Overview

- Current Combustible Dust Landscape
- Why was NFPA 652 needed?
- Who does NFPA 652 cover and how is it applied?
- Key Aspects of NFPA 652
- Conflicts between NFPA 652 and other NFPA standards
- Examples of Hazards Covered by NFPA 652

Still 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
Key Factors Contributing to Incidents

- Workers and managers
  - Often unaware of dust explosion hazards (SDS ≠ help)
  - Failed to recognize the serious nature of dust explosion hazards
- Facility management failed to conform to NFPA standards that would have prevented or reduced the effects of the explosions
- Warning events were accepted as normal and their causes were not identified and resolved
- Outside parties inspecting the facilities failed to identify dust explosion hazards:
  - Government Enforcement
  - Insurance Underwriters
  - Safety & Health Professionals

HOW MANY STANDARDS CURRENTLY ADDRESS COMBUSTIBLE DUST HAZARDS???
Why Was NFPA 652 Needed?

- Requirements were inconsistent between the various industry sectors and the dust types
- Lead to confusion in determining which standard applied and how to protect similar hazards within a given process
- Establishes the relationship and hierarchy between NFPA 652 and any of the NFPA combustible dust standards
- Simplifies OSHA compliance and enforcement
Scope & Application of NFPA 652

• Provides the basic principles of and requirements for identifying and managing the fire and explosion hazards of combustible dusts and particulate solids

• Applies to ALL facilities and operations manufacturing, processing, blending, conveying, repackaging, generating, or handling combustible dusts or combustible particulate solids

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

<table>
<thead>
<tr>
<th>Plastic Dust</th>
<th>Corn Starch Dust</th>
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<tbody>
<tr>
<td>99% 420 μm</td>
<td>100% 420 μm</td>
</tr>
<tr>
<td>Kst = 340 b.m/s</td>
<td>Kst = 144 b.m/s</td>
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</tbody>
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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
Combustible Dust Hazards

- **Flash Fire**
  - Fire that spreads by means of a flame front rapidly through a diffuse fuel without the production of damaging pressure

- **Deflagration**
  - Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium

- **Explosion**
  - Bursting or rupturing of an enclosure or a container due to the development of internal pressure from a deflagration

Scope & Application

- NFPA 652 does not apply to the following:
  1. Storage or use of consumer quantities of such materials on the premises of residential or office occupancies
  2. Storage or use of commercially packaged materials at retail facilities
  3. Such materials displayed in original packaging in mercantile occupancies and intended for personal or household use or as building materials

- NFPA 652 does not apply to the following:
  4. Warehousing of sealed containers of such materials when not associated with an operation that handles or generates combustible dust
  5. Such materials stored or used in farm buildings or similar occupancies for on-premises agricultural purposes
General Requirements

• The owner/operator of a facility with potential combustible dust shall be responsible for:
  1. Determining the combustibility and explosibility hazards of materials in accordance with Chapter 5
  2. Identifying and assessing any fire, flash fire, and explosion hazards in accordance with Chapter 7
  3. Managing the identified fire, flash fire, and explosion hazards in accordance with 4.2.4
  4. Communicating the hazards to affected personnel in accordance with Section 9.5

Screening for Combustibility

• Determination of combustibility or explosibility shall be based upon:
  1. Historical facility data or published data that are deemed to be representative of current materials and process conditions
  2. Analysis of representative samples in accordance with the requirements of 5.4.1 and 5.4.3

To Test or Not To Test?

• Testing may not be required where reliable, in-house commodity-specific testing data or published data of well-characterized samples are available
  – Published data should be used for preliminary assessment of combustibility only
• Test data derived from testing material within a facility will result in the most accurate results for the DHA, performance-based design, and hazard management options
• Absence of previous incidents cannot be used as the basis for deeming a particulate to not be combustible or explosive
Sampling Strategy

- A sampling plan shall be developed and documented to provide data as needed to comply with the requirements of Chapter 5.
- The sampling plan shall include the following:
  1. Identification of locations where fine particulates and dust are present.
  2. Identification of representative samples.
  3. Collection of representative samples.
  4. Preservation of sample integrity.
  5. Communication with the test laboratory regarding sample handling.
  6. Documentation of samples taken.
  7. Safe sample collection practices.

Hierarchy of Combustible Dust Testing

- Importance of Test(s)
  - Specificity of Hazard
  - Particle Size
  - LOC, Charge Relaxation, Resistivity, Chargeability
  - MEC, MIE, MIT, LIT
  - $K_{DP}$, $P_{max}$
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
• Does not need to comply with the PHA requirements contained in OSHA’s PSM Standard

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 shall be responsible to ensure a DHA is completed
• 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

Conflicts

• Where a requirement specified in a commodity-specific NFPA standard differs from the requirement specified in NFPA 652, the requirement in the commodity-specific standard shall be used
• Where a commodity-specific NFPA standard specifically prohibits a requirement specified in NFPA 652, the prohibition in the industry or commodity-specific standard shall be applied
Conflicts

- Where an industry or commodity-specific NFPA standard neither prohibits nor provides a requirement, the requirement in NFPA 652 shall be applied.
- Where a conflict between a general requirement of NFPA 652 and a specific requirement of NFPA 652 exists, the specific requirement shall apply.

Explosion Prevention/Protection

- Where an explosion hazard exists within any operating equipment greater than 8 ft$^3$ of containing volume, the equipment shall be protected from the effects of a deflagration using one or more of the following methods of protection:
  1. Oxidant concentration reduction in accordance with NFPA 69
  2. Deflagration venting in accordance with NFPA 68
  3. Deflagration venting through listed flame-arresting devices in accordance with NFPA 68
  4. Deflagration pressure containment in accordance with NFPA 69
  5. Deflagration suppression system in accordance with NFPA 69
  6. Dilution with a noncombustible dust to render the mixture noncombustible
Dust Containment Design

• All components of enclosed systems that handle combustible particulate solids shall be designed to prevent the escape of dust, except for openings intended for intake and discharge of air and material
• Where the equipment cannot be designed for dust containment, dust collection shall be provided
Dust Collection Systems

- System Documentation & Monitoring
- Required Duct Transport Velocity Maintained
- Bonding and Grounding
- Analysis of Additional Branch Ducts
- Prohibition of Blankling Off Unused Portions
- Limit Use of Blast Gates

Housekeeping

- Housekeeping procedures shall be documented and should include:
  1. Risk assessment
  2. Personal safety procedures (including fall protection)
  3. Personal protective equipment
  4. Cleaning sequence
  5. Cleaning methods to be used
  6. Equipment, including lifts, vacuum systems, attachments, etc.
  7. Cleaning frequency
- Housekeeping frequency and accumulation goals shall be established to ensure that the accumulated fugitive dust levels on surfaces do not exceed the threshold dust accumulation limits
Portable Vacuum Cleaners

- Portable vacuum cleaners that meet the following minimum requirements shall be permitted to be used to collect combustible particulate solids in unclassified (nonhazardous) areas:
  1. Materials of construction shall comply with 8.5.7.1
  2. Hoses shall be conductive or static dissipative
  3. All conductive components, including wands and attachments, shall be bonded and grounded
  4. Dust-laden air shall not pass through the fan or blower
  5. Electrical motors shall not be in the dust-laden air stream unless listed for Class II, Division 1, locations
  6. Where liquids or wet materials are picked up by the vacuum cleaner, paper filter elements shall not be used
  7. Vacuum cleaners used for metal dusts shall meet the requirements of NFPA 484

Compressed Air Blowdowns

- Where blowdown using compressed air is used, the following precautions shall be followed:
  1. Prior to using compressed air, vacuum cleaning, sweeping, or water washdown methods are used to clean surfaces that can be safely accessed
  2. Dust accumulations in the area after vacuum cleaning, sweeping, or water washdown do not exceed the threshold housekeeping dust accumulation
  3. Compressed air hoses are equipped with pressure relief nozzles limiting the discharge pressure to 30 psi in accordance with OSHA requirements in 29 CFR 1910.242(b)
Compressed Air Blowdowns

Where blowdown using compressed air is used, the following precautions shall be followed:

4. All electrical equipment, including lighting, potentially exposed to airborne dust in the area during cleaning is suitable for use in a Class II, Division 2, hazardous (classified) location.

5. All ignition sources and hot surfaces capable of igniting a dust cloud or layer are shut down or removed from area.

6. After blowdown is complete, residual dust on lower surfaces is cleaned prior to re-introduction of potential ignition sources.

7. Where metal or metal-containing dust or powder under the scope of NFPA 484 is present, the requirements of NFPA 484 apply.
Other Important Aspects of NFPA 652

- Sources of Ignition
- Flame-Resistant Garments
- Management Systems
- Management of Change

Future of NFPA Combustible Dust Standards

- Standardized Definitions for Specific Terms
- Similar Layouts for Standards
- Better Correlation Between Standards
- What is Fundamental?

Hazard Identification

Dust Hazard Analysis

- Engineering Controls
- Administrative Controls

Hazard Mitigation
What to Look For in Your Facilities

• Has all of your dust(s) been tested to determine its combustibility and explosibility?
• Have all potential combustible dust hazards been assessed using a DHA, risk assessment or similar method?
• Are all surfaces and floor areas cleaned at an adequate frequency?

What to Look For in Your Facilities

• What methods are used to clean or remove combustible dust(s) from your facility?
• Is all process equipment effectively protected against fires, deflagrations and explosions?
• Are all employees effectively trained on the hazards associated with your dust(s)?

Questions???

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