CASESTUDY

FAUSKE & ASSOCIATES, LLC

Spotlight: A Risk-Based Approach for Combustible Dust Hazard Mitigation

Issue

A fire and combustible dust explosion occurred at a wood pellet manufacturing plant. A smoldering nest started in the pellet cooler and the local fire department was notified. As fire fighters prepared to extinguish the pellet cooler fire, a hot ember travelled through the ducting to the pellet cooler bag house and initiated a combustible dust deflagration. The deflagration ruptured the bag house explosion vent, resulting in a fire that propagated through the 6 foot duct through the wall and onto the side of a nearby corrugated steel silo located 8 feet away from the building. The flames spread up the side of the silo containing dried-wood particulate and through vents on the underside of its cone-shaped roof, causing hot embers to enter the silo and start another fire.

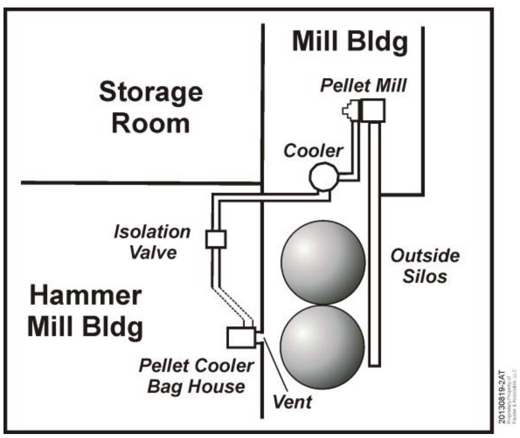

Figure 1. Pellet Cooler Bag House House (Post-repair)

Figure 2. Vent Discharge Openings

Figure 3. Pellet Cooler Bag

Hazard Identification: Material Properties and Process Description

This plant receives both green and kiln-dried (KD) wood particulate that it handles separately until storage prior to pellet making. Figure 4 provides a process flow diagram of the pellet making process and identifies both green and KD wood particulate sampling points identified in the sampling plan.

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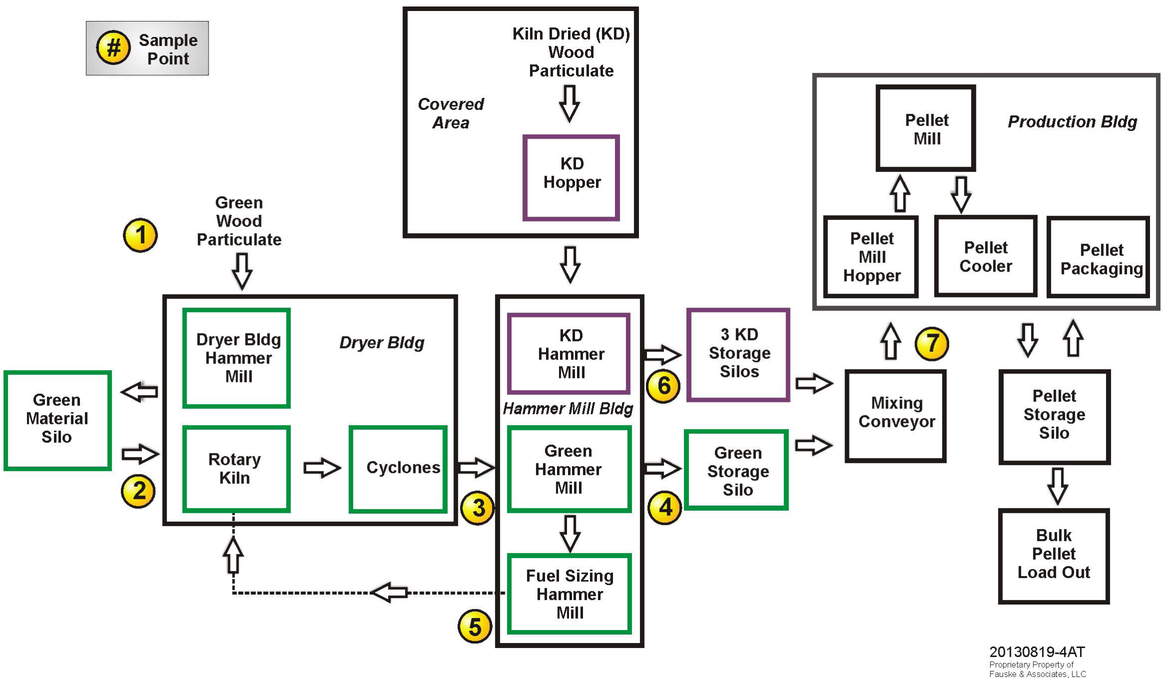

Figure 4. Process Flow Diagram

Green wood, primarily large wood chips with smaller chips and sawdust, has moisture content near 50%. This material is reduced in size, dried and then reduced in size again. Then, roughly 85% of the wood particulate is conveyed into a storage silo in preparation for pellet making. The remaining 15% of the green wood particulate is fed through a third, smaller hammer mill for further size-reduction to enable it to serve as fuel for the rotary kiln. The green wood particulate does not provide a combustible dust deflagration hazard until it undergoes size reduction for the third time for use as rotary kiln fuel. Even then, the difficulty to ignite a cloud is apparent from the high Minimum Ignition Energy (MIE > 1000 mJ) and large mass median particulate size greater than 500 microns. Even a 5 kJ igniter did not ignite the post fuel hammer mill sample. The low KSt, 31 3 30% bar-meter/sec, produced when ignited by a fairly high energy source (10 kJ) is yet another indicator of the lower risk presented by the green wood particulate until it is mixed with KD particulate before pellet making. This ignition data is contrary to the NFPA 664 definition of dry non-deflagrable wood dust as long it is not a result of overdriving the ignition in a 20 liter vessel.

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The KD wood particulate, on the other hand, often arrives at the plant as a combustible dust and the design decision to process this material separately is prudent. KD wood particulate is easily lofted into the air and easily ignited, particularly by electrostatic discharge. An unprotected bag house serving the enclosed conveyor and the hopper in the KD wood particulate receiving area poses a higher risk of fire and deflagration as do the up-stream conveyors, Hammer Mill and silos. Employees unloading KD wood particulate were at an increased risk of exposure to deflagration from the receiving area equipment as well as to fire ignited by hot surfaces of powered industrials trucks used in KD wood particulate unloading.

Gap Analysis

The wood pellet corporation hired FAI to provide technical support in achieving NFPA compliance. First, FAI conducted an NFPA gap analysis of the facility, process, and programs. Gap analysis involves identifying and documenting the discrepancies between NFPA guidance or standards and existing implementation of equipment, practices and management systems.

The gap analysis identified several concerns that could be grouped into three broad categories: protection for equipment handling combustible dust, electrical area classification, and safety management systems.

Electrical Area Classification

The gap analysis included a review of the electrical area classification. The facility had electrical wiring, enclosures, conduits and outlets compliant with Class II Division 2 requirements. However, the facility did not have a documented electrical classification plan, and did not use appropriately rated equipment such as powered industrial trucks in the Class II Division 2 space. Other spark producing equipment such as unrated portable vacuums should have also been prohibited.

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Gap Analysis (Continued)

Protection for Equipment Handling Combustible Dust

Some dust collectors at the facility did not have explosion protection installed. Where installed, the explosion protection vents were designed based on the OSHA KSt = 19 bar-meter/sec, instead of a value determined in accordance with NFPA 68 and ASTM Method E1226. This use of the grossly under-predicted value occurred despite a notation on the OSHA report not to use the reported KSt value for design calculations.

In an effort to minimize fugitive dust, most conveyors were enclosed and under negative pressure provided by an air material separator. This allowed the conveyors to serve as air ducts allowing small particulate to be carried in the air stream while heavier particles rode the conveyor between pieces of equipment.

Other equipment issues were identified such as verifying that duct work and enclosed conveyors were properly sized, provided adequate air flow, and included tramp metal separation equipment.

Safety Management Systems

The gap analysis identified that written combustible dust management programs such as Management of Change (MOC), housekeeping, and preventive maintenance and inspections did not exist. Combustible dust training efforts were minimal and poorly documented.

FAI provided guidance for new policies, written programs, and training to be developed and implemented. It was verified that these new programs would meet recordkeeping and auditing requirements. With these policies and programs in place, a new comprehensive personal protective equipment evaluation was conducted. An important finding identified from this evaluation and later supported by the PHA, was providing fire resistant coveralls for employees unloading KD wood particulate.

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Process Hazard Analysis (PHA)

Before performing the PHA, FAI spent time with the client to develop a Risk Management Matrix representative of their own risk tolerance. The risk matrix development addressed personnel and public safety, environmental protection, and business interruption or loss consequences from episodic events. This effort produced a detailed five-level-likelihood by seven-level-severity risk matrix. For each level of risk an urgency directive was established to identify the allowable time for follow up actions to be completed.

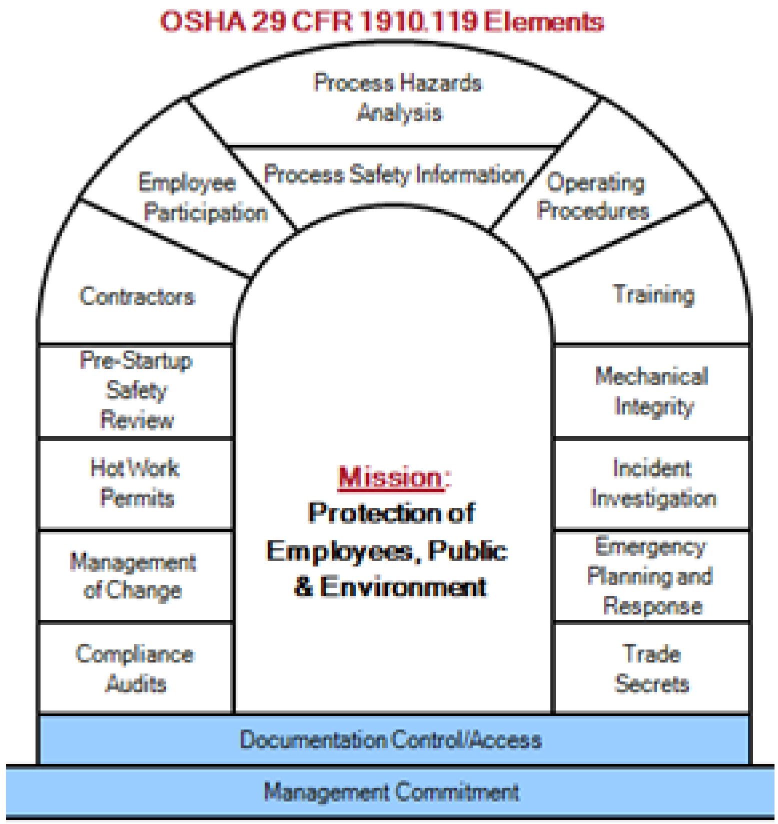

Figure 5: OSHA 29 CFR 1910. 119 Elements

FAI led the PHA team to identify hazards, consequences, and safeguards. Process parameters such as wood flow, air flow, equipment operation and signal flow were analyzed using both standard and process specific guide words.

One scenario identified a design control flaw where the green wood is metered into the rotary kiln during start-up operations. This scenario was later realized during start-up operations following maintenance shut down and resulted in a small fire before the recommended changes were implemented. In all, the PHA developed 54 recommendations in response to unacceptable and marginally acceptable risks identified.

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Conclusion

Using a well-defined testing strategy for hazard identification, gap analysis and process hazard analysis provided plant personnel an opportunity to understand hazards not previously realized and to determine the relative risk associated with those hazards. This approach engendered new ownership of the individual issues by the plant staff. The PHA allowed the client to prioritize actions and assign responsible personnel to address recommendations and follow through on implementation. The client retained FAI to complete the same process at each of their other facilities.