ASSESSING COMBUSTIBLE DUST HAZARDS

Organic dust can be explosive under the right circumstances and has caused severe damage to structures, in addition to injuries and fatalities. Are you doing everything possible to prevent such a tragedy?

By Jon Anderson

On February 7, 2008, one of the largest sugar refineries in the U.S. felt the effects of a combustible dust explosion. The nation watched as it took more than 200 firefighters several days to extinguish the blaze. The explosion occurred in the warehouse where the product is packaged. Vibrations from the initial explosion shook loose sugar dust that had accumulated on conveyors, light fixtures and rafters, filling the air with tiny particles and creating the perfect storm for the multiple explosions that rapidly occurred. The impact was felt seven miles away; 13 people died and dozens were injured in the aftermath.

Unfortunately, combustible dust explosions are not uncommon in the food industry. Organic dust from grains, wheat, flour, sugar, dehydrated food products, etc. can be explosive under the right circumstances and have caused severe structural damage, injuries and fatalities. Under OSHA’s Combustible Dust National Emphasis Program, there are many food industries that can be part of the national inspection focus. Those industries include crop preparation services, wholesale bakeries, sugar refining, grain based mix production, and others.

A dust explosion is the result of a rapidly burning fire fueled by organic dust contained inside an enclosure. Four basic factors are needed to produce an explosion: fuel, air, an ignition source and a closed container. But what makes dust combustible? As defined by NFPA 6541, combustible dust is “any finely divided solid material that can pass through a U.S. No. 40 Standard Sieve and presents a fire or explosion hazard when dispersed and ignited in air.” Although very small, dust particles have a very large surface area relative to their mass. This increases the surface area and allows the material to catch fire and burn much faster and with much less energy than bulk material.

For example, if the fuel is grain dust, it must be present in a quantity sufficient to support ignition. If you have too little fuel, no ignition can take place, if you have too much fuel, the environment is termed fuel rich and cannot support ignition. In order to have enough fuel for ignition you would need approximately 25 to 500 grams/meter² mass concentration. What this means is that the dust concentration would appear as a dense cloud, a 100-watt light bulb would not be visible from about 10 feet, you could not see your hand at arm’s length, and it would be difficult to breathe.

Dense dust concentrations can be present in the work area or inside specific types of processing or handling equipment. When these concentrations are created in equipment and an ignition source, such as static electricity, is added, catastrophe can occur. Equipment and areas like bucket elevators, grain bins, dust collectors, flour rooms, flour silos and air conveyance systems tend to have the highest dust concentrations.

Facility explosions tend to begin from a primary explosion, such as in equipment. The primary explosion then causes other static dust to become airborne and the primary explosion becomes the source of ignition for the secondary and typically more destructive explosion. Static dust typically comes from overhead structures, other equipment, false ceilings, walls, floors, etc. This is another reason why housekeeping and proper facility design are important.

Ignition sources can be found in many places. The most common in grain dust explosions tend to be from welding operations. Hot metal or slag from welding, cutting or brazing can produce enough heat to ignite dust when it is present in the right amount. Other sources could be faulty electrical systems, static electricity, pilot light or over burner flames, smoldering cigarettes, etc. However, these sources are not as easy to identify.

OSHA HAZARD CLASSIFICATIONS

OSHA offers a great reference to put into perspective the hazards associated with work environments that have the potential for explosive dust concentrations—29 CFR Subpart S - Electrical §1910.399 – “Definitions Applicable to this Subpart.” Most food manufacturers that have combustible dust will fall under the hazard classification of a Class II, Division 2, Group G location, which have flour, starch, grain, etc. The classification also lists the type of electrical installations appropriate for Class II, Division 2, Group G locations. Consult with your electrical contractor when selecting the correct National Electrical Manufacturers Association (NEMA) rated electrical installations.

WHAT IS OSHA DOING ABOUT IT?

On March 11, 2008, OSHA announced the Combustible Dust National Emphasis Program (NEP). Under the NEP, OSHA focuses inspection efforts on those industries and businesses that may produce combustible dust in quantities that could support ignition. Several inspections have taken place in the food industry with attention focused on how the site manages...
processing equipment that handles combustible dust, conveyance systems, dust collection, housekeeping, hot work permitting, employee training and a variety of other concerns.

Review all OSHA standards that apply to combustible dust to identify elements that apply to your location, then work toward implementation. Check www.osha.gov for guidance in reducing the possibility of a combustible dust explosion at your facility.

**WHAT REGULATIONS MAY APPLY?**
There are a handful of standards that are relevant to dust explosion hazards, but the most applicable to the food industry is 29 CFR 1910.272 Grain Handling Facilities (GHF), which covers control of grain dust fires and explosions. This standard includes information on hazard identification and control, which is important and applicable in many situations, but the target audience includes grain elevators, feed mills, flour mills, rice mills, dust pelletizing plants, dry corn mills, soybean flaking operations, and the dry grinding operations of soy cake. These facilities generate dust by processing raw agricultural products that generate dust from various grains.

GHF standards address minimum amounts of grain dust that may accumulate in bucket elevators, grinding equipment, grain dryers, etc. According to this standard, there can be no more than 1/8 inch of dust accumulation in these priority areas. However, in OSHA’s NEP, no greater than 1/32 of an inch of dust accumulation is allowed. Preventive equipment maintenance is also indicated to prevent ignition sources, dust leaks and accumulation. Specifics on fire and explosion venting and fire suppression equipment are also included.

**DUST EXPLOSION PREVENTION**
The NFPA standards are not regulatory, however they do provide guidance and when referenced in an OSHA regulation, they can be cited by a compliance inspection.

NFPA 61 Prevention of Fires and Dust Explosions in Agriculture and Food Processing applies to facilities that receive, handle, process, dry, blend, use, mill, package, store or ship dry agricultural bulk materials, their byproducts, or dusts that include grains, oilseeds, agricultural seeds, legumes, sugar, flour, spices, feed and other related items.

NFPA 654 (mentioned above), applies to all phases of manufacturing, processing, blending, pneumatic conveying, repackaging and handling of combustible particulate solids or hybrid mixtures, regardless of concentration or particle size, where the materials present a fire or explosion hazard.

Each OSHA or NFPA standard includes employee training and education as an important element. Educating employees to understand if any combustible dust is present in the work area and what conditions cause combustion will help prevent hazardous conditions before they are created. Explaining how important housekeeping is and how far regular cleaning procedures go to keep employees safe by keeping dust accumulation down is critical. This adds a new dimension to the importance of the Master Cleaning Schedule and routine cleaning. It’s not just food safety, it’s employee safety too!

It is also important to note that many regulations include installing fire suppression systems and pressure venting to mitigate the results of a fire and protect employees and equipment. Preventive maintenance is also necessary to keep equipment from leaking dust and prevent ignition sources. Overheated bearings and electrical systems and metal-to-metal sparking can become ignition sources for a combustible dust fire and explosion.

**ON-SITE HAZARD ASSESSMENT**
The National Safety Council Food and Beverage Division is working on a hazard assessment that you can apply to your facility. Measure your potential for combustible dust fires and explosion by taking a few simple steps to determine your level of exposure and risk.

The initial assessment will identify the type of material present and determine if it is considered a combustible dust. You can research the products handled and processed and determine the $K_{st}$ explosion class, which indicates the potential severity of an associated dust explosion by measuring the rate of pressure rise in a confined enclosure. The chart above may help with your assessment. For example, grain dust has a $K_{st}$ of 89, flour has a $K_{st}$ of 63, corn a $K_{st}$ of 75, soy flour a $K_{st}$ of 110, starch and wheat a $K_{st}$ of 115, and sugar a $K_{st}$ of 138, placing them all in the St1 Dust Hazard Class.

As an additional part of the initial assessment you should also identify the operations and work areas that may produce combustible dust or allow it to accumulate. Then perform the hazard assessment and consider the effectiveness of housekeeping and control of the fuel source. Review engineering controls that will prevent dust accumulation and the overall control of ignition sources. Review preventive maintenance, inspection and testing, etc. Consider managing changes to new equipment, new processes, and additional raw materials that can be considered combustible. Also review administrative controls such as training and educating employees and monitoring processes, cleaning practices, work area inspections and dust accumulation.

Review the related standards for any elements that may be applied to your site. Look for key concepts that you can adopt such as hot work permitting by your employees and contractors, fire and explosion suppression and venting.

Maintain strict control of fuel sources through effective housekeeping and remove any dust accumulations over 1/32 inch. Absolutely include overhead structures in your cleaning schedule. Keep in mind that hazardous accumulations of dust can be found in false ceiling areas and the top surfaces of equipment and tanks, etc. Clean by brushing, scooping, vacuuming and sweeping. Compressed air cleaning will create airborne combustible dust and must be avoided. Only use compressed air after other cleaning methods are complete, isolate any electrical power first, remove or shut down any other possible ignition sources and use low pressure air.

Work to eliminate ignition sources with proper NEMA-rated equipment for Class II Division 2 Group G environments and control static charge through bonding and grounding equipment. Control flames and sparks, control friction points and train employees to know the hazards of combustible dust.

(Source: OSHA Combustible Dust NEP)

The author is Head of OSHA Compliance and Educational Product Development Safety, AIB International.