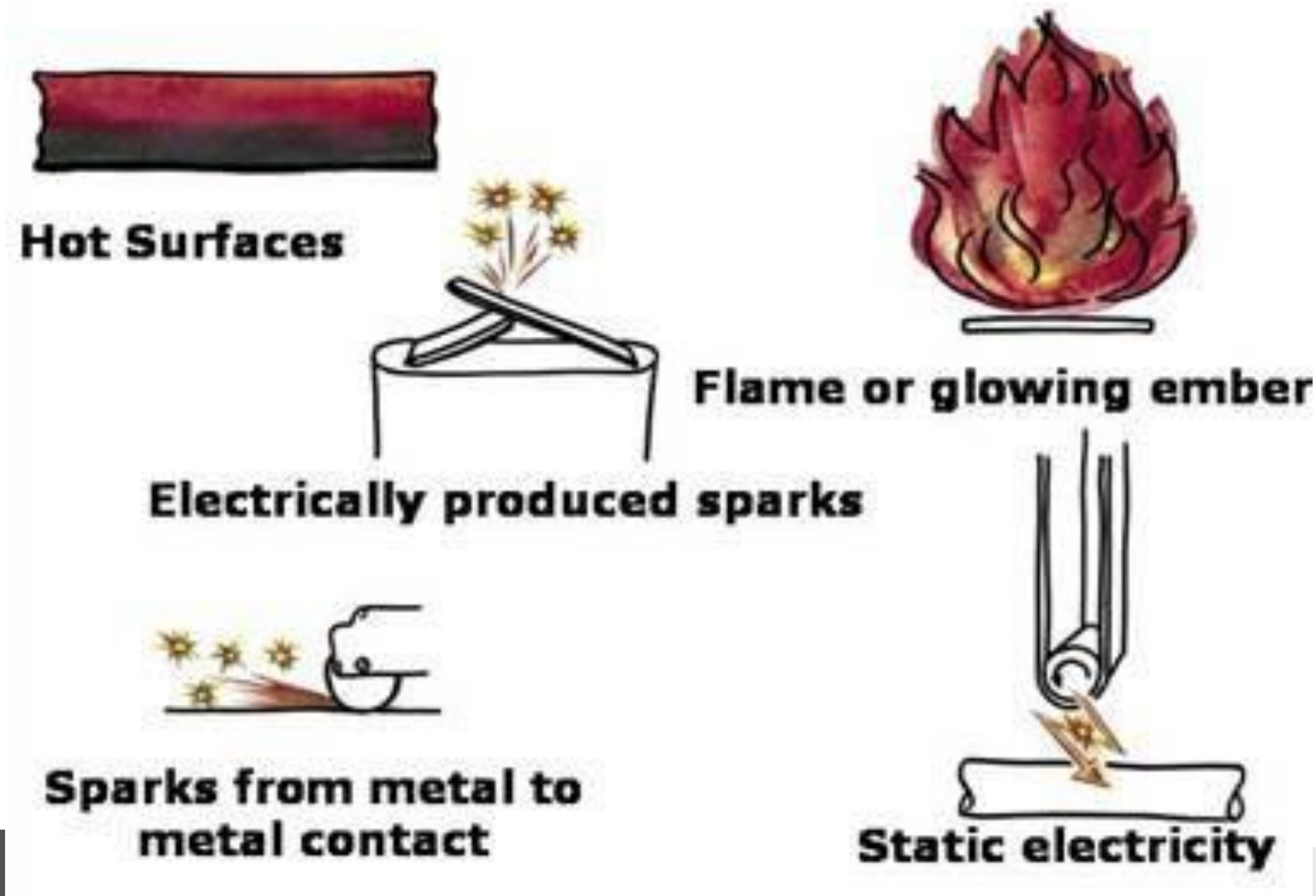
Combustible Particulate Solid

- Any solid material composed of distinct particles or pieces, regardless of size, shape, or chemical composition that, when processed, stored, or handled in the facility, has the potential to produce a combustible dust
- Includes dusts, fibers, fines, chips, chunks, flakes, or mixtures of these

Dust Explosion Pentagon



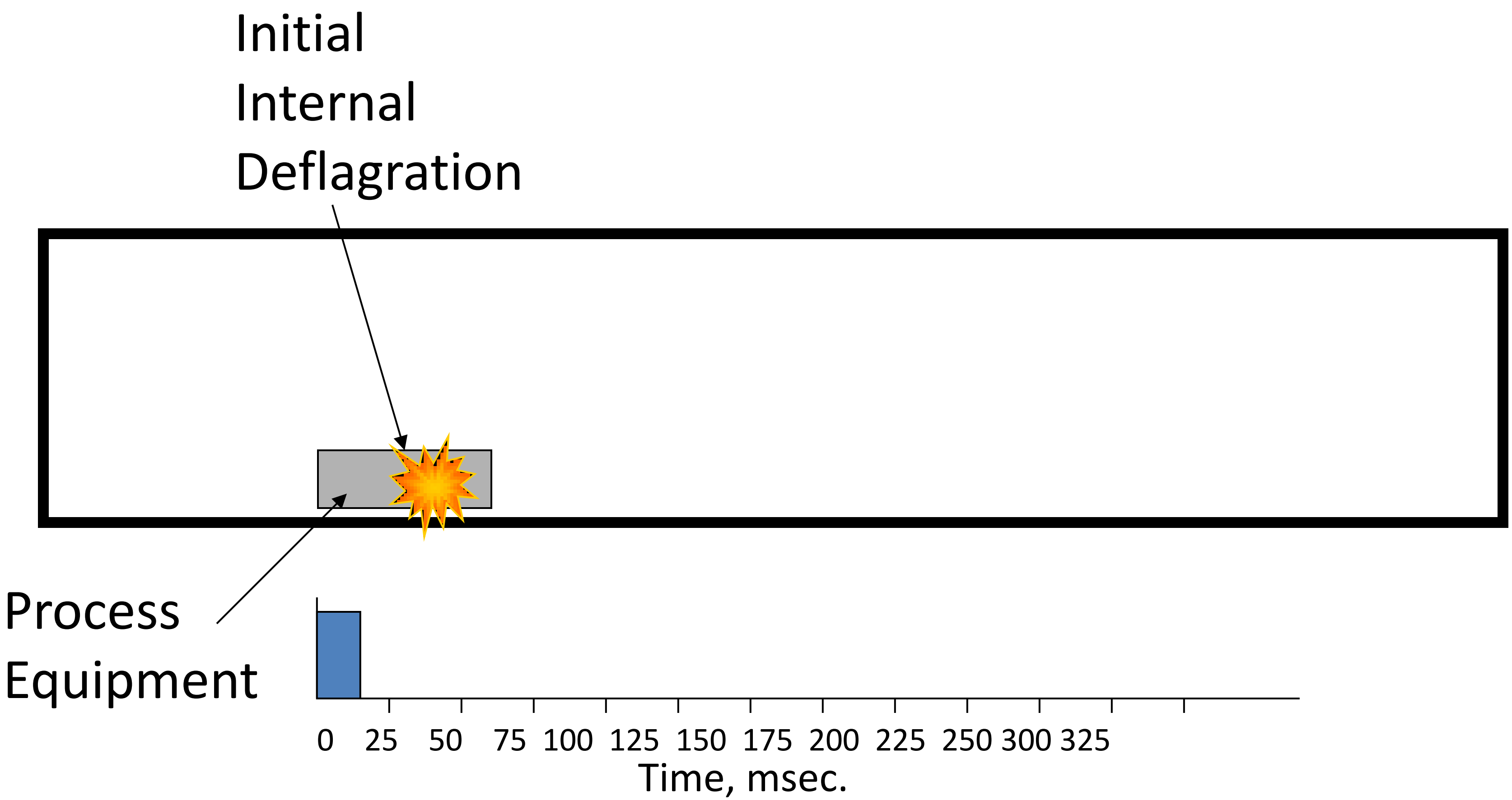
Sources of Ignition



Combustible Dust Hazards

- Flash Fire
  - Fire that spreads by means of a flame front rapidly through a diffuse fuel <u>without the production of damaging pressure</u>
- Deflagration
  - Propagation of a combustion zone at a velocity that is <u>less than the speed of sound</u> in the unreacted medium
- Explosion
  - Bursting or rupturing of an enclosure or a container due to the development of internal pressure from a deflagration

The "Typical" Explosion Event



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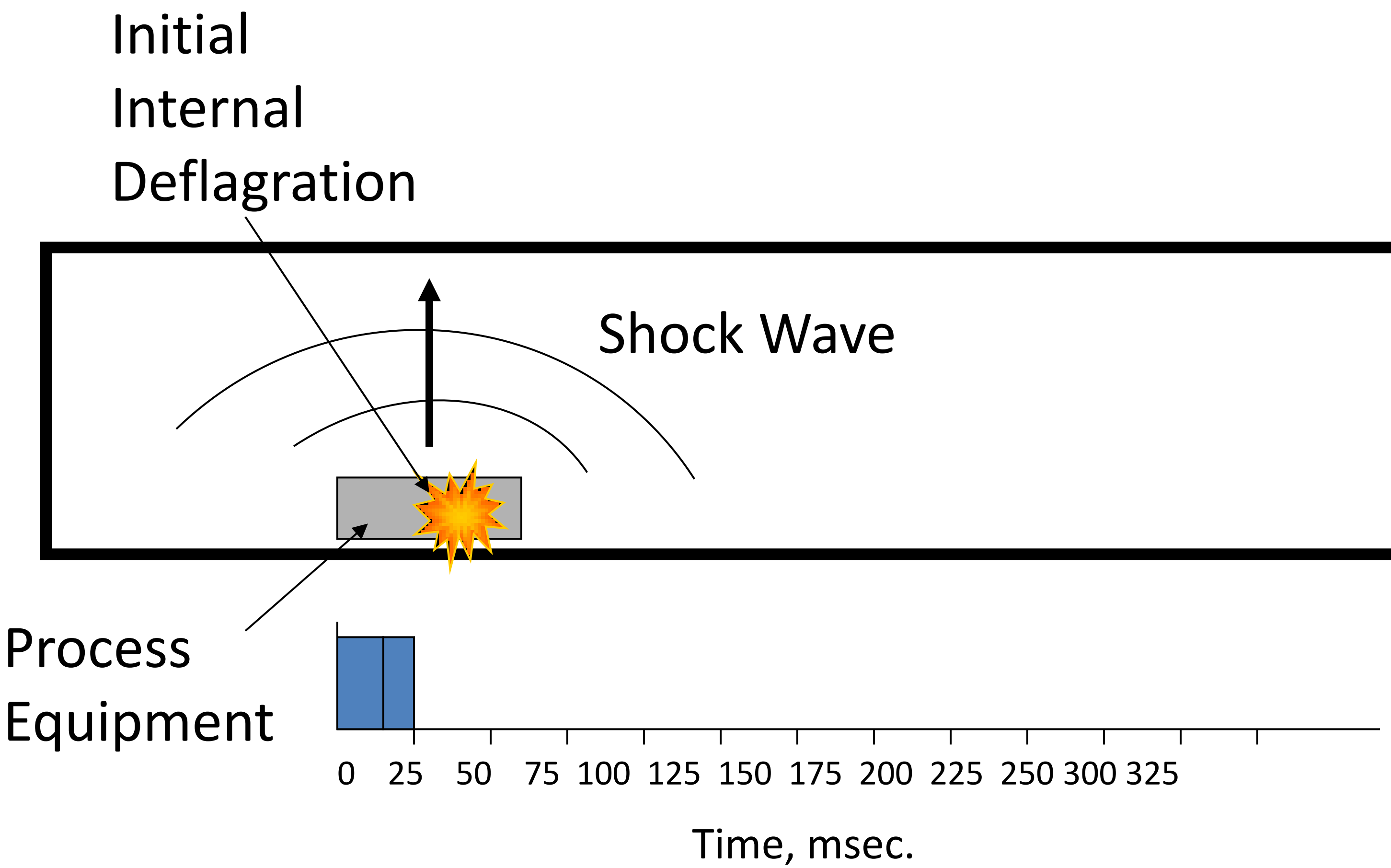

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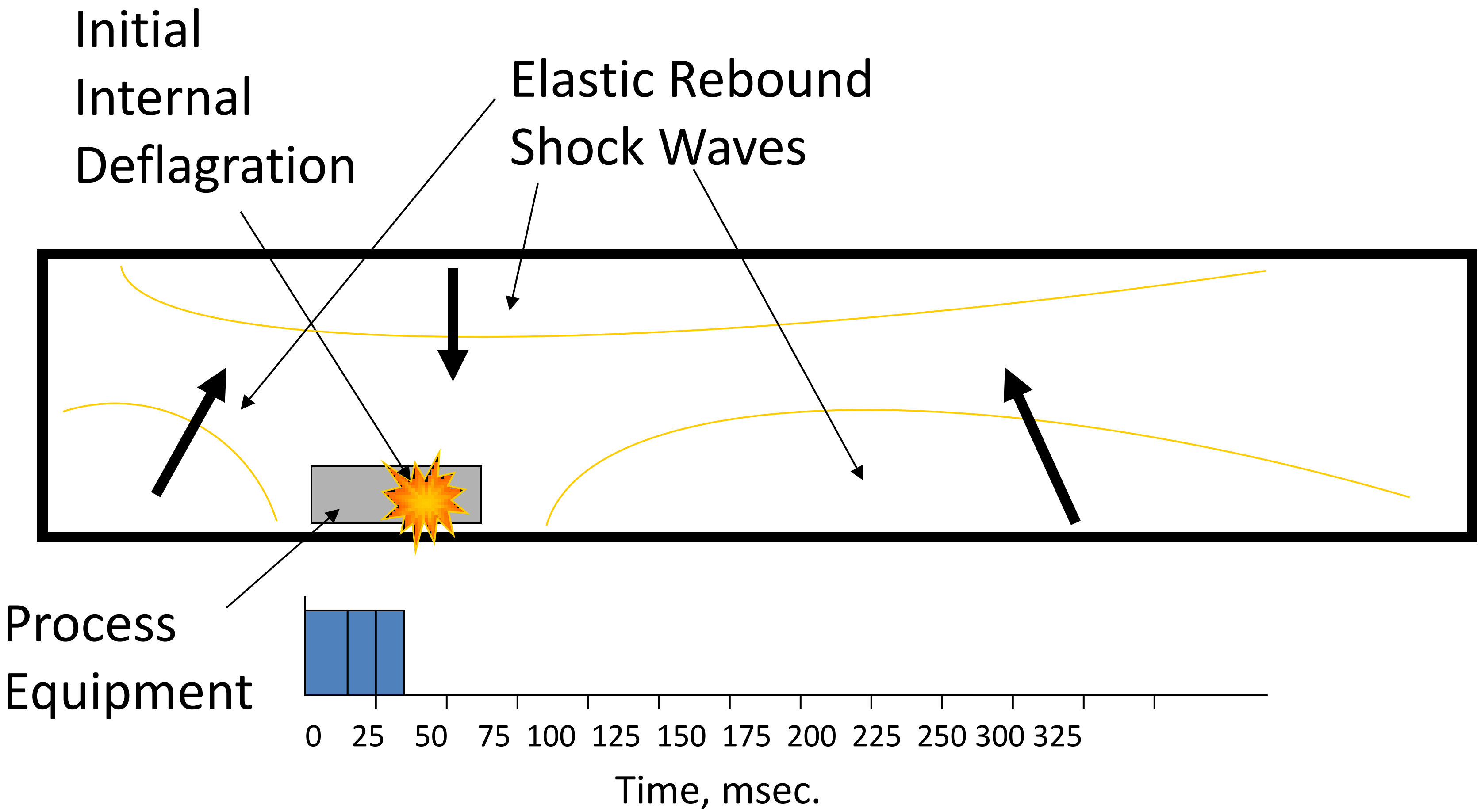

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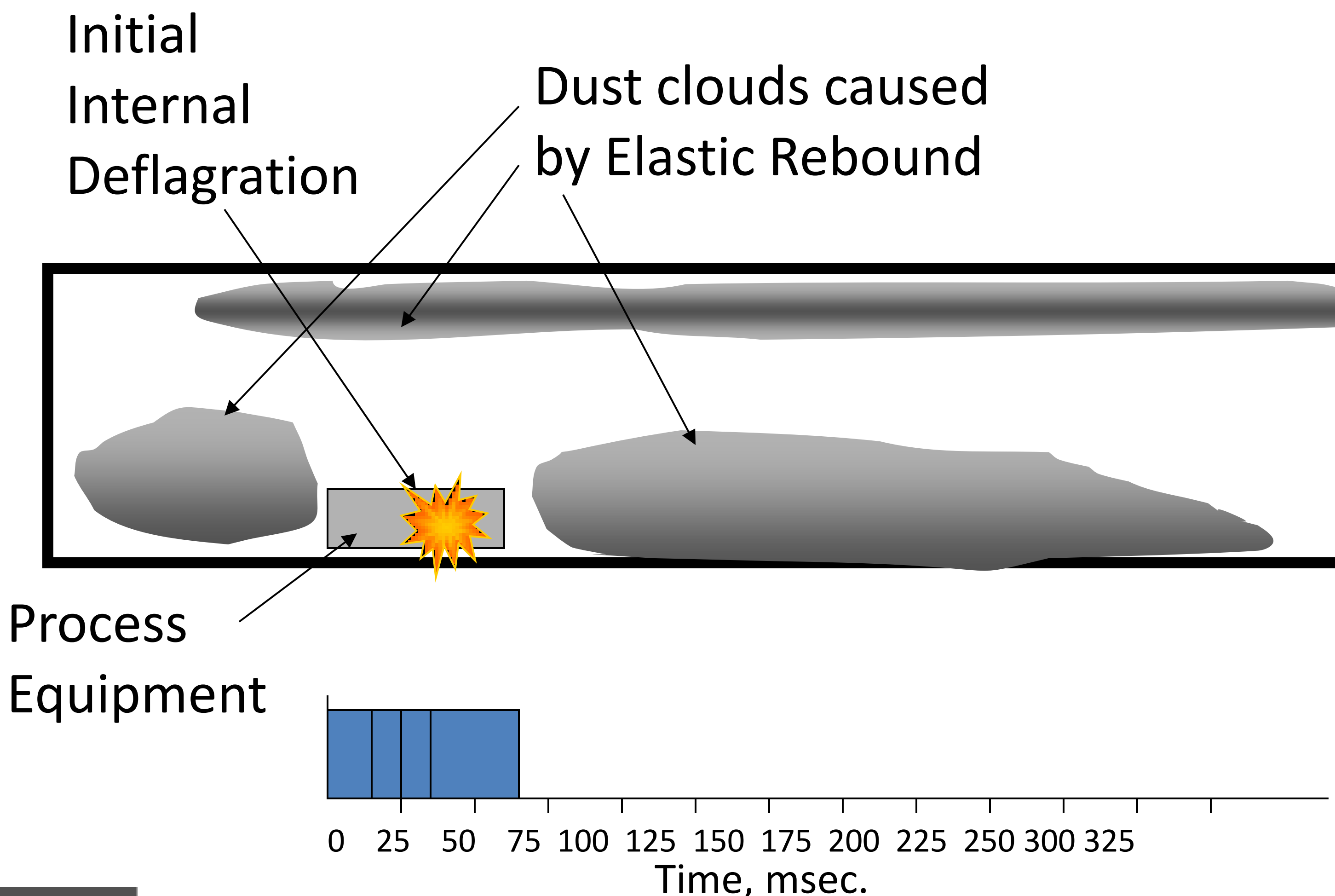

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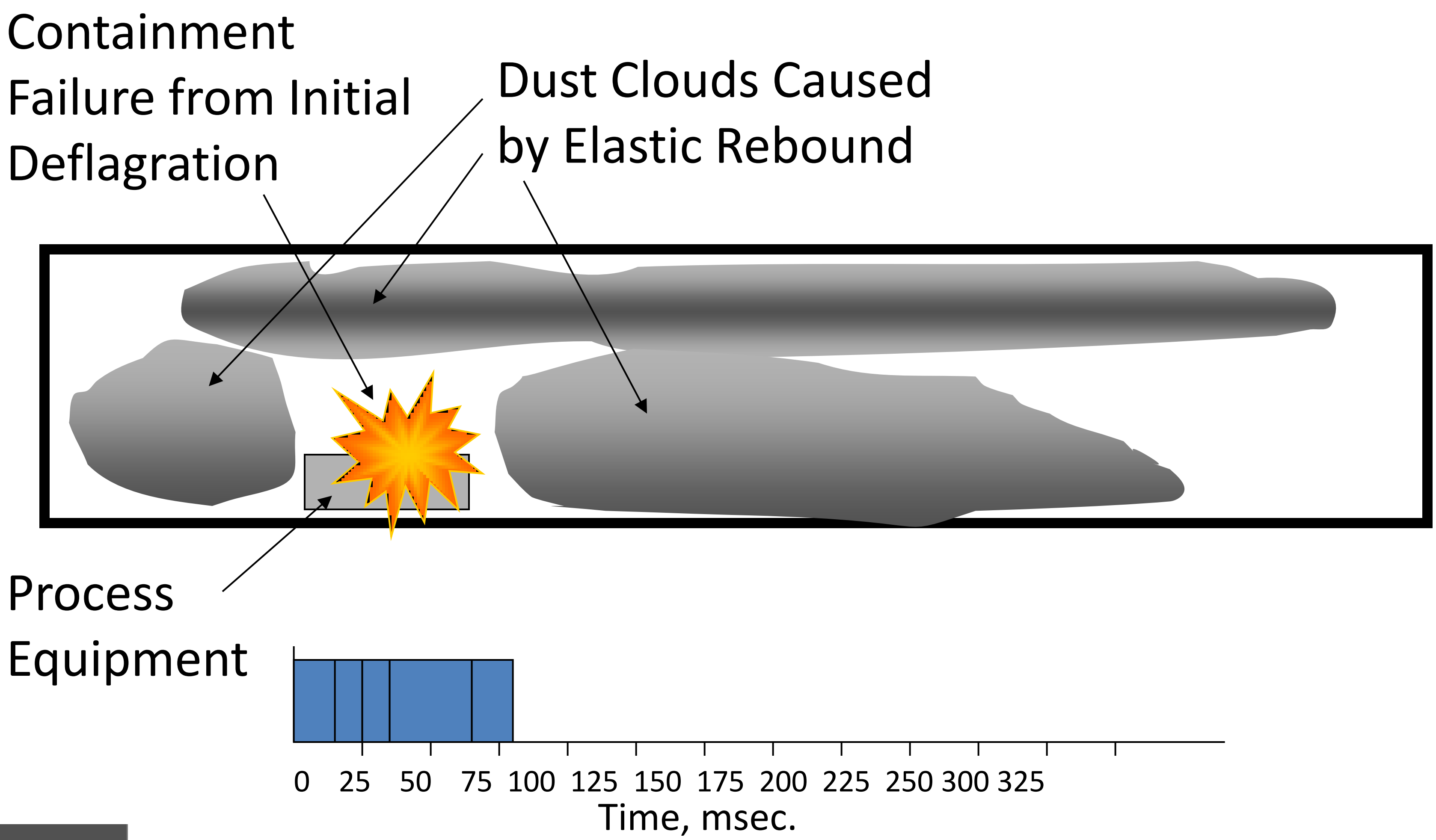

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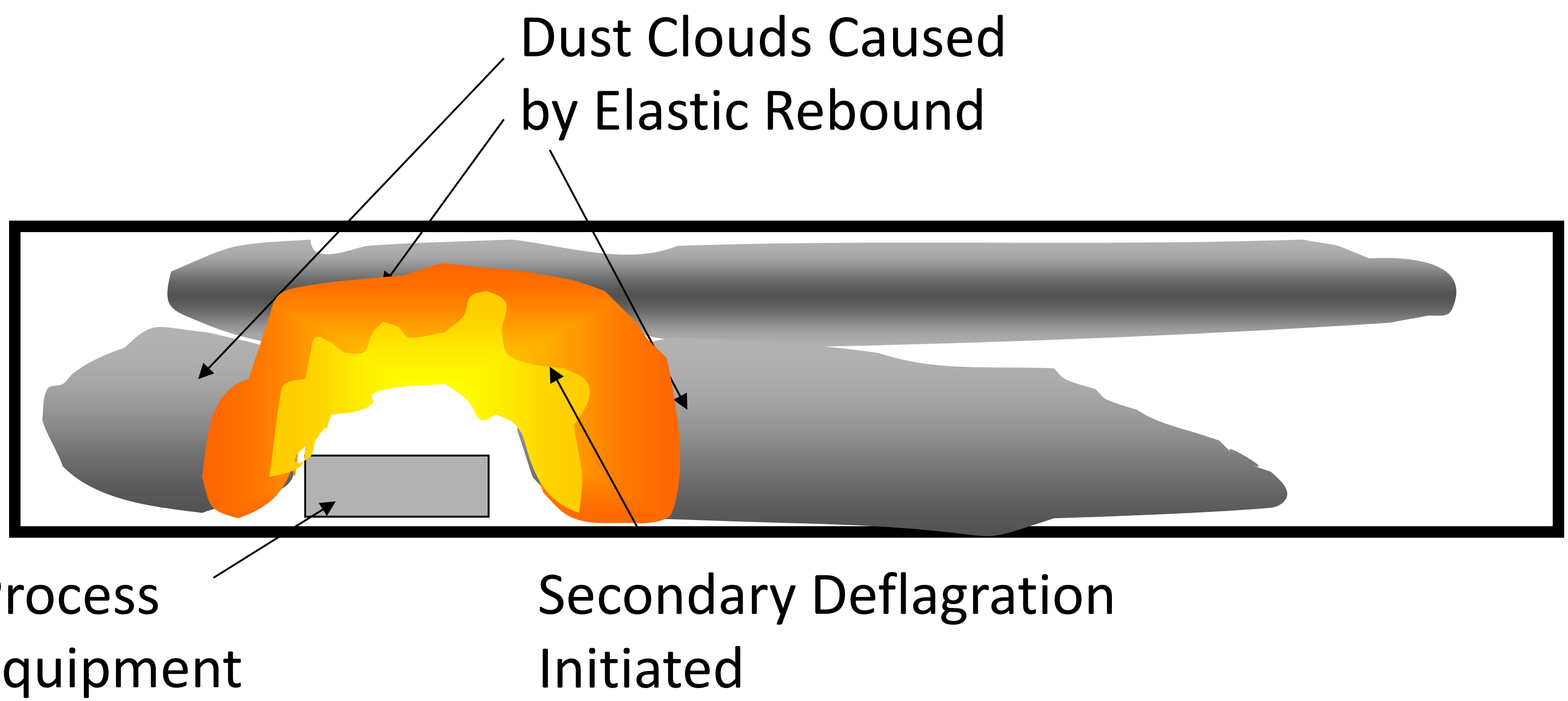

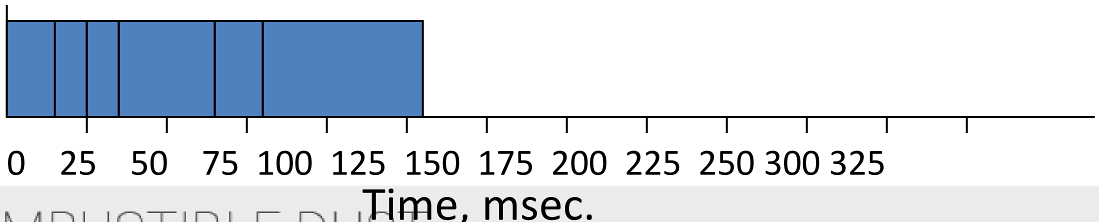

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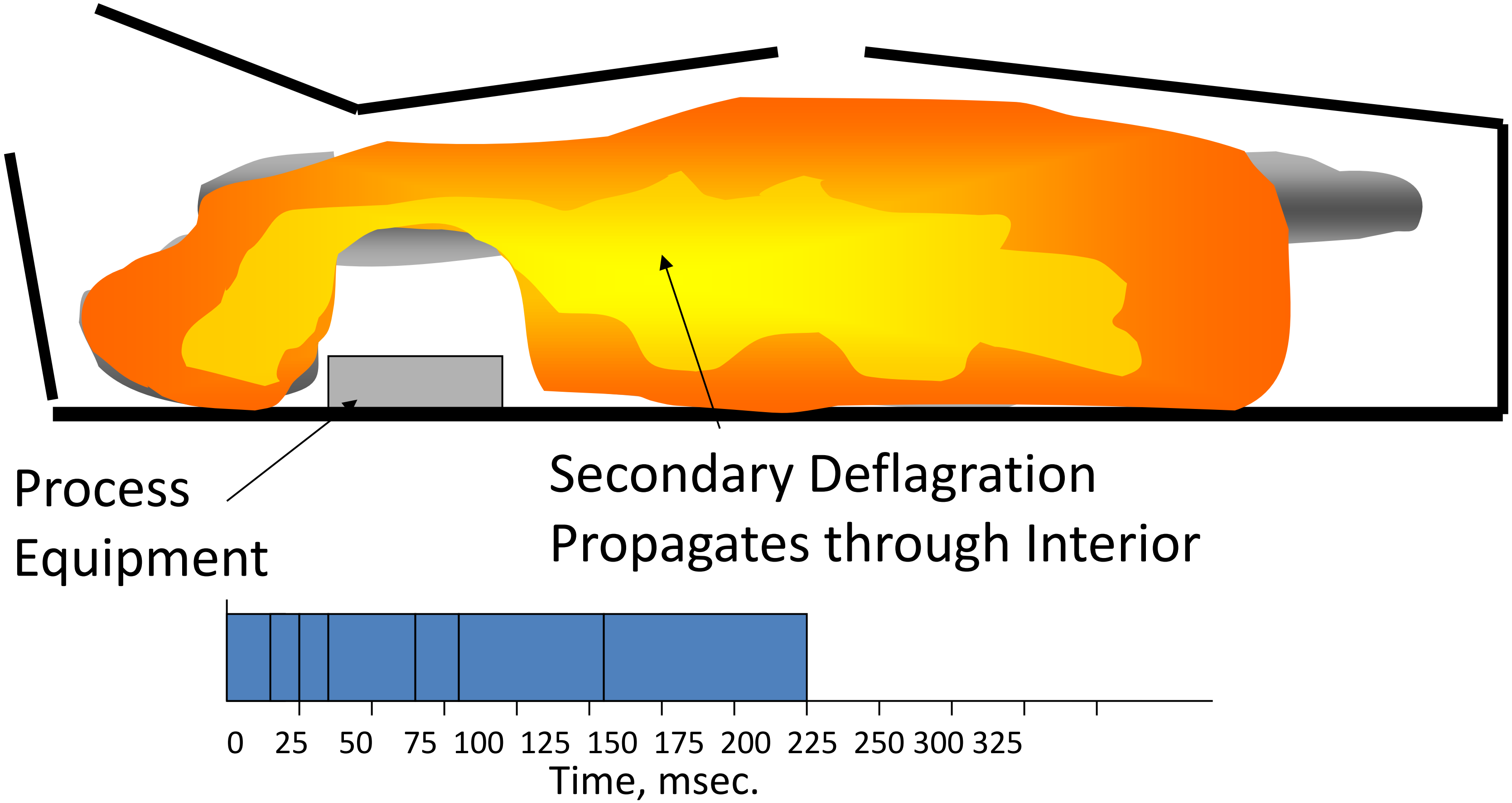

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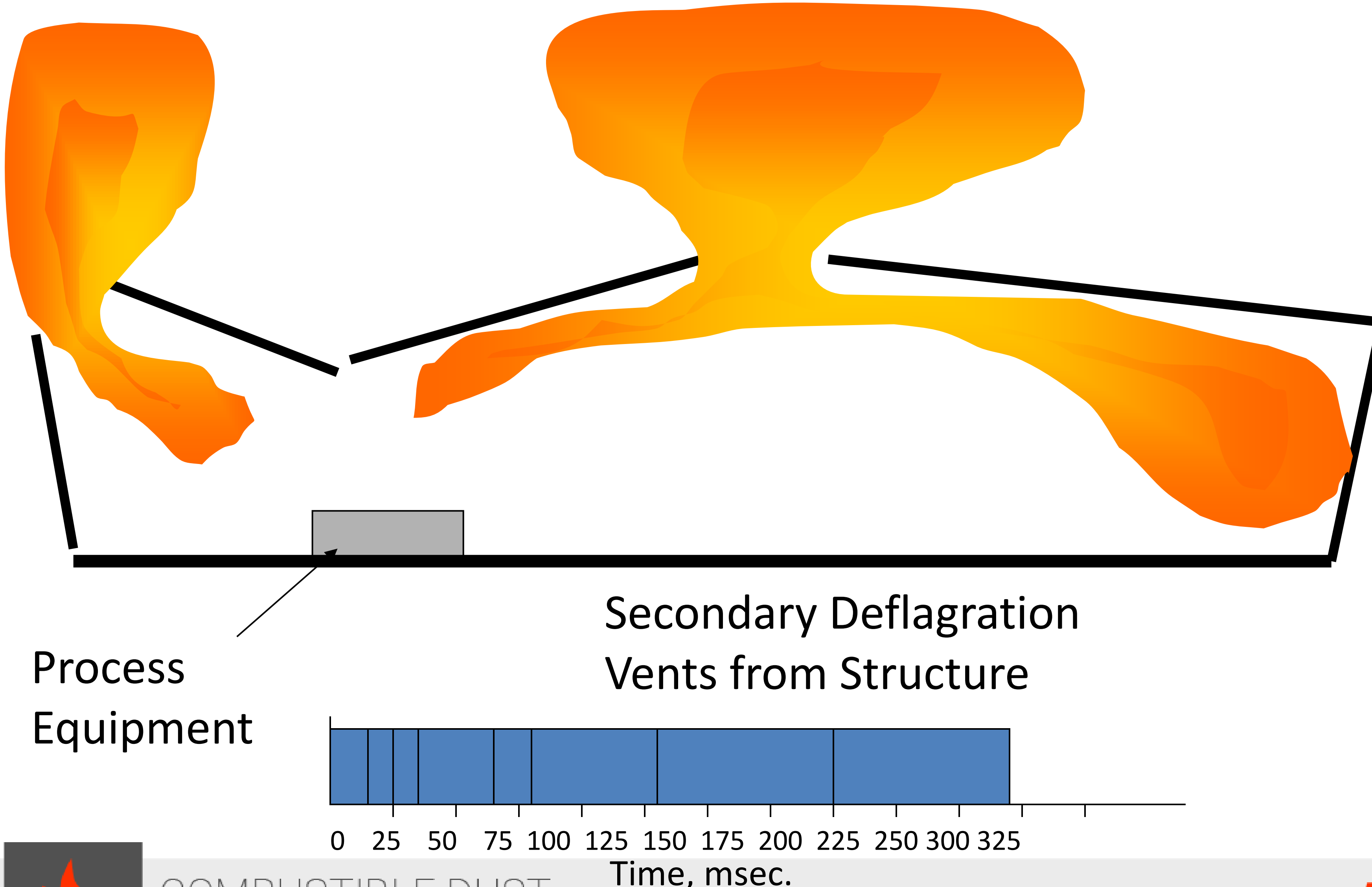
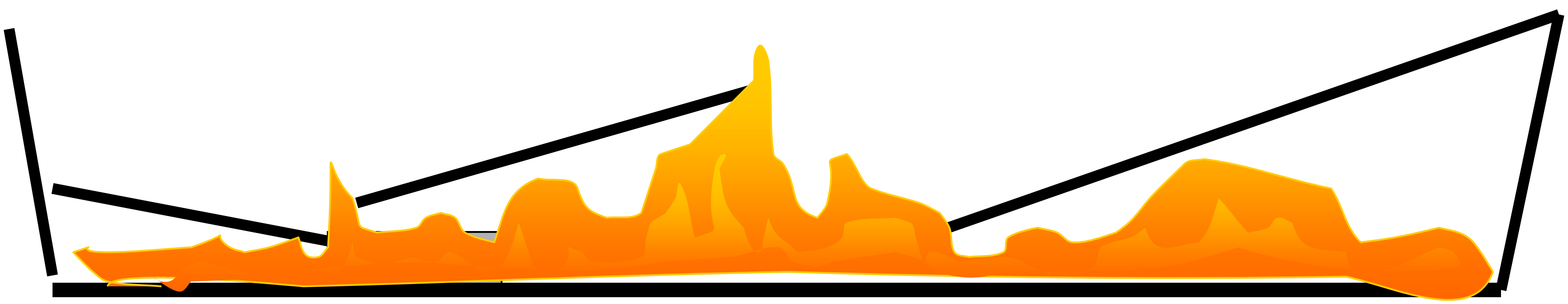
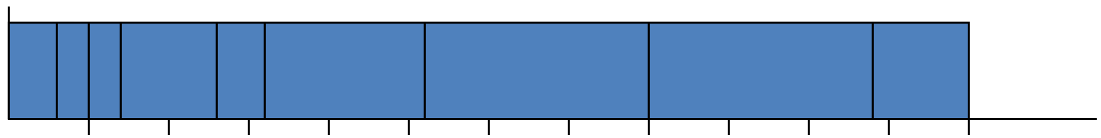
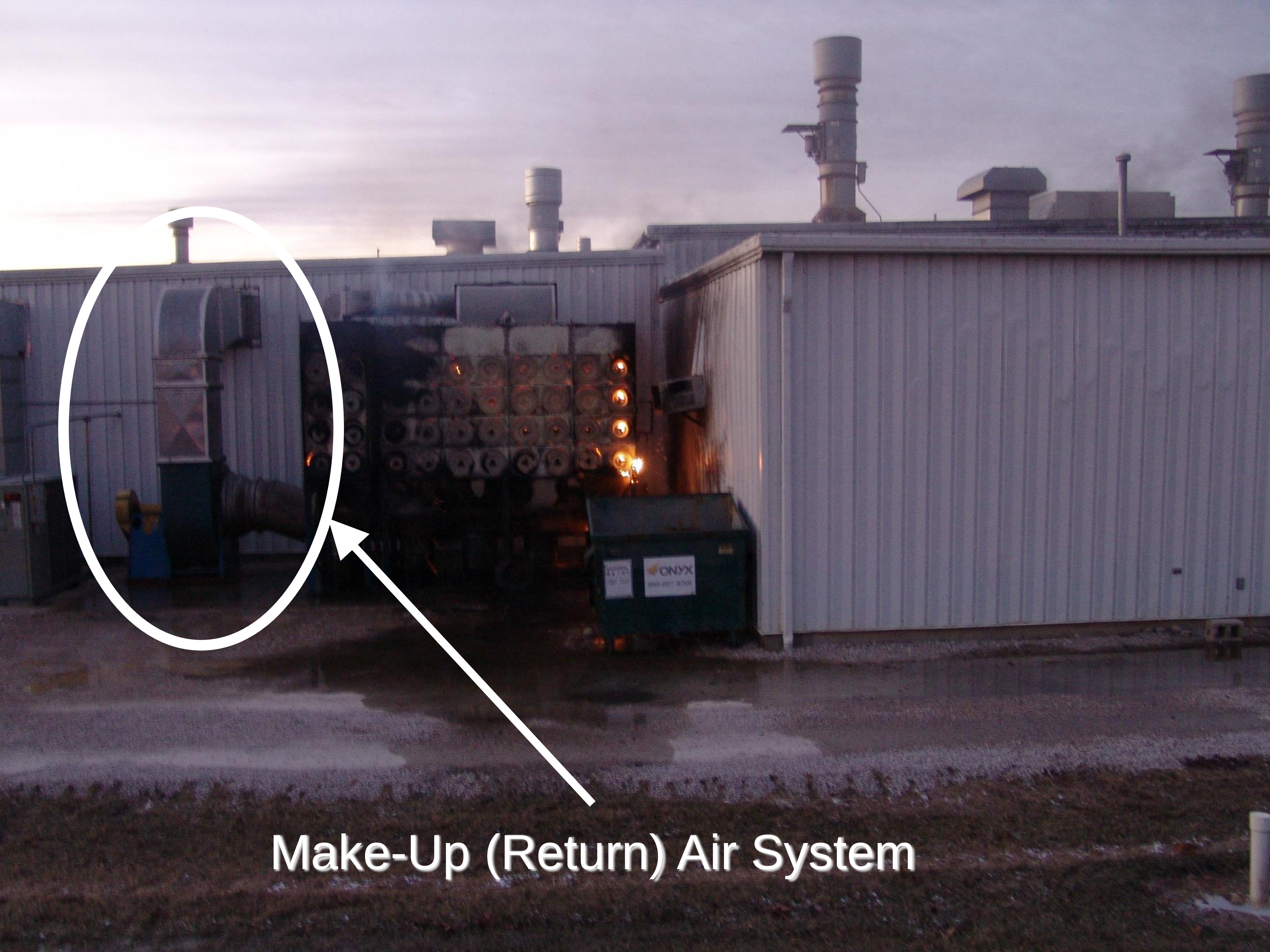


The “Typical” Explosion Event

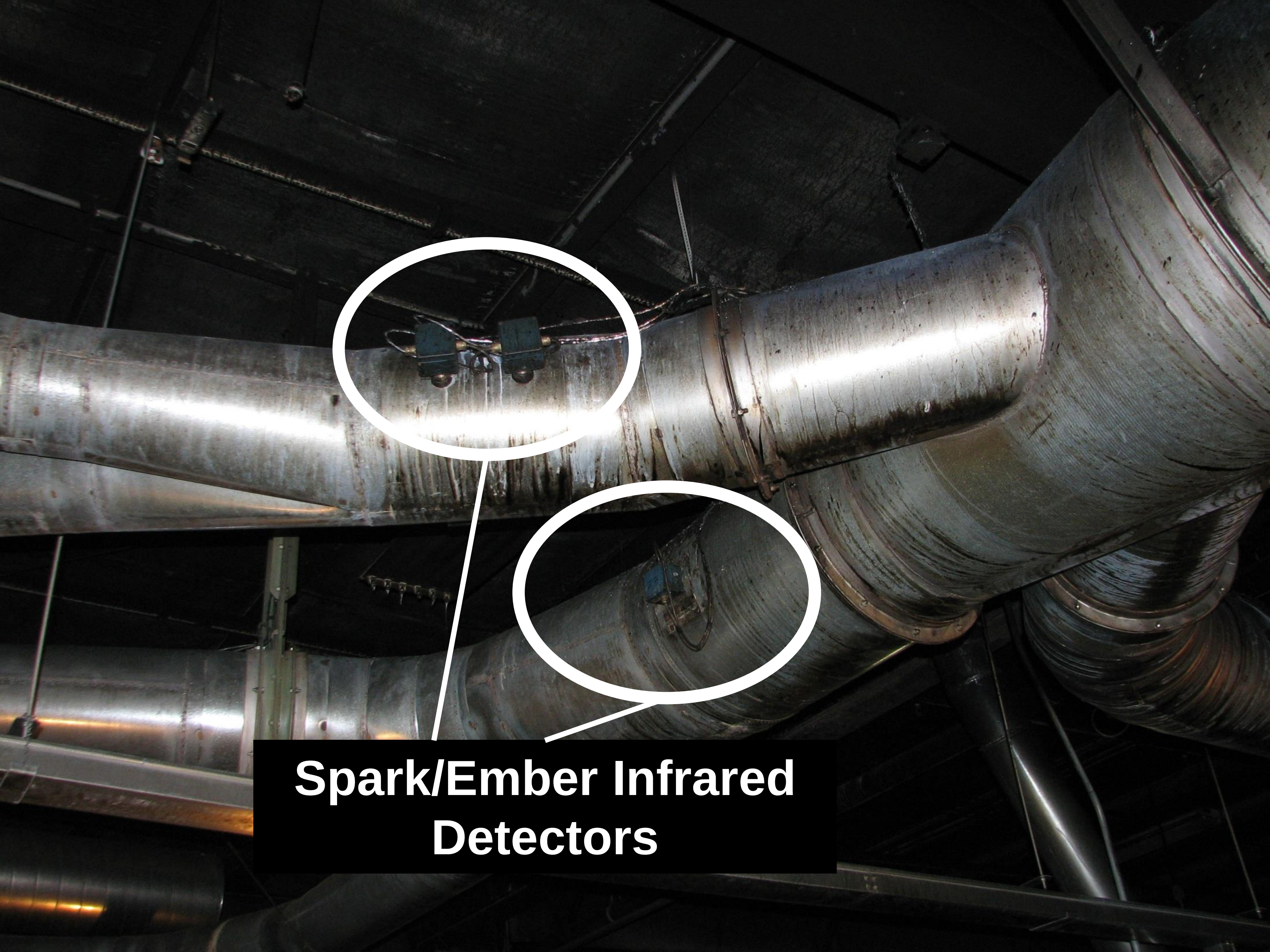
Secondary Deflagration
Causes Collapse and Residual Fires

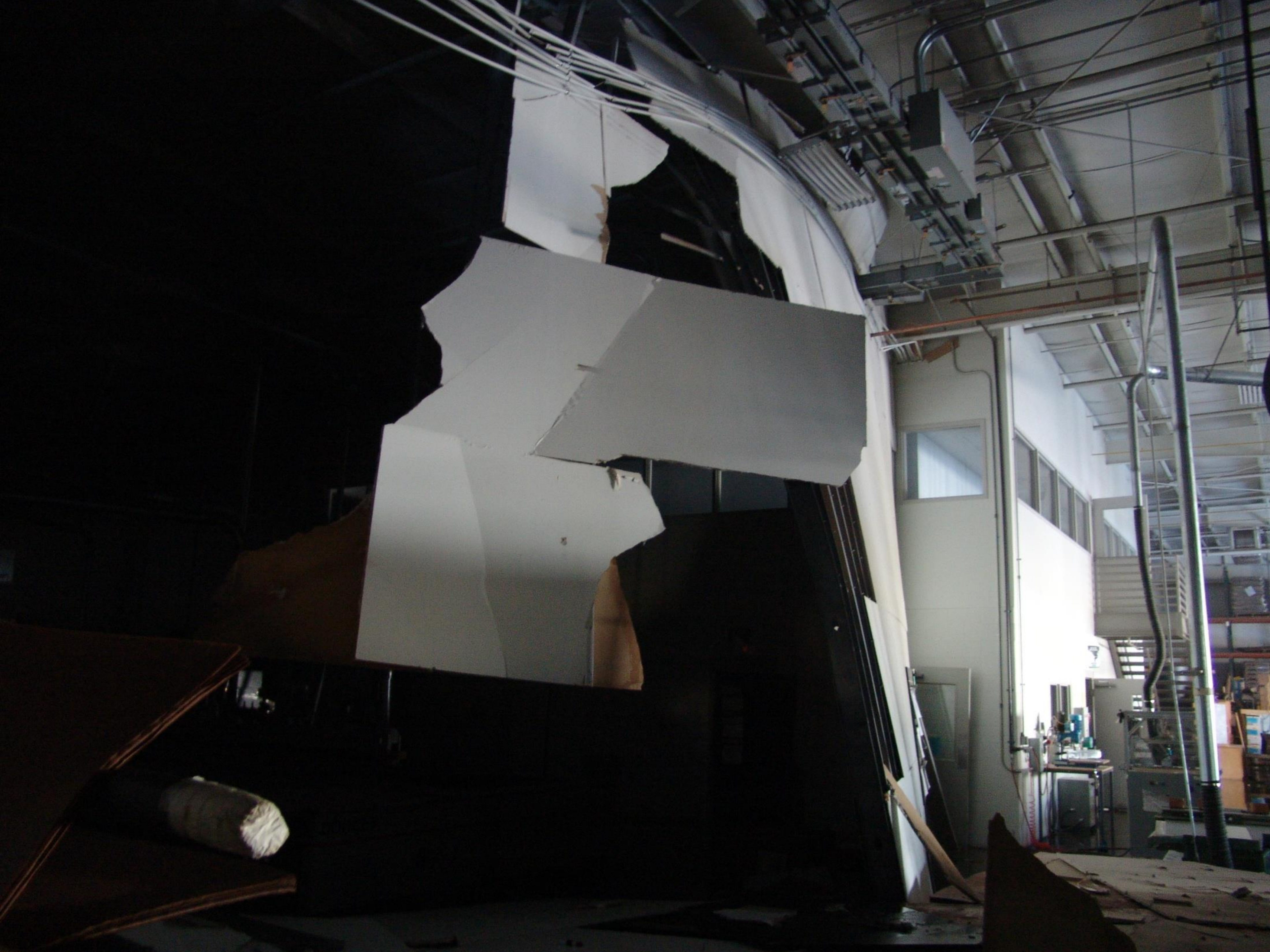





ONYX
Make-Up (Return) Air System


CAUTION
CAUTION
CAUTION


Spark/Ember Infrared Detectors



Combustible Dust Standards

Relevant OSHA Standards for Combustible Dust

- 1910.22 Housekeeping
- 1910.36 Design and Construction for Exit Routes
- 1910.37 Safeguards and Features for Exit Routes
- 1910.38 Emergency Action Plans
- 1910.39 Fire Prevention Plans
- 1910.94 Ventilation
- 1910.119 Process Safety Management
- 1910.132 Personal Protective Equipment
- 1910.145 Specifications for Accident Prevention Signs and Tags
- 1910.146 Permit-Required Confined Spaces
- 1910.157 Fire Extinguishers
- 1910.165 Employee Alarm Systems
- 1910.176 Material Handling
- 1910.178 Powered Industrial Trucks
- 1910.252 Hot Work (General Requirements)
- 1910.261 Pulp, Paper, and Paperboard Mills
- 1910.272 Grain Handling Facilities
- 1910.307 Hazardous Locations
- 1910.1200 HazCom

Industry or Commodity-Specific NFPA Standards

NFPA 61 STANDARD — Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities

NFPA 484 STANDARD — Standard for Combustible Metals

NFPA 664 STANDARD — Standard for the Prevention of Fires and Dust Explosions in Wood Processing and Woodworking Facilities

NFPA 654 STANDARD — Standard for the Prevention of Fires and Dust Explosions from Manufacturing, Processing and Handling of Combustible Particular Solids

Standard on Fundamentals of Combustible Dusts (NFPA 652-2016)

- Effective Date September 7, 2015
- Coexists with other NFPA industry specific standards
- Simplifies OSHA compliance and enforcement
- Provides the basic principles of and requirements for identifying and managing the fire and explosion hazards of combustible dusts and particulate solids

Retroactivity of NFPA Standards

- Where specified, provisions of the standards are retroactive
- For major replacement or renovation of existing facilities, all provisions of standards apply
- Where AHJ determines that the existing situation presents an unacceptable degree of risk, AHJ shall be permitted to apply retroactively **ANY** portions of standards deemed appropriate

2015 International Fire Code (IFC)

- 2204.1 – The fire code official is authorized to enforce applicable provisions of the codes and standards listed in Table 2204.1 to prevent and control dust explosions.
  - NFPA 61
  - NFPA 69
  - NFPA 484
  - NFPA 654
  - NFPA 655
  - NFPA 664

Uniform Fire Code (NFPA 1-2015)

- Equipment, processes, and operations that involve the manufacture, processing, blending, repackaging, or handling of combustible particulate solids or combustible dusts regardless of concentration or particle size shall be installed and maintained in accordance with this chapter and the following standards as applicable:
  - NFPA 61-2013
  - NFPA 68-2013
  - NFPA 69-2014
  - NFPA 484-2015
  - NFPA 654-2013
  - NFPA 664-2012

The "Magic" Formula

Identify Your Hazard

↓

Define the Scope of the Hazard in Your Process

↓

Identify Controls

↓

Identify Resources

↓

Commissioning & Documentation

↓

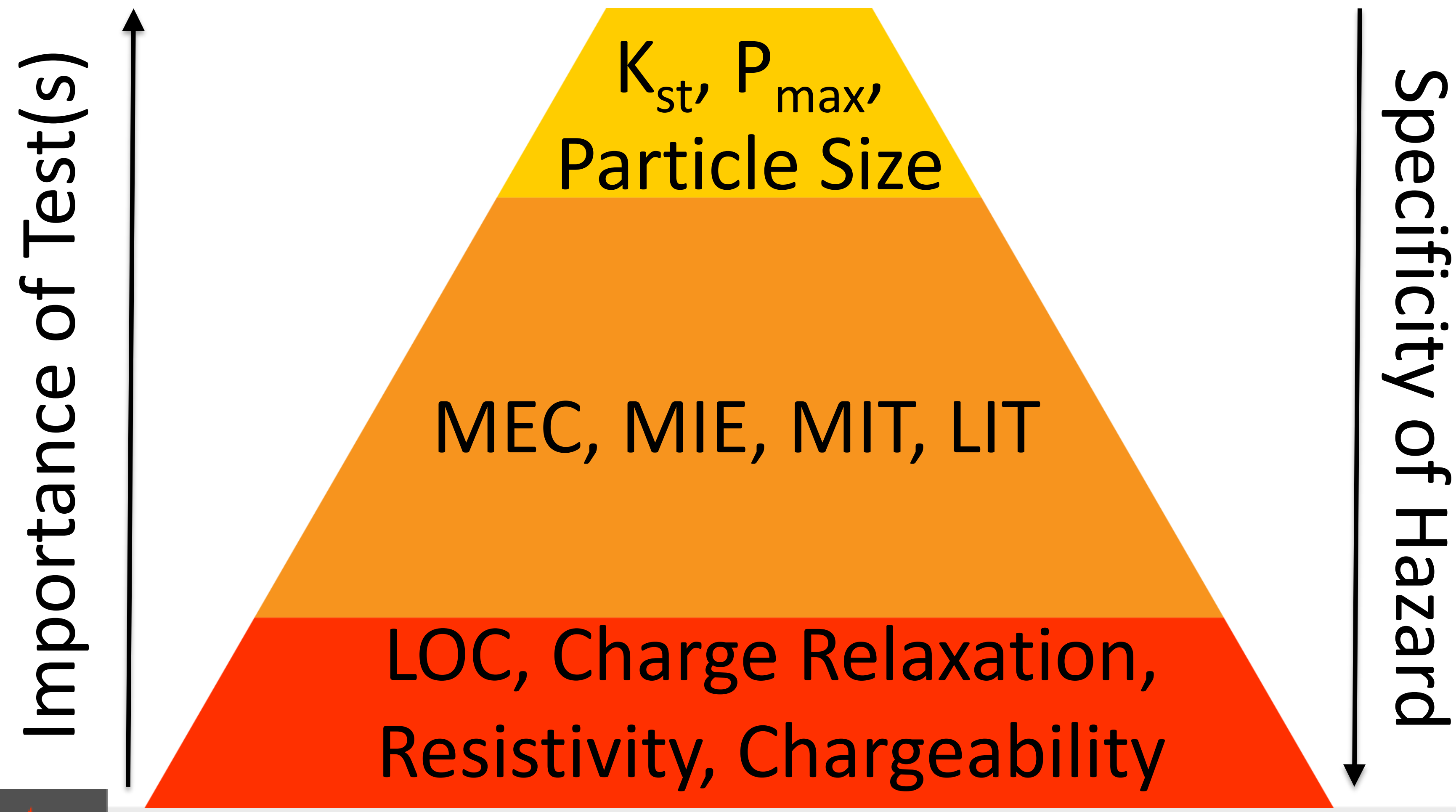
Sustain Performance

Step 1: Identify Your Hazard

Developing A Sampling Strategy

- Do you have every dust tested?
- What about if you have multiple dusts that may and may not mix?
- Do you test the dust buildup on surfaces, floor areas, or both?
- Do you test "as received" or prepared by sizing?
- Do you test at different stages of a process or at one location?

Hierarchy of Combustible Dust Testing



Step 2: Define the Scope of the Hazard in Your Process

Dust Hazard Analysis (DHA)

- Systematic review to identify and evaluate the potential fire, flash fire, and explosion hazards associated with the presence of one or more combustible particulate solids in a process or facility
- Determine the consequences of what could go wrong and to determine what safeguards could be implemented to prevent or mitigate those consequences
- <u>Does not need to comply with the PHA requirements contained in OSHA's PSM Standard</u>

DHA Methodology

- Identifies and evaluates the process or facility areas to determine if fire, flash fire, and explosion hazards exist
- Where such a hazard exists, identify and evaluate specific fire and deflagration scenarios:
  a. Identification of safe operating ranges
  b. Identification of the safeguards that are in place to manage fire, deflagration, and explosion events
  c. Recommendation of additional safeguards where warranted, including a plan for implementation

DHA Methodology

- What's Normal?
- What Can Go Wrong?
- How Bad is Bad?
- What Protection Currently Exists?
- What Additional Protection is Needed?

DHA General Requirements

- The owner/operator of a facility where materials that have been determined to be combustible or explosible are present in an enclosure <u>shall be responsible to ensure a DHA is completed</u>
- Requirement applied retroactively
- Must be performed by a qualified person
- Absence of previous incidents cannot be used as the basis for not performing a DHA

Timeline to Complete DHAs

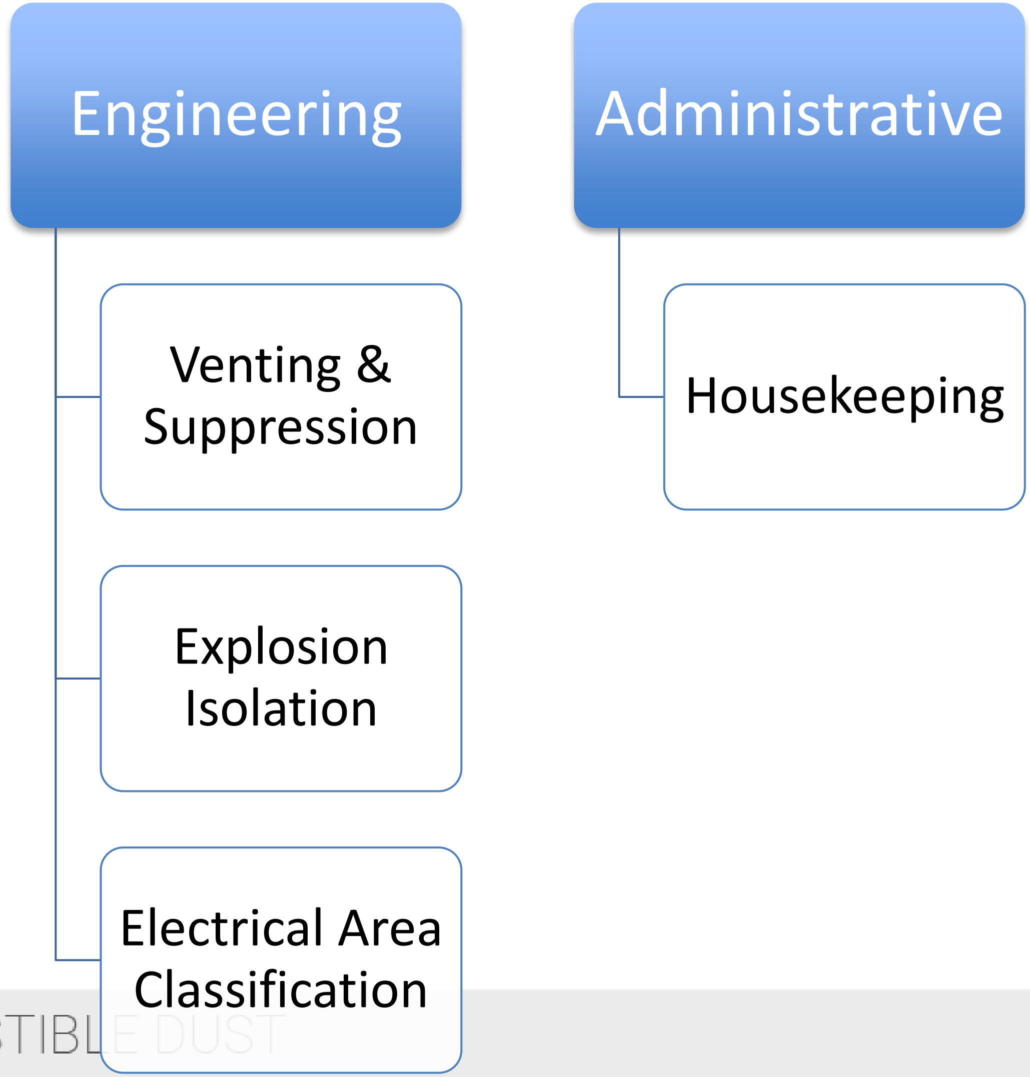
- For existing processes and facility compartments that are undergoing material modification, the owner/operator shall complete DHAs as part of the project
- For existing processes and facility compartments that are not undergoing material modification, the owner/operator shall schedule and complete DHAs of existing processes and facility compartments within a 3-year period from the effective date of the standard

Step 3: Identify Controls

Identify Controls to Minimize Hazards

- Use Information from DHA & Applicable Content from Consensus Standards to:
  - Develop a Basis of Design (BOD)
    - Overall process
    - Individual aspects of the process
  - Include in BOD
    - Facility design concepts
    - Equipment design concepts
    - Electrical classification concepts (NFPA 499)
    - Explosion & Fire Protection/Prevention (NFPA 68, 69)
    - Administrative Controls/Processes

Risk Mitigation Controls



EXAMPLES OF ENGINEERING CONTROLS

Explosion Protection Systems (Section 8.9.3.2 of NFPA 652-2016)

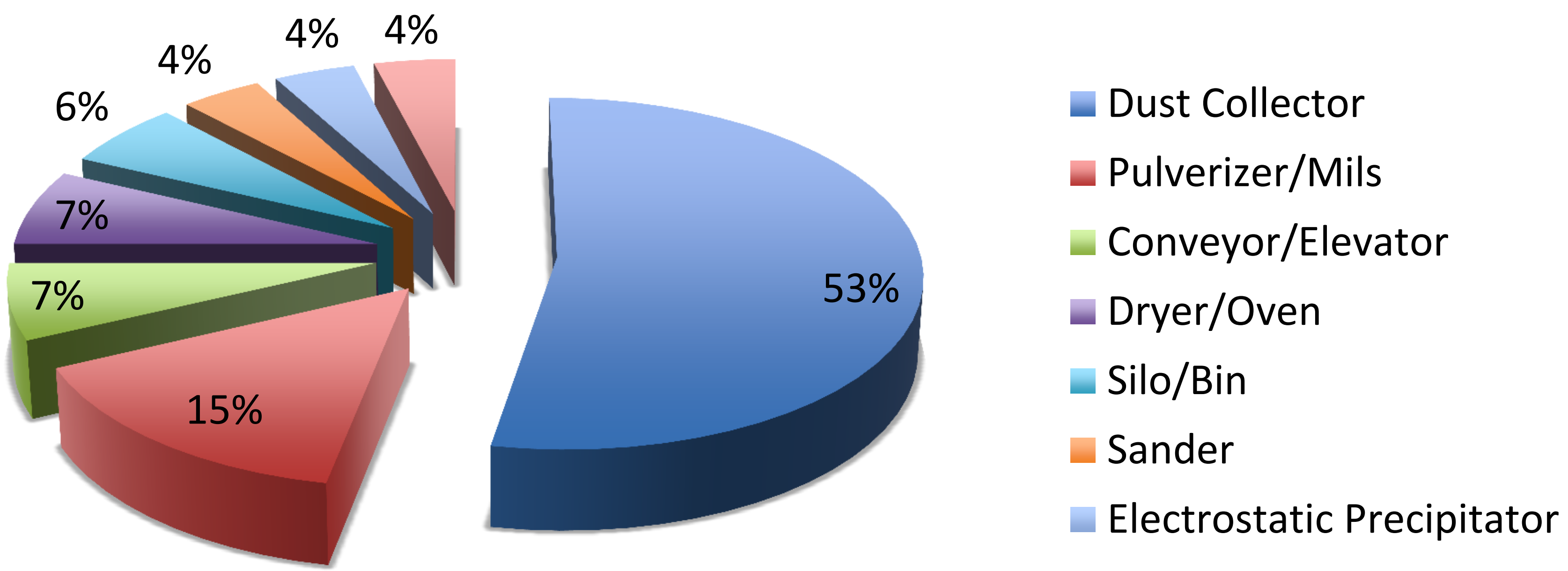
<u>Passive</u>

- Deflagration Venting
- Deflagration Pressure Containment
- Deflagration Venting Through a Listed Dust Retention and Flame-Arresting Device

<u>Active</u>

- Oxidant Concentration Reduction
- Deflagration Suppression Systems
- Dilution with a Noncombustible Dust

Explosions by Type of Process Equipment




WARNING
WARNING
WARNING
AIRFLOW
AIRFLOW
camfil


Donaldson
Torit
Donaldson
Torit

Suppression vs. Venting

- Equipment indoors & vent duct not practical
- Not enough vent area on equipment
- High K_{st} or hybrid dust
- No safe place to vent
- Toxic dusts cannot be discharged to atmosphere via a vent
- Flame propagation through interconnection suppression on equipment - isolation suppression controlled by same controls

EXAMPLES OF ADMINISTRATIVE CONTROLS

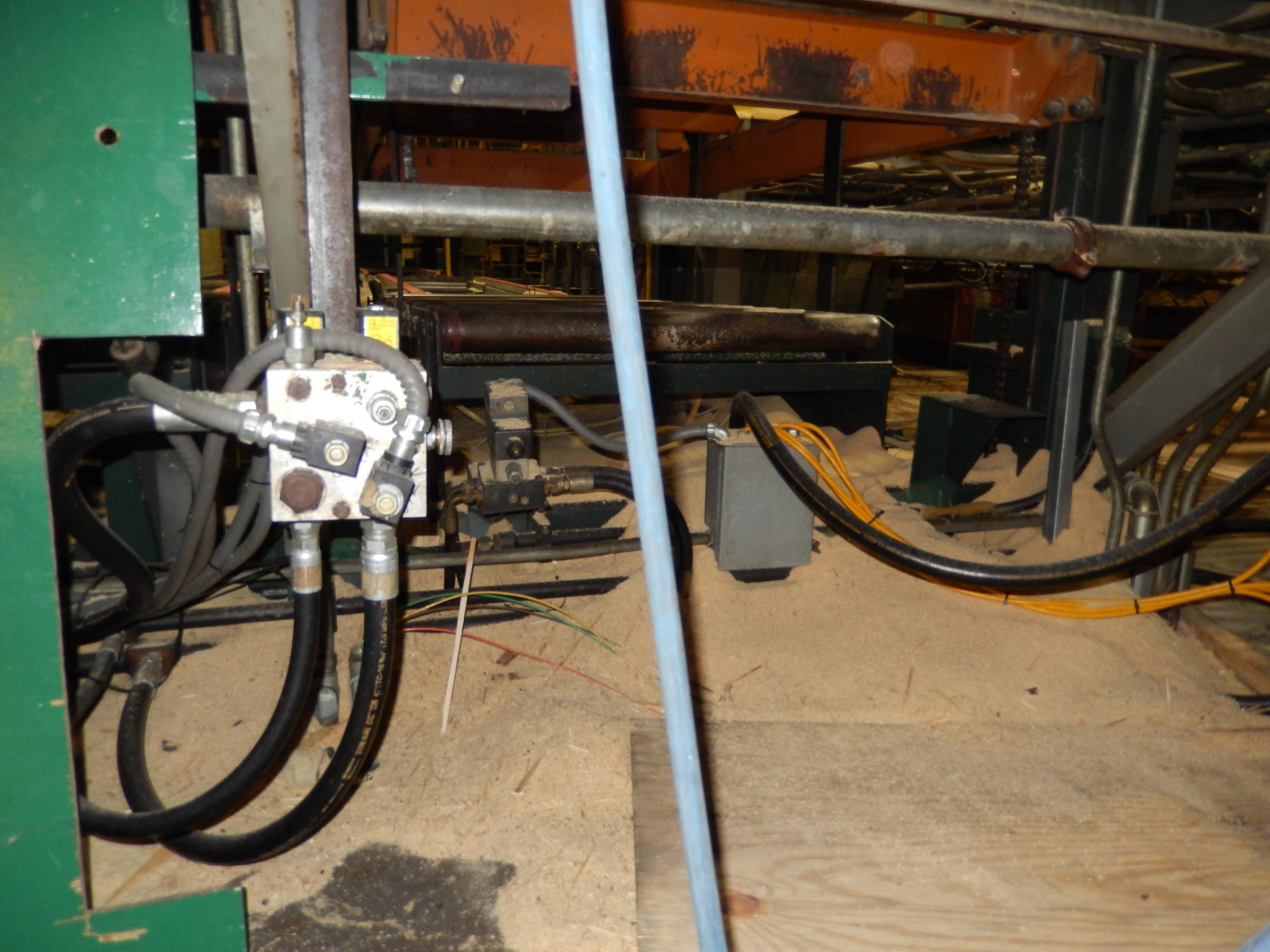
The Truth About Housekeeping

- **Good housekeeping alone <u>WILL NOT</u> prevent a fire or explosion, as well as injuries or fatalities**
- Large dust accumulations are a <u>secondary explosion hazard</u>
- Cleaning methods associated with housekeeping can actually introduce significant hazards

HOW MUCH DUST IS TOO MUCH DUST???

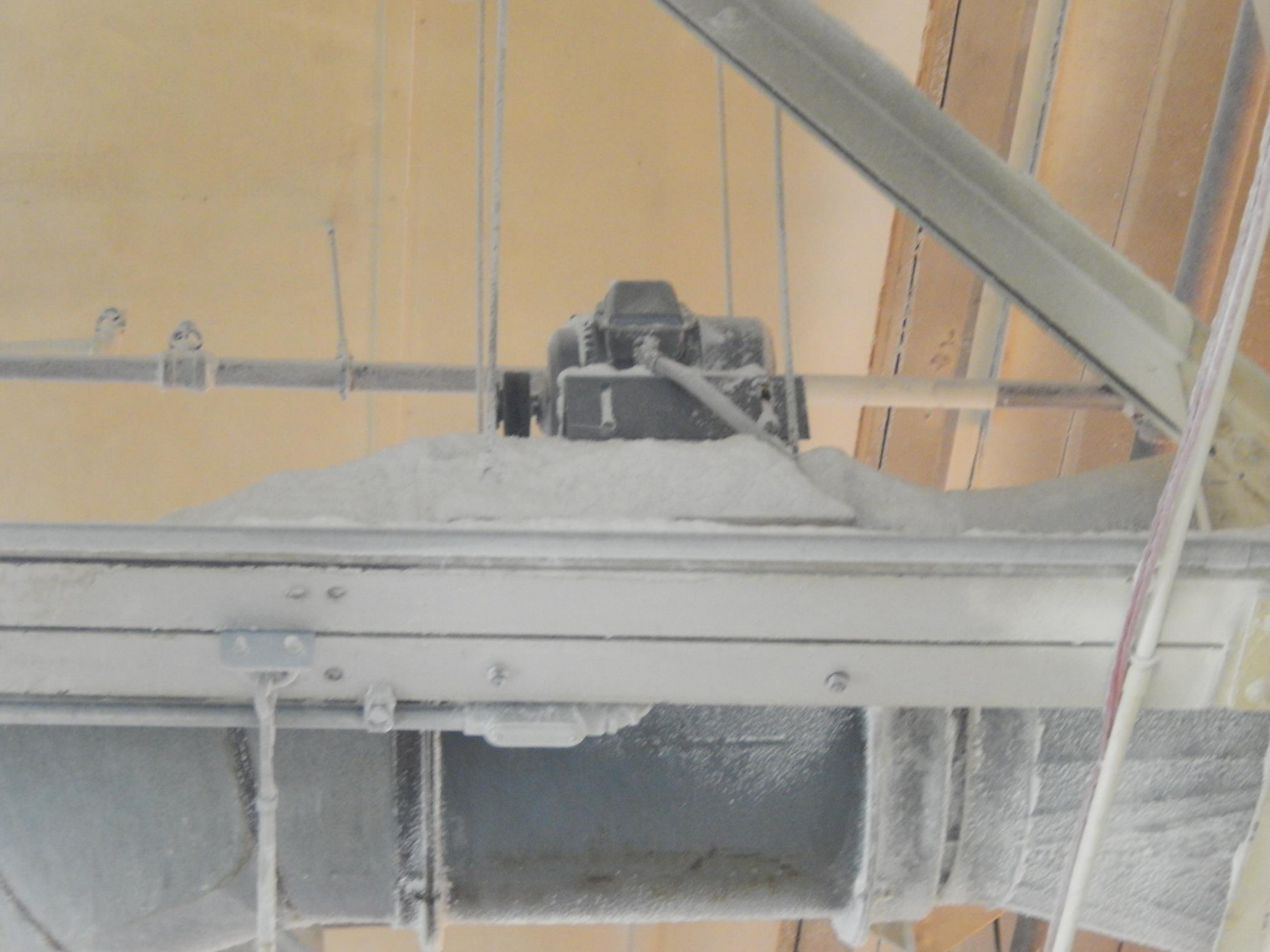
Housekeeping Memorandum

- Issued on April 21, 2015
- Provides guidance in calculating the levels of dust accumulations that may be allowed at workplaces for combustible dusts with bulk densities less than 75 lb/ft^3
- Supplements the dust accumulation guidance provided in several sections of NEP, including IX.E.3.c and d; IX.E.8; and IX.E.9.c and d
- Very low bulk density materials, such as tissue paper dust, may not create a deflagration hazard even at an accumulation level of ¼ inch, covering over five percent of the floor area or 1000 ft^2, whichever is less
- https://www.osha.gov/dep/enforcement/Combustible_Dusts_04212015.html




DANGER


AFFEX
BN1000



Poor Housekeeping Can Affect

- Electrical Classification
- Emergency Egress Requirements
- Selection of Powered Industrial Trucks
- Use of Flame-Resistant Clothing

op·vac
INDUSTRIAL
PUMP VAC
ASPIRATEUR POMPE
ASPIRADOR DE LA BOMBA
Peak HP
HP Max
Máximo
shop

Step 4: Identify Resources to Execute Your Plan

Resources

Internal

- Operations
- EHS
- Engineering
- Maintenance
- QA
- Procurement

External

- Consulting Firms
- Regulatory Authorities
- Insurance Reps
- NFPA
- US Chemical Safety Board

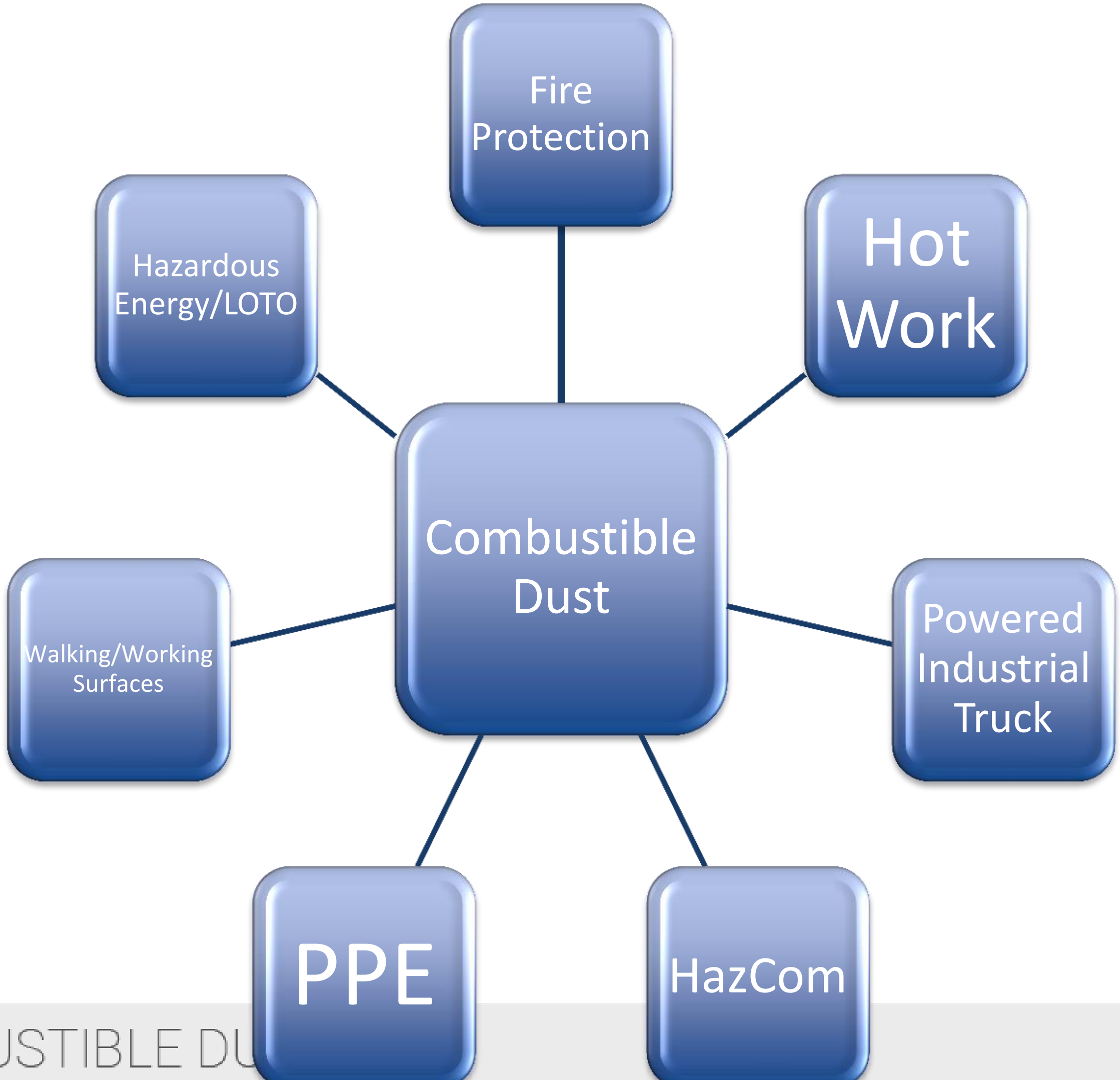
Step 5: Commissioning & Documentation

Document EVERYTHING

- Dust Testing Data
- PHA (Review Every 5 Years)
- Basis of Design
  - Facility
  - Explosion Protection
  - Administrative Controls
- Commissioning Documents
  - Explosion Suppression & Isolation Systems
- Training Records
- Names & Qualifications of Resources Used

Step 6: Sustain Performance

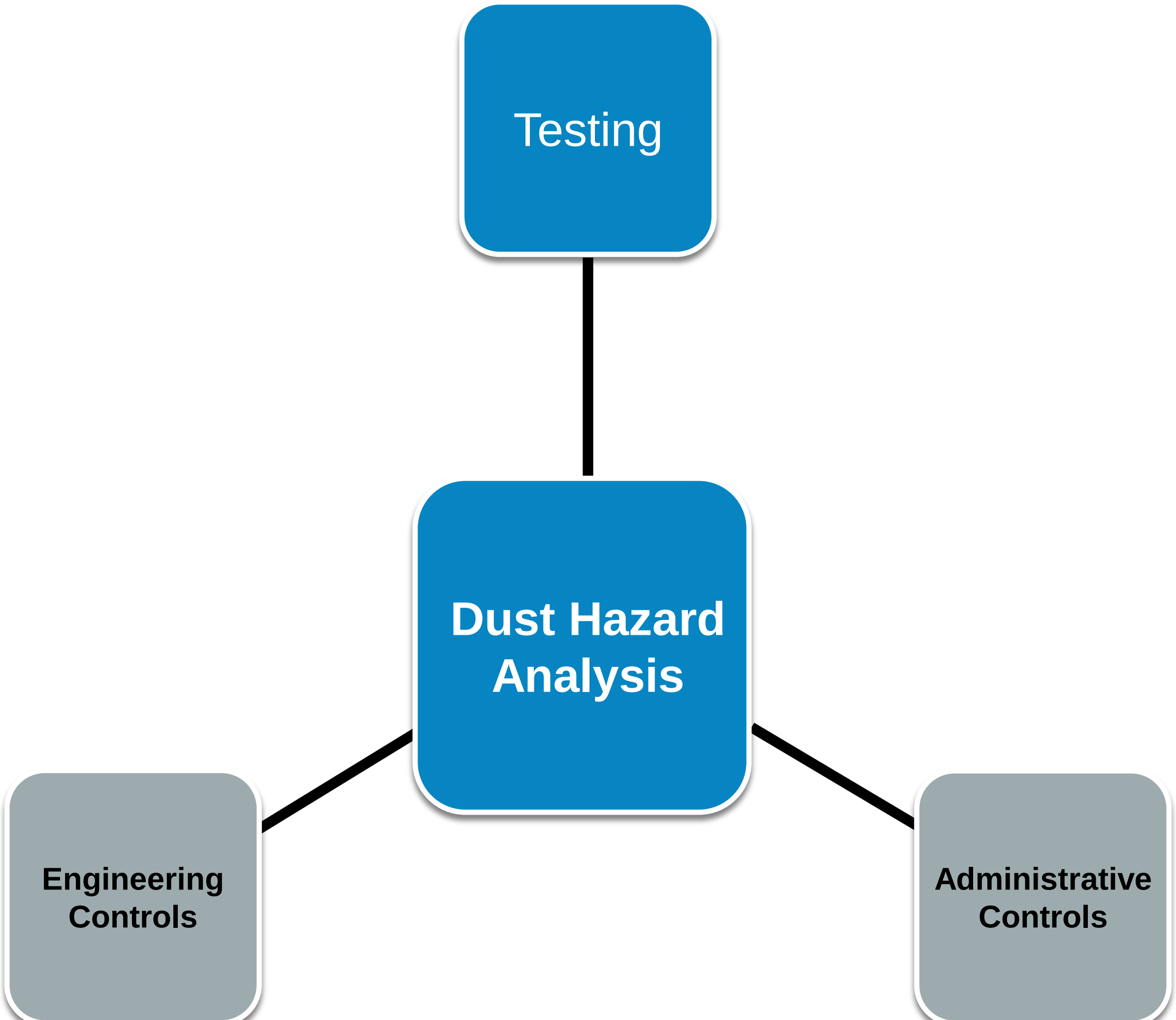
Safety Program Integration



Environmental Implications

- Loss of Building Containment
- Soil & Groundwater Contamination
- Emissions from Combustion By-Products
- Disturbance of Asbestos Containing Materials
- Permitting for Dust Collectors
- "Firing Element" for Chemical Suppression
  - Tier II Reporting
- By-Products of Fighting Fires

Hazard Recognition



Hazard Mitigation

Questions???

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