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Combustible Dust Hazards and Abatement Techniques in Feed and Grain Industries

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About CTI and the Presenter

Conversion Technology, Inc. (CTI) is an Environmental and Safety Engineering Firm with over 33 years experience working with industrial clients across North America.

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Engineering Manager
Alternate Principal Member of NFPA 61 and 664

Adam Haroz, EIT

Introduction

Today we will discuss:

- Why to conduct a Dust Hazard Analysis (DHA) at your facilities
- Who “regulates” the DHAs
- Who can conduct a DHA
- Typical hazards and challenges in Feed and Grain
- Hazard Abatement Techniques and Implementing DHA recommendations

Image from U.S. Chemical Safety Board

Why Conduct a DHA?

- Ensure fire and explosion protection is sufficient to:
  1. Protect employees,
  2. Maintain business continuity.
- Identify safe operating ranges.
- Codes require it (North America and Europe).

Lakeland Mills Sawmill Explosion
Photo from Brent Braaten / The Canadian Press

National Fire Protection Association

- Several standards exist to prevent dust fires and explosions.
- In the USA, the National Fire Protection Association (NFPA) maintains standards associated with combustible dust.
- The National Fire Protection Association (NFPA) is charged with creating standards for fire prevention.
- NFPA has no enforcement power of their own.

Current NFPA Standards

The below standards can apply to facilities:

- NFPA 652 – Fundamentals of Combustible Dust
- NFPA 654 – Prevention of Fire and Dust Explosions from Combustible Particulate Solids (General)
- NFPA 484 – Standard for Combustible Metals
- NFPA 655 – Standard for Prevention of Sulfur Fires and Explosions
- NFPA 664 – Wood Processing and Woodworking Facilities
- NFPA 61 – Agricultural and Food Processing Facilities
- NFPA 68 – Standard for Explosion Protection by Venting
- NFPA 69 – Standard on Explosion Prevention Systems
- NFPA 91 – Standard for Exhaust systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids

NFPA 652

NFPA 652 – Standard on the Fundamentals of Combustible Dust – has specific requirements for conducting DHAs:

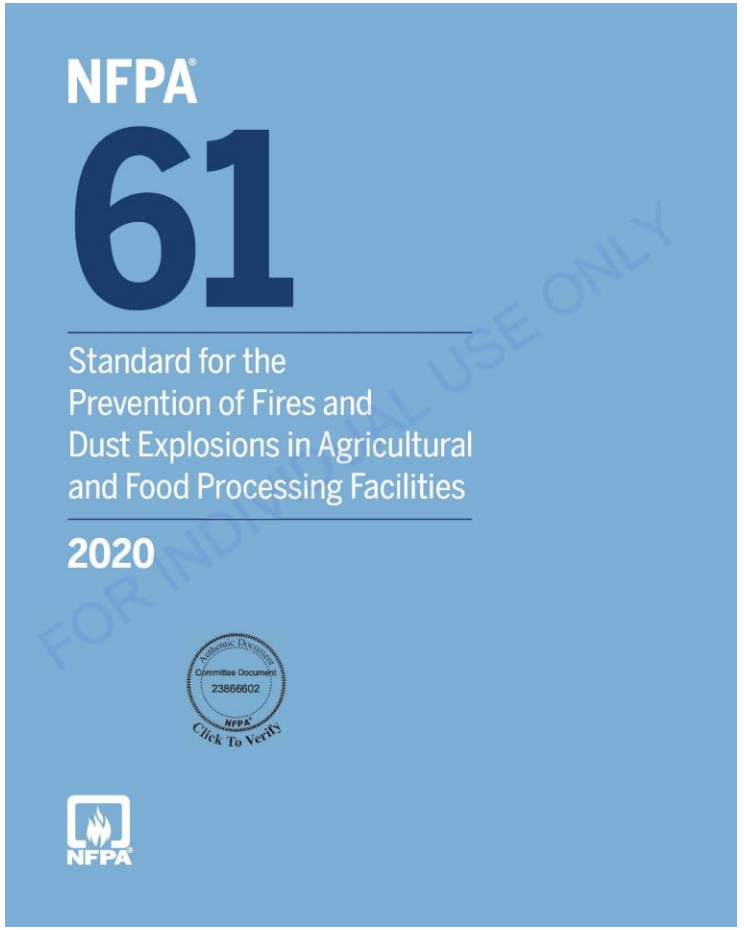
- Existing facilities must complete DHAs for all processes by Sept. 7, 2020 (NFPA 652, 2019).
- For new processes or processes undergoing modification, DHA must be done as part of the project.
- DHAs must be performed or led by a qualified person.
- DHAs must be reviewed and updated every 5 years.

Applying the Standard

- NFPA 652 is an overarching standard that applies to all facilities with combustible dust.
- NFPA 61, 654, 664 and others are “Commodity Specific” standards.
- Start with 652, and then use the commodity standards for specific equipment and to be more consistent with industry standards.
- When there are differences in 652 and the commodity standard, NFPA allows the user to choose either standard.
- NFPA is working goal to consolidate all standards into one standard (NFPA 660).

NFPA 61 – 2020 Edition

- NFPA 61 – Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities.
- 2020 Edition of NFPA 61 was issued in late 2019.
- The DHA requirement for existing facilities changed the deadline to **January 1, 2022**.
- NFPA 61 was the only commodity standard to change the deadline and NFPA 652 still uses September 7, 2020.



NFPA 652 DHA VS NFPA 61 DHA

NFPA 652, Chapter 7.1.1.2:

"For existing processes and facility compartments, a DHA shall be completed by September 7, 2020."

NFPA 61, Chapter 7.1.2.2:

"For existing processes and facility compartments that are not undergoing significant modification, the owner/operator shall schedule and complete the DHAs of bucket elevators, conveyors, grinding equipment, spray dryer systems, and dust collection systems by January 1, 2022.

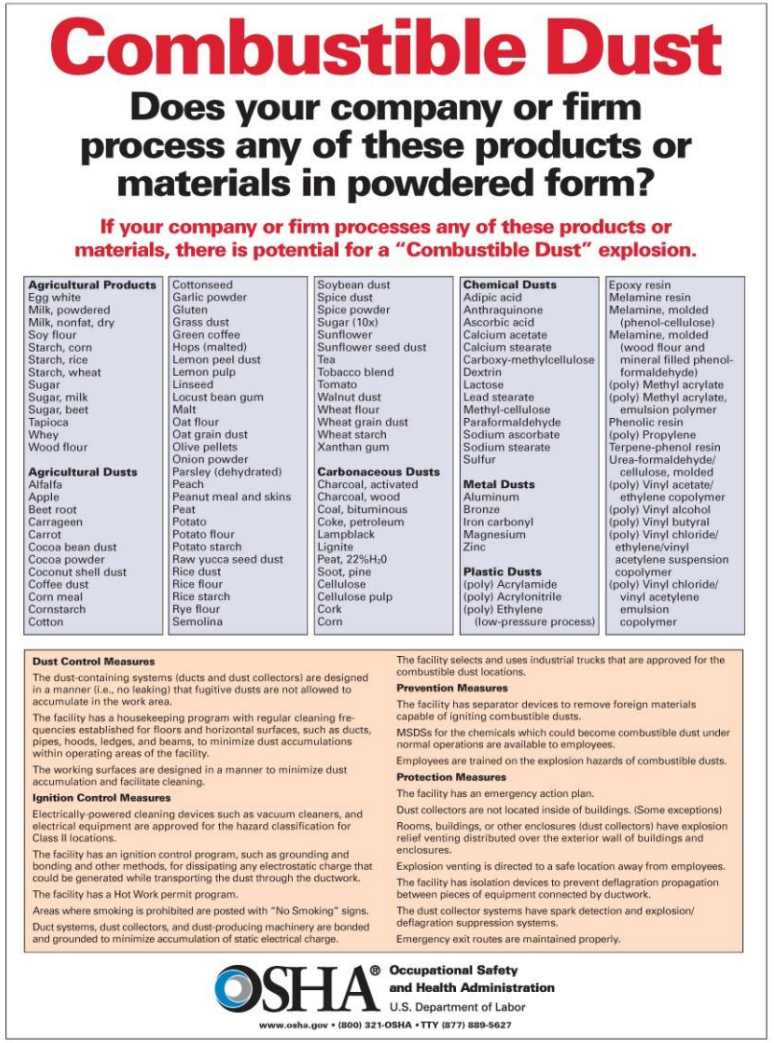
Enforcement

Who is “enforcing” the combustible dust requirements?

- NFPA?
  - No, they have no enforcement power of their own.
- Insurance Companies?
  - Yes, many insurance companies are requiring affected facilities to have their DHA’s completed or risk loss of coverage or increased premiums.
- Local Building Code Enforcement/Fire Marshalls?
  - Not really…some cities/municipalities are starting to require DHAs for new construction, but this isn’t all that common, yet.
- OSHA (in the U.S.)?
  - Sort of…?

OSHA and Combustible Dust

- OSHA does not have a specific combustible dust rule, though they do have a Grain Handling standard – 1910.272.
- OSHA has a National Emphasis Program (NEP) for combustible dust – Directive CPL 03-00-008.
- Under the NEP, OSHA performs combustible dust inspections and utilizes the general duty clause to cite hazards related to NFPA standards, but the combustible dust NFPA standards are not adopted as code by OSHA.



Combustible Dust

Does your company or firm process any of these products or materials in powdered form?

If your company or firm processes any of these products or materials, there is potential for a "Combustible Dust" explosion.

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_2O
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 Control Measures

The dust-containing systems (ducts and dust collectors) are designed in a manner (i.e., no leaking) that fugitive dusts are not allowed to accumulate in the work area.

The facility has 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.

The working surfaces are designed in a manner to minimize dust accumulation and facilitate cleaning.

Ignition Control Measures

Electrically-powered cleaning devices such as vacuum cleaners, and electrical equipment are approved for the hazard classification for Class II locations.

The facility has 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.

The facility has a Hot Work permit program.

Areas where smoking is prohibited are posted with "No Smoking" signs.

Duct systems, dust collectors, and dust-producing machinery are bonded and grounded to minimize accumulation of static electrical charge.

The facility selects and uses industrial trucks that are approved for the combustible dust locations.

Prevention Measures

The facility has separator devices to remove foreign materials capable of igniting combustible dusts.

MSDSs for the chemicals which could become combustible dust under normal operations are available to employees.

Employees are trained on the explosion hazards of combustible dusts.

Protection Measures

The facility has an emergency action plan.

Dust collectors are not located inside of buildings. (Some exceptions)

Rooms, buildings, or other enclosures (dust collectors) have explosion relief venting distributed over the exterior wall of buildings and enclosures.

Explosion venting is directed to a safe location away from employees.

The facility has isolation devices to prevent deflagration propagation between pieces of equipment connected by ductwork.

The dust collector systems have spark detection and explosion/deflagration suppression systems.

Emergency exit routes are maintained properly.

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Who Can Perform / Lead a DHA

- NFPA 652 & 61, Chapter 7.2.2 – “The DHA shall be performed or led by a qualified person.”

- NFPA 652 defines a Qualified Person as “A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems related to the subject matter, the work, or the project.” (NFPA 652, Chapter 3.3.39)

- Sounds kind of vague, doesn’t it?

Qualified Person

- NFPA's intent was to have the definition of the Qualified Person to be open ended. It's up to the person to be able to document why they are "qualified."

- NFPA does have Annex material that gives further guidance.

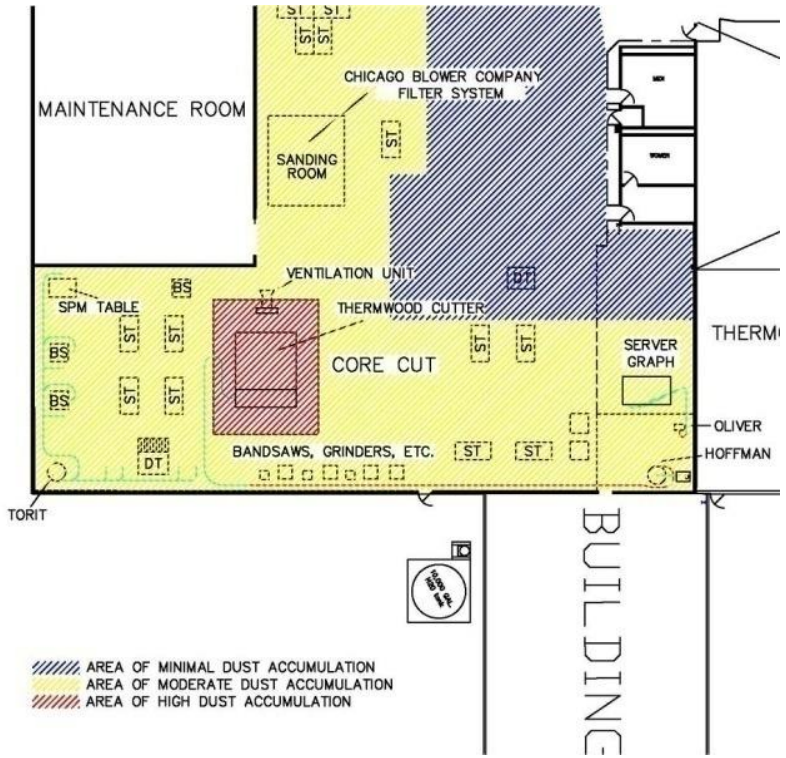
- "…The individuals involved in the DHA could include facility operators, engineers, owners, equipment manufacturers, or consultants." (NFPA 652, A.7.2.2)

- The DHAs can be done:
  - Completely in-house,
  - Completely 3rd party (after you let them in, of course),
  - Or, somewhere in between.

What is a Dust Hazard Analysis (DHA)

A DHA is a systematic review of the process to:

- Identify where fires and explosions can occur,
- Identify the potential causes and consequences,
- Determine if existing and proposed safeguards are sufficient.



Drawing from a Combustible Dust Hazard Analysis

Steps in a DHA

1. Evaluate the material being handled at each stage of the process,
2. List the processes and equipment that handle particulates,
3. Identify equipment and areas where fire, deflagration, or explosion hazards exist,
4. Identify potential ignition sources,
5. Discuss fire and explosion scenarios (consequences),
6. Review safeguards in place to mitigate the hazards,
7. Evaluate the level of risk.

General Examples

Generalized Example: Grain Elevators & Feed Mills

Equipment:

- Silos
- Bucket Elevators & Mechanical Conveyors
- Dryers
- Milling Equipment
- Mixers
- Extruders

Challenges:

- Qualified persons to lead DHA
- Old Equipment
- Budget Availability
- Multiple facilities

Generalized Example: Flour Mills

Equipment:

- Silos
- Bucket Elevators
- Mechanical & Pneumatic Conveyors
- Sifters
- Milling Equipment
- Dust Collectors
- Chlorine Systems?

Resources:

- Experience (many of these facilities have been around for years)
- Relatively simple and understood process
- Engineering and/or Process Safety Team (if PSM related to chlorine processes)

Challenges:

- Old Equipment
- Budget Availability

Hazards & Abatement: Bucket Elevators

Hazards:

- Bucket Elevator Bearings
- No alert system for a malfunction of misalignment
- Explosion / deflagration propagating to connected equipment (eg. Turnheads)

Abatement Techniques:

- Explosion relief panels
- Bearing monitors and sensors
- Plastic / Poly buckets
- PM to check resistivity across the belt

Hazards & Abatement: Bucket Elevators

Recommendations From the Standard:

- Bearing Monitors:

  Bucket elevator legs should be equipped with monitors at the head, tail, and knee pulley bearings that indicate high bearing temperature, vibration detection, and belt alignment. Abnormal conditions should trigger the sensors to actuate a visual and audible alarm requiring operator intervention and corrective action, in accordance with NFPA 61 Chapter 9.3.14.1.12.

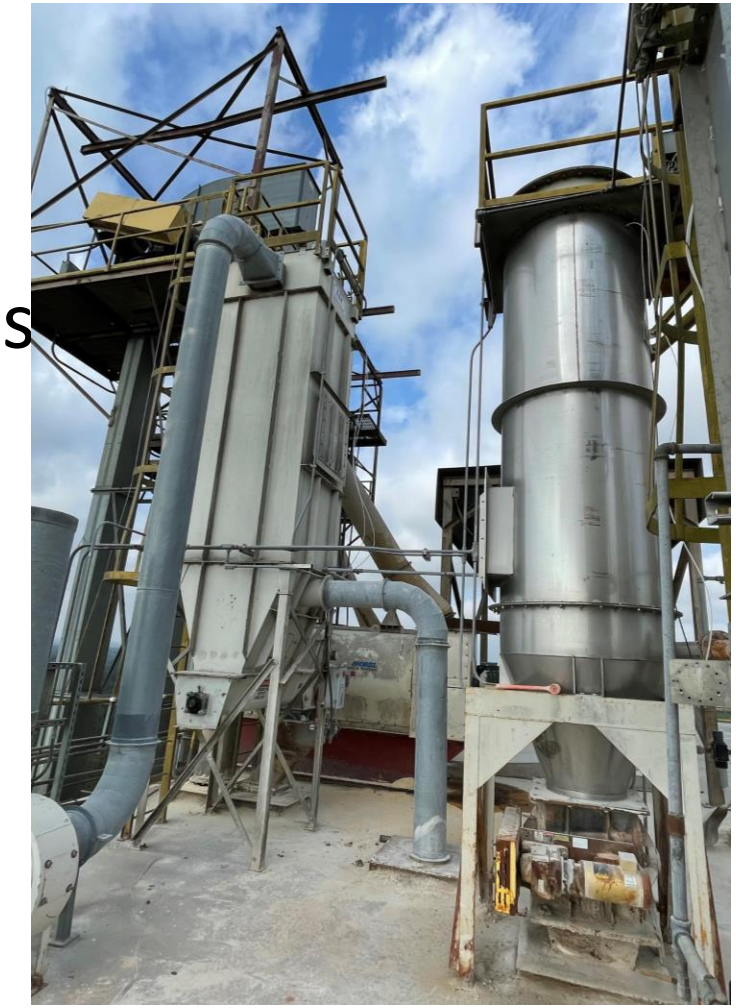
- Explosion Venting:

  Explosion venting or protection should be installed on the inside potions of the Bucket Elevator legs in accordance with NFPA 61 Section 9.3.14.2. This includes either deflagration relief vents in accordance with NFPA 68 or explosion protection (i.e. suppression) in accordance with NFPA 69. If venting is to be utilized, flameless vents would be required if the vents cannot be discharged to a safe, outside location.

Hazards & Abatement: Dust Collectors

Hazards:

- Proximity
- Direction of explos relief
- No Isolation
- Pulling from Hammermills?



Abatement Techniques:

- Explosion relief panels directed away from other equipment and people
- Isolation on the inlet lines and use of rotary **AIRLOCK**
- Explosion relief panels or suppression on the unit
- PMs

Hazards & Abatement: Dust Collectors

Recommendations From the Standard & BMPs:

- Isolation:

  The inlet lines to the Receiving Pit Dust Collectors should be equipped with explosion isolation. Upon installation of the explosion isolation system, the system should be inspected and maintained according to the manufacturer recommended PM schedules, in accordance with NFPA 69.

- Rotary Airlock as Isolation:

  The facility should consider replacing the current rotary valves at the discharge of each dust collector with ones that maintain a clearance between the vane and valve body less than or equal to 0.2 mm and meets the criteria for close-clearance rotary valves as defined in NFPA 69 Chapter 12.2.4.5.

Hazards & Abatement: Dryers

Hazards:

- Fire

Source: world-grain.com

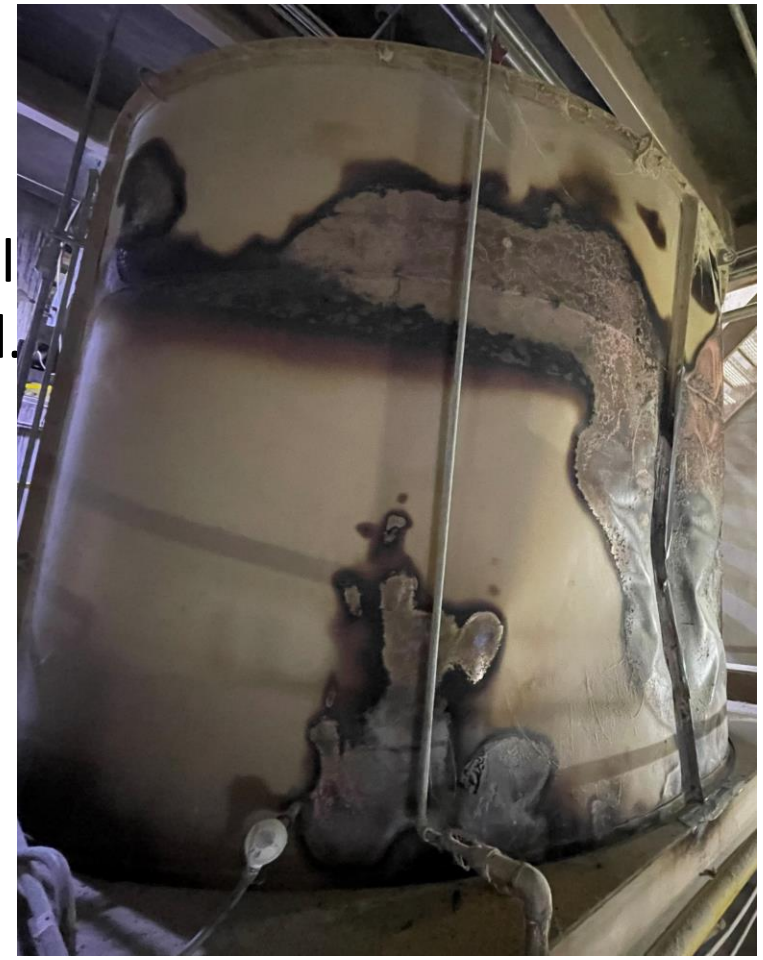
Abatement Techniques:

- Ensure that you have WRITTEN SOPs in place for dealing with fires.
  - For example: SOP to open the hatches and release the corn onto the ground where it can be extinguished. Please be cautious when exposing to oxygen.

Hazards & Abatement: Coolers

Hazards:

- Fire Tornado
- Sparks from metal-to-metal contact due to tramp metal.
- Overheated materials or tramp metal could be generated at the Conditioners.
- Heated material and dust may accumulate in dead zones in the Coolers.



Abatement Techniques:

- PMs & Inspections
- Sensors and Monitors
- Root-Cause Analysis to determine cause of fire
- Ensure Cooler maintains structural integrity

Generalized Example: Food Manufacturing Facilities

Equipment:

- Silos/Bins
- Mechanical & Pneumatic Conveyors
- Sifters
- Milling Equipment
- Extrusion Equipment
- Dryers
- Dust Collectors
- Ammonia Refrigeration Systems?

Resources:

- Large engineering and maintenance staff
- Process Safety Team (if PSM related to ammonia refrigeration)

Challenges:

- Complex equipment/processes
- Many different types of powders/dusts
- Different types of operations within the same facility

Hazards & Abatement: Bakery Dust Collector

Hazards:

- Fire – Crumbs after oven
- Flour Dust

Source: bakeryinfo.co.uk

Abatement Techniques:

- Fire suppressions or deluge system
- PMs
- Overhead Sprinklers

Multiple Facilities DHA Options

DHA Options:

1. If you have qualified people, just a lack of experience in the DHA itself, use a 3rd Party to for a couple sites and then use the results to complete the DHAs for the other sites.
   - As experience may be the difficulty here, consider having a 3rd party review/certify the DHAs that are completed in-house.
   - If you have a Process Safety Management (PSM) Program related to chlorine, leverage your PSM team as they will have experience in Process Hazard Analysis (PHAs).
2. Use a 3rd party to complete the DHAs for all sites.
   - Leverage a multi-site discount, especially since many of the sites are likely similar in operation.

The Elephant in the Room

What do I do with the findings from my DHA?

Multiple Facilities DHA Options

DHA Options:

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2. Use a 3rd party to complete the DHAs for all sites.
   - Leverage a multi-site discount, especially since many of the sites are likely similar in operation.

Implementing DHA Findings

A complete DHA should have the following:

- Recommendations designed to reduce the likelihood and/or severity of fires and explosions where there is unacceptable risk (as determined by the DHA). Recommendations should be based on the NFPA commodity standard specific to your facility (NFPA 61) and NFPA 68 and 69.
- The priority of the recommendations should be based on a balance of which items present the greatest risk and which recommendations are most feasible.

Implementing DHA Findings

Are you putting off the DHA because of a concern over what the potential recommendations will be?

It is important to understand:

- What is required vs what is recommended?
- Are there other control options in lieu of protection recommendations?
  - This is where a 3rd party can be crucial as they would have the knowledge of the NFPA codes as well as the firsthand experience of seeing what others have done.

Summary

- The purpose for completing the DHAs should not be to just check off that box on the list of things to do but is to protect people and property.
- Under NFPA 61, Food/Ag facilities had until **January 1, 2022** to complete the DHAs for their existing processes.
- DHAs must be led by a Qualified Person – but should be a team effort of people knowledgeable in the DHA and those knowledgeable of the process/facility.
- DHAs can be done completely in-house or completely 3rd party, but the best option is likely somewhere in between these two.
  - Focus on your strengths but know your weaknesses.
  - Find the right 3rd party for your company.
- Develop a program to implement your findings.

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