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Combustible Dust

Contents

Is the IH Respiratory Hazard also an Explosion Risk? 2

Considerations for Dust and Fume Control in the Workplace 4

Going Beyond Dust Hazard Analysis. 6

OSHA's Combustible Dust Emphasis Program: *How You Can Be Prepared*. 9

Is the IH Respiratory Hazard also an Explosion Risk?

By Mark Yukich

As a professional the importance of identifying respirable industrial hygiene hazards and taking the steps necessary in reducing the amount of exposure to encourage a safe atmosphere for workers is vitally important. However, when tasked with reducing respirable dust hazards within a facility's process, a recommended best practice is to identify the potential for explosible and/or combustible dust that may be present within the process line. Our aim is to provide a brief overview of questions to consider when assisting a facility with respirable dust hazards and how to determine the potential for combustible dust risks.

When you are conducting a safety assessment at a facility where dust is airborne within the process area, the question that should be asked of the facility operator is, "Have you ever had this dust tested for explosibility or combustibility?" The dust generated in many different processes can be found to be explosible and/or combustible, but the first step is to test a representative sample from the process by running the Explosibility and Combustible Screening Tests. These tests will provide a 'yes' or 'no' result for each test result. NFPA 652 Standard on the Fundamentals of Combustible Dust mandates that if a facility has a combustible and/or explosible dust, the facility operator is mandated to complete a Dust Hazards Analysis (DHA) of the process are that handles these materials.

Once you have the baseline test data compiled (KSt, MIE & MEC), schedule the on-site Dust Hazards Analysis (DHA) to be completed with the assistance of a qualified engineer to guide the risk identification process by following applicable NFPA codes, specifically NFPA 652 and NFPA 70 National Electrical Code. The DHA is a hazard identification assessment with recommendations in reducing risk within the operation. The recommendations could include any need for explosion/deflagration protection, grounding and bonding, ignition source control, electrical area classification and training personnel to identify hazards, just to name a few items.

The practice of good housekeeping on a regular schedule is a fundamental recommendation towards reducing the risk related to combustible and explosible dust within any process. As an IH professional, you understand how important it is to reduce the airborne hazards present, so you play a key role in the primary recommendation that is found for any facility handling combustible dust. Airborne dust found to be explosive and/or combustible will be recognized as a primary fuel source, just like any other flammable fuel like acetone or gasoline. Whenever you find yourself within a facility focusing on the IH hazards, take a moment to ask them the question, "Have you ever tested your dust for explosibility and combustibility." Every facility operator has the duty to know what combustible dust risk, if any, is present to protect the safety of their people and facility. Fauske & Associates can assist with all facets of the testing and on-site process safety support. ■

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Prevention and Mitigation of Combustible Dust and Severe Accidents

- Dust Hazards Analysis (DHA)
- Combustible Dust Testing
- NFPA 652 DHA Training
- OSHA Compliance

ISO/IEC 17025 Accredited Testing Lab

By: Ashley Griesenbrock, CIH, CSP, *Contributor*

Considerations for Dust and Fume Control in the Workplace

You may think of "dust" as just a nuisance in the workplace; however, dusts and fumes in the workplace can pose a significant hazard to employees and even equipment.

Dusts and fumes can be found in almost any industry or workplace setting. Dusts are defined as mechanically produced solid particles (crushing, grinding, sweeping, etc.). Fumes are defined as solid particles generated by condensation from the gaseous state, generally after volatilization from melted substance (welding, hot work, etc.).

When engineering controls are not being implemented, or are not an option, respiratory protection may be needed to keep employee exposures within OSHA limits. *(photo courtesy Adobe Stock)*

Hazards of Dust Exposure

When dust is breathed in through the nose, only a small fraction reaches the lungs. The size of the particle determines how far into the respiratory tract it will travel. Smaller particles (respirable) can make their way past the nose and the respiratory tract and enter the lungs. Respirable crystalline silica is one example of a severely hazardous particulate that deposits in the deepest parts of the lungs. This can cause scaring and fibroids of the lungs (fibrosis); fibrosis caused by crystalline silica is called silicosis.

Slips, trips and falls may not seem like a hazard of dust exposure; however, depending on the type of dust and flooring, accumulated dust can cause slick walkways.

Employee health is not the only concern when talking about dust in the workplace. Accumulation of dust inside equipment can dramatically affect operations. Dust accumulation on electrical and instrumental equipment can act as an insulator—resulting in overheating and, possibly, fire.

Hazards of Fume Exposure

Fumes are generally associated with welding operation. Welding fumes contain metals such as aluminum, arsenic, copper, lead, manganese and zinc. Exposures to welding fumes can result in short-term symptoms, such as shortness of breath, nausea and metal fume fever. Long-term exposure to welding fumes can cause extensive lung damage, kidney damage, and cancer of the lungs, larynx and urinary tract. Welding fumes are not the only fumes of concern. Not all fume hazards originate from large industrial settings; smaller operations, like nail and hair salons, can also produce harmful fumes for employees.

Method of Dust Control:

- **Local exhaust ventilation (LEV)** – Dusts are captured directly at the source and filtered/exhausted. Typically, LEV units are equipped with hoses that can be positioned to best capture smaller sources of dust. *(Examples include grinding, manual material mixing and manual product charging.)*
- **Exhaust ventilation (canopy hoods)** – Dusts are pulled away from the work area and into ductwork above the work area.
- **Downdraft table** – Ventilation built-in below a work bench or table that draws dusts down and away from the employees. *(Examples include woodworking, sanding and metalworking.)*
- **Exhaust and filter** – Large volumes of air are captured and passed through a filter and recirculated or vented to the outside.
- **General ventilation** – Fresh air is naturally or mechanically brought into the workspace to dilute airborne dust. *(Examples include lesser concentrations of dust being generated in a larger area.)*

- **Integrated** – Small vacuum hoses attached to an instrument directly at the source of dust. *(Examples include respirable crystalline silica grinding/cutting tools.)*

Methods for Fume Control:

- **LEV** – Ventilation hose that can be moved to best capture fumes. These can have stationary bases or be mobile units. These are commonly used for operations that may not have one stationary workspace. *(Examples include portable welding stations, grinding or sanding large pieces material.)*
- **Fume removal/separation** – Air scrubbers or filters are incorporated into the exhaust system.*(Examples include workplaces with fumes being generated in lesser concentrations throughout.)*

Welding fumes contain metals such as aluminum, arsenic, copper, lead, manganese and zinc. Exposures to such fumes can result in short-term symptoms, such as shortness of breath, nausea and metal fume fever. Long-term exposure can cause extensive lung damage, kidney damage, and cancer of the lungs, larynx and urinary tract. *(photo courtesy Adobe Stock)*

Considerations Before Installing Controls:

1. Do you have employee exposure data to help determine appropriate level of ventilation needed?
2. Have you performed a dust hazard analysis for potentially combustible dust?
3. Does your facility product dust that is classified as an air pollutant? (A baghouse dust collector may be necessary.)
4. Discuss potential engineering controls with employees; installing controls that employees understand and are willing to use can be a game changer!
5. Do you have potentially flammable vapors that could potentially be captured by ventilation controls. Additional considerations need to be made when exhausting flammable vapors.

While dusts and fumes may not be the first thought when thinking of workplace hazards, they shouldn't be ignored. Dust exposures are not limited to heavy industrial settings. Employees working in food manufacturing, mixing spices and flour, and industrial food fryer smoke are just a few more examples of how dust exposure can be everywhere.

Lastly, engineering controls are the best choice for reducing employee exposures. When engineering controls are not being implemented, or are not an option, respiratory protection may be needed to keep employee exposures within OSHA limits. IHW

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Going Beyond Dust Hazard Analysis

A safety expert walks agricultural and food processing companies through dust hazard analysis, NFPA 61 compliance, and leading options to address the risk of combustible dust explosions

For owners and operators in the agricultural and food processing industries, January 1, 2022, was the deadline for completion of a dust hazard analysis (DHA) for existing facilities in accordance with Chapter 7 of the National Fire Protection Association's Standard 61 (2020), for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities. NFPA 61 and other related NFPA Standards detail essential strategies and procedures for the protection of people, processes and property from the hazards presented by fires and dust explosions in facilities handling, processing, and storing bulk grains such as corn, wheat, oats, barley, sunflower seeds, and soybeans, their by-products, as well as other agricultural related combustible dusts. All new processes and facilities handling and generating combustible dusts are now required to perform a DHA.

Appendix F of NFPA 61 (2020) provides a comprehensive checklist which serves as a blueprint for generating a DHA. This check list includes evaluating the dust explosion protection for process equipment that can often be at risk such as bucket elevators, conveyors, grinders, silos, and systems for spray drying and dust collection.

Recognizing the risk of non-compliance along with the potential liability, grain and food processors have completed their mandated DHA, and are working through the determination of what the next steps are to comply with NFPA 61 as a component of their local jurisdictional safety requirements. This includes making decisions relating to the explosion protection of process equipment which can represent a considerable financial investment requiring careful consideration.

Following preparation of the DHA document, the job is not finished. The DHA team must then develop an action plan for the identified hazards and prepare a prioritized action item list with specific tasks, assigned parties, target timeframes, and required resources. This serves as both a road map for hazard reduction and a working document demonstrating reasonable effort towards managing risk. Recommendations for addressing deficiencies in managing combustible dust hazards must be documented and addressed in a timely fashion acceptable to the authority having jurisdiction.

"The DHA is only the starting point for bringing a facility and process into compliance with the relevant NFPA standards. The next step is implementation. Before doing so, owner/operators should consider some key questions," says Clive Nixon, Sales Manager at Tulsa, OK-based BS&B Pressure Safety Management, a manufacturer of a broad range of dust explosion prevention and protection technologies.

Nixon advises owners and operators of facilities to ask these questions:

- Was the DHA completed by a person or team having credible experience in the facility and its process equipment with knowledge on the application of the relevant NFPA standards?
- Are there any areas of the DHA that are missing or incomplete?
- Have there been any relevant changes to the facility or process that merit an update to the DHA?
- Are all components of the DHA clear with specific action items or are clarifications needed?
- Do we know how to implement the action items arising from the DHA?
- What are our protection options to achieve compliance?

Nixon recommends reviewing or updating the DHA with a safety expert if anything is missing or unclear, since the risk and potential liability of insufficient compliance and protection can be very costly if a combustible dust explosion were to occur in a facility.

"There are a range of solutions to provide cost-effective protection against the combustible dust hazard, but each facility's choice will vary depending on their specific needs. The technology selection should not only consider factors such as the nature of the dust hazard and its characteristics, but also equipment location, strength, operating pressures, temperatures, and process interconnections," says Nixon.

"Owners and operators are best served by working with an expert supplier with access to a complete range of safety solutions for a particular application. They should be aware that a supplier having only one particular solution may be biased in their recommendations."

According to Nixon, the primary options for explosion protection & prevention in grain and food processing facilities broadly include explosion venting, explosion suppression, and explosion isolation.

EXPLOSION RELIEF VENTING

Venting is the most widely adopted protection mechanism because it frequently provides a convenient and economical solution. While it is often perceived as a fit-and-forget solution, it does require regular inspection per NFPA 68. It is often the most practical solution for equipment located outside or near to an outside wall where there is a clear path for the projection of a dust explosion fireball to a safe area where it will not endanger people or damage equipment or nearby structures.

During the early stages of a dust explosion, explosion relief vents open rapidly at a predetermined burst pressure. This allows the rapidly expanding combustion gases and dust / air mixture to escape to the atmosphere and limit the pressure generated within the equipment to calculated safe limits. Most agricultural dust materials would develop a pressure in excess of 100 psi in a fraction of a second if the process enclosure was sufficiently strong.

As an example, explosion panels can be applied to bucket elevators located outside, or close to an outside wall where the dust explosion can be safely vented to the outside via short vent ducts. These vents are mounted onto the leg casing(s) and elevator head and open rapidly to relieve the explosion pressure of a rapidly burning dust, known as a deflagration.

For venting solutions, the method of sizing vents and the strength of the equipment is an important consideration. The sizing of vents for bucket elevators handling raw grain is covered by NPFA 61. For processed grain, NFPA 61 defers to NFPA 68, in which the required strength of the equipment is dictated by the material explosivity index (Kst value). The vent area calculation basis is not the same for raw grain and processed grain, with the arising vent quantity and position typically different for the two forms of material.

The path for the explosion relief flame ball and the accessibility of the vent panels for occasional inspection and maintenance are important considerations when selecting this method of protection. These are covered in NFPA 61 – 2020 section 9.3.14 and NFPA 68 – 2018 section 8.8.

FLAMEFREE™ VENTS

According to Nixon, there are some applications such as where the boot of a bucket elevator or other food processing equipment is inside a building or below grade. That creates a challenge for explosion relief venting due to the release of flame and pressure into a confined space, requiring different protection approaches such as flamefree venting and suppression.

Where equipment is located inside, or where people or combustible material are present, conventional vents, which will release a fireball, can be replaced by flamefree vents. These vents are designed to diffuse the pressure wave and eliminate the flame that would normally be projected by a vented explosion. For applications outside of the grain, feed and food industries, consideration should be given to the potential of toxic byproducts being generated during activation of these devices when located inside a building. For all applications, a safety zone shall be established around the flamefree vent which will emit hot gases for a short time when venting a deflagration. Additionally, the size of the room in which the protected equipment is located must be factored into the evaluation of this protection approach. This is needed to avoid pressurizing small rooms when venting the expanding gases from a deflagration.

Flamefree vents consist of a conventional vent mounted in front of a housing which incorporates a stainless-steel mesh that extracts the heat of the deflagration while allowing the explosively expanding gases to be discharged safely. This mesh arrests the flame front and acts at least partially to filter the release of dust and soot. The stainless-steel mesh represents a restriction to flow, and an allowance is made for this by assigning a vent efficiency to ensure selection of the correct size of vent. The mesh is configured to partially absorb the pressure wave of the expanding gases and to capture dust and soot particles to a varying degree that determines the 'vent efficiency' of the flameless venting device. Vent efficiency may typically range between 50 % and 95 %, which means that a flamefree vent area calculation is going to be larger than a conventional vent for the same application. Great care on this point is required whenever considering replacement of a conventional vent with a flamefree vent.

The weight and vent efficiency of flamefree vents are considered when selecting them for applications such as the protection of bucket elevators. The relevant codes are NFPA 61 – 2020 section 9.3.14 and NFPA 68 – 2018 section 8.8.

Table of Contents

EXPLOSION SUPPRESSION

Explosion suppression systems are designed to suppress a deflagration in its initial stage before destructive pressure can be generated. This is in contrast to explosion venting, which allows the deflagration to proceed to completion while exposing the equipment to combustion temperatures.

Explosion suppression equipment is designed to respond in milliseconds to the signal generated by pressure or flame detectors monitoring the process. This results in explosion suppressors rapidly discharging a flame quenching agent, such as sodium bicarbonate, into the protected equipment volumes. This effectively halts the explosion in its infancy and results in a reduced explosion pressure that is safe for the protected equipment.

‘Think of explosion suppression as a fire extinguisher that triggers automatically but at about 1,000 times the speed,” says Nixon.

Suppression systems can be desirable, because the speed of cleanup and refit allows for a quick return to production. With venting or flamefree venting, the explosion fully develops in the process equipment, requiring cleanup, mitigation of fire-related damage, and other consequences that take time to get the process back into operation.

The suppression method of protection is often applied to double leg bucket elevators, used in grain handling. Protection consists of explosion detection and suppression of the elevator head and boot section, as well as explosion isolation of the leg casings, feed and discharge points, and dust extraction points.

Suppression of single leg bucket elevators is also practical in grain applications, although the open internal volume between boot and head will require additional extinguishing agent injection points. Most importantly, whether applied to a double leg or single leg bucket elevator, suppression systems are recommended to incorporate explosion isolation to prevent the propagation of an explosion to connected equipment volumes such as silos.

EXPLOSION ISOLATION

Explosion isolation is a vital component to any explosion protection strategy. The propagation of a dust explosion can result in secondary events in connected equipment which can be more destructive than the initial event. Isolation should be considered for all process interconnections such as inlet ducts, discharge ducts, and dust extraction points.

Although explosion isolation is a component of explosion suppression systems, it is not an intrinsic feature of explosion venting systems. When explosion vents are selected for explosion protection, a means of chemical or mechanical isolation must be considered to prevent explosion propagation to interconnected process volumes via inlet ducts, outlet ducts, conveyors, and dust extraction points. See NFPA 69 for compliant solutions and refer to NFPA 61-2020 section 9.7.4.

While it can be tempting for the owner / operator to consider applying partial protection to a process system, care must be taken to manage the risk both from and to connected equipment. A piece of unprotected equipment can be the Achilles heel to a facility protection plan.

For grain and food processors, there are many critical decisions involved beyond the DHA in selecting dust explosion prevention, protection, and mitigation equipment given the areas at risk, the methods of protection, relevant NFPA codes, other jurisdictional requirements, and the type of material processed.

However, careful attention to dust explosion mitigation and isolation in processing equipment can ensure the protection of both facility personnel and infrastructure. This will also limit the potential for preventable production and business interruptions. ■

For more information, contact BS&B Safety Systems at 7455 East 46th Street, Tulsa, OK 74145-6379, (918) 622-5950, e-mail: sales@bsbsystems.com or visit www.bsbsystems.com.

By: **Rachel Krubsack**, *Contributor*

OSHA's Combustible Dust Emphasis Program: *How You Can Be Prepared*

In January 2023, OSHA issued a revised Combustible Dust National Emphasis Program (NEP), CPL 03-00-008, which replaces its March 2008 directive. Like its predecessor, the revised NEP contains policies and procedures for inspecting workplaces that generate or handle combustible dusts; and for determining whether such workplaces have addressed fire, flash fire, deflagration and explosion hazards associated with combustible dusts. Examples include:

- Metal dust, such as aluminum, magnesium and some forms of iron dusts
- Wood dust
- Coal and other carbon dusts, including carbon black
- Plastic dust, phenolic resins and additives
- Rubber dust
- Biosolids
- Other organic dust, such as sugar, flour, paper, soap and dried blood
- Certain textile materials

In January 2023, OSHA issued a revised Combustible Dust National Emphasis Program (NEP), CPL 03-00-008, which replaces its March 2008 directive. *(photo courtesy Adobe Stock Images)*

What Prompted the Changes?

OSHA revised and reissued the NEP based on enforcement history and combustible dust incident reports. The agency conducted more than 2,500 combustible dust inspections in fiscal years 2013 to 2017 and found 3,389 combustible dust violations during this period. The top five industries with combustible dust hazards were:

- Farm suppliers
- Institutional furniture manufacturers
- Metal window and door manufacturers
- Sheet metal work manufacturers
- Reupholstery and furniture repairing operations

The highest numbers of combustible dust-related fatalities and catastrophes during this period were:

- Animal food manufacturing
- Sawmills
- Wood manufacturing (e.g., cut-stock, re-sawing and planing)
- Agricultural processing facilities (e.g., grain and field beans)

Changes to Targeted Industries

Several industries with a higher likelihood of having combustible dust hazards (e.g., more than five inspections and greater than 50% of the inspections with combustible dust hazards) or experienced combustible dust-related fatalities/catastrophes were added to the NEP:

- 311812 – Commercial Bakeries
- 325910 – Printing Ink Manufacturing
- 321912 – Cut Stock, Resawing Lumber and Planning

- 316110 – Leather and Hide Tanning and Finishing
- 321214 – Truss Manufacturing
- 424510 – Grain and Field Bean Merchant Wholesalers

Industries with a lower likelihood of having combustible dust hazards and a lower number of potential workers exposed were removed from the NEP:
- 22112 – Fossil Fuel Electric Power Generation
- 311821 – Cookie and Cracker Manufacturing
- 325810 – Pharmaceutical Preparation Manufacturing
- 326121 – Unlaminated Plastic Profile Shape Manufacturing
- 335932 – Noncurrent Carrying Wiring Device Manufacturing
- 337920 – Blind and Shade Manufacturing

The NEP does not replace the grain handling facility directive, CPL 02-01-004. However, operations involving grain processing that are outside the scope of that directive may be covered under the combustible dust directive.

The NEP may apply to facilities covered under the Process Safety Management (PSM) standard that generate or handle combustible dusts, except for PSM-covered explosives and pyrotechnic facilities.

What's Required?

Combustible dusts are fine particles that present an explosion hazard when suspended in air under certain conditions. Almost any material that will burn in air in a solid form has the ability to catch fire and explode as a dust. Under certain conditions, even materials that do not burn when in larger form, such as aluminum or iron, can explode or catch fire as a dust. The force from such an explosion can cause employee deaths, injuries and destruction of entire buildings. Such incidents have killed scores of employees and injured hundreds over the past few decades.

Although OSHA doesn't have a standard specific to combustible dust, several general industry regulations, such as Ventilation (1910.94), Sawmills (1910.265) and Grain Handling Facilities (1910.272), address certain aspects of combustible dust hazards. Regardless of industry:
- **Train** employees to recognize and prevent the hazards associated with combustible dust.
- **Follow** the specific OSHA requirements for your operations and industry.
- **List** the possible sources of dust in the workplace and areas of accumulation. Check safety data sheets (SDSs) for the materials used in the facility that might become combustible dust under normal operations.
- **Ensure** working surfaces are designed to minimize the buildup of dusts.
- **Follow** good housekeeping programs to prevent the buildup of dust, emphasizing regular cleaning of floors and horizontal surfaces (e.g., pipes, hoods, ledges and beams).
- **Use** grounding, bonding and other methods to dissipate any electrostatic charge that could be generated while dust moves through ductwork.
- **Ensure** electrically-powered devices (e.g., vacuum cleaners) and equipment are approved for the hazard classification for Class II locations.
- **Select and use** powered industrial trucks (e.g., forklifts) that are approved for combustible dust locations.
- **Implement and comply** with the company's Hot Work Permit program.
- **Smoke** only in designated areas.
- **Install and maintain** dust-containment systems, if necessary, and ensure they do not allow fugitive dusts to accumulate in the work area.
- **Locate** dust collection systems outside or in specially designed areas.
- **Install** separator devices to remove foreign materials capable of igniting combustible dusts.
- **Direct** explosion venting away from employees.
- **Develop** a facility emergency action plan and train employees on it.
- **Properly mark and maintain** emergency exit routes.

Be Prepared

During an inspection, compliance officers will make observations and verifications concerning the above list and will review the following to determine whether fire, flash fire, deflagration or explosion hazards exist:
- Plant history of fires and explosions
- Safety data sheets (SDSs)
- Electrical area classification drawings/documents
- Dust Hazard Analysis (DHA) conducted by the employer or independent evaluator

Employers should investigate any activity that creates dust to determine if there's a risk that the dust is combustible. By following the recommendations above, you can be prepared in the event of an inspection. IHW

About the Author:

Rachel Krubsack joined J. J. Keller & Associates, Inc. in 2010 and is an Environmental, Health and Safety (EHS) Editor. She edits two manuals, OSHA Rules for General Industry and Hazard Communication Compliance, as well as answering questions from subscribers, and contributes content for other publications, including Safety Management Suite and Compliance Network. Rachel's topics of expertise include hazard communication, hearing conservation, training requirements, bloodborne pathogens and emergency action plans.

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