FIRE PREVENTION

by Thomas Frank, P.E.

A Handful of Dust Can Destroy Your Facility

A perfect "recipe" for a mill disaster could be this: start with a building with thin, barely visible layers of combustible dust. Add unvented equipment that draws in suspended dust. Let a few airborne particles stray and find a spark. Add the spark to the dust and you've set your recipe ablaze! The first explosion ruptures the equipment, releasing building dust into the air; a second explosion deflects the building walls and roof. Deflection could partly collapse the building and break sprinkler piping. And as soon as the sprinkler protection is disabled, your fire is out of control.

Combustible dust may appear benign, but it's a beast that can devastate your facility and business unless you control it. Because airborne dust burns fiercely, all it takes is a quarter-inch layer of dust to fuel an explosion strong enough to blow out walls or roof panels of a building.

A study of fires in plywood and composite panel facilities insured by Allendale Insurance, Arkwright, and Protection Mutual Insurance between 1986 and 1997 showed that about 90 percent of the 80 major incidents (in excess of $1 million each) involved wood dust. Losses totaled close to $141 million in gross damage. (See tables below.)

The study also revealed that:

- Boilers, heaters, dryer fireboxes, and hot dryer exteriors topped the list of ignition sources.
- Veneer dryers, thermal oil systems, grinders, and flakers were leading equipment involved in severe incidents.

Loss investigations show that the two most hazardous areas for dust to collect are at the roof or over big hydraulic presses in both plywood and OSB plants, and inside sander dust collection systems for the finished panels.

Flash fires at ceiling areas almost always start in or on equipment at lower elevations. Often resinous, combustible dust deposits, accumulating as steam releases from the process equipment, cause flash fires above veneer dryers and hot presses.

Widespread accumulations of dust at ceiling levels can easily fuel a flash fire. The roof itself contributes to the firespread because as heat from the fire plume rises it has nowhere to go except laterally when it reaches the roof. Fire can spread rapidly across the dust deposits, and even stir up the dust, possibly triggering a dust explosion.

Eliminating or minimizing the ingredients that fuel both flash fires and dust explosions requires a solid loss prevention program with three prime objectives:

- Keep it clean.
- Control ignition sources.
- Evaluate protection with the hazards in mind.

COMBUSTIBLE DUST LOSS STATISTICS
Plywood/Composite Panel Facilities, 1986-1997

Cause	No. of Losses	Est. Gross Amount ($1,000–1998$)
Hot Dryer Exterior	1	$ 37,775
Hot Surface of Heat Transfer System Valve	1	36,655
Machine Part Friction	5	29,654
Overheated Dryer/Kiln	8	5,127
Hot Work	4	4,505
Dryer Exhaust Stack Spark	1	4,427
Boiler/Heater/Dryer Firebox Spark	10	4,167
Hot Surface of Boiler Firebox	1	2,869
Spontaneous Ignition	5	2,840
Miscellaneous Overheating	5	2,828
Electrical Defect	7	2,626
Mechanical Spark	6	2,492
Miscellaneous Sparks	5	2,201
Other	9	1,658
Unknown/No Data	12	761
Totals	**80**	**$140,585**

FIRES BY EQUIPMENT TYPE
Plywood/Composite Panel Facilities, 1986-1997

Equipment	No. of Losses	Est. Gross Amount ($1,000 – 1998$)
Veneer Dryers	12	$ 46,054
Thermal Oil System	6	41,797
Grinder, Flaker et. al.	7	29,506
Particleboard Press	16	8,491
Veneer Lathe	3	4,092
Conveyor/Bucket Elevator	4	3,988
Wood Chip Dryer	5	3,729
Plywood Veneer Press	1	1,183
Sander	2	1,173
Dust Collector	4	912
Mobile Equipment (loader/power shovel)	2	452
Air Compressor	4	283
Process/Heat Boiler	3	278
Electrostatic Precipitator	1	239

Keep It Clean

Schedule housekeeping programs. If you don't have the dust, you don't have the threat. How often you clean depends upon how fast dust accumulates. Look for wood dust deposits that accumulate on overhead structural members, piping, ducts, and other equipment.

Vacuuming is the best way to remove dust. If you use air hoses, be sure to shut down any heat-producing process. Removing resinous deposits over veneer dryers and hot presses frequently requires more tedious methods like high-pressure water spray or scraping.

Part of effective housekeeping involves good maintenance. Keeping cutting tools sharp helps reduce fires originating from saws, sanders and other milling equipment.

To reduce the number of fires originating inside dryers, operate the equipment within the design operating temperatures and clean it frequently where deposits or waste can accumulate. In addition, use electrical equipment suitable for the environment, particularly where dust accumulations are present.

A well-designed dust collection system can capture dust before it migrates to hard-to-reach ceiling areas. Fires and explosions can ignite in areas around equipment like trim saws and sanders that lack an effective dust collection system.

New building and equipment designs can affect your housekeeping program. An explosion in an outside dust collector can penetrate into the building. If the equipment and building are not designed for this possibility, sprinkler or hazardous processing piping (e.g. natural gas, thermal oil, hydraulics, etc.) could break and cause an uncontrolled fire or building explosion.

Also during the design state, minimize surfaces where dust can accumulate to reduce the number of areas requiring cleaning.

Control Ignition Sources

The key to minimizing ignition is to detect and isolate sparks. In a dusty environment, prohibit any spark that can lead to catastrophe. Sources of sparks can come from people or equipment.

Loss history shows that people doing hot work--any operation that produces open flames, heat or sparks, such as cutting, grinding, brazing, welding, soldering, thawing pipe, torch-applied roofing--have triggered some of the most severe flash fires. About half of documented losses involve outside contractors.

A flawless hot work permit system is the answer, but too often plant permit systems aren't rigorously practiced. Workers (often contractors) sometimes take shortcuts or fail to follow up jobs with required precautions. Management support and constant vigilance by those administering the program are essential. Ongoing training and review with those who do the hot work are critical.

Detecting and isolating sparks as they move to the collection equipment also is very important. Ignition sources almost always originate at the processing machinery and move through the collection system ductwork to cyclones or bag filters where a fire or explosion occurs.

The key to minimizing ignition is to detect and isolate sparks as they move to the collection equipment. Provide automatic sprinklers or waterspray nozzles to protect the dust collectors from fire damage.

Sensitive infrared detectors can sense glowing wood embers in a blowpipe and activate an intermittent waterspray system to extinguish the sparks while they are still in the blowpipe. If the spark is extinguished, no system shutdown is necessary.

Additional "fail-safe" spark detectors often can be used further downstream to check that the spark was extinguished. If not, the extinguishing system can activate some of the following additional protection equipment:

- **High-speed abort gates** are used on positive pressure blowpipe systems to divert the airflow to atmosphere prior to any dust collectors, thus averting fire or explosion. They are also used to divert airflow to atmosphere on the return air duct on systems that return filtered air back to the plant for energy conservation.
- **Steel-tipped rotary airlocks** isolate fires and explosions from downstream equipment. (Rubber-tipped airlocks cannot be relied upon for this function.)
- **Reversing fire dump screws** are used along with steel-tipped airlocks to not only isolate downstream equipment, but also to empty burning material safely from the system
- **Explosion vents** release explosion pressures to atmosphere before serious damage can occur to the equipment.
- **Explosion suppression systems** quench the explosion before damaging pressures can be developed.
- **Backblast dampers** (basically a check valve with a built-in explosion vent) prevent explosions from blowing back through the conveying ductwork into the building or into other equipment.

Evaluate Protection with Hazards in Mind

Provide draft curtains without openings. A draft curtain is a noncombustible, solid curtain attached to the bottom of a ceiling or underside of a roof to impede the flow heat to the area on the other side of the curtain. Without such a barrier, a flash fire will spread to the limits of the dust deposits ahead of the automatic sprinklers. Only backup water supplies or immediate and effective fire department response can control a flash fire's damaging effects.

Make sure draft curtains fit tightly against the roof. They should be at least one-eighth the distance from the roof to the floor (four feet minimum).

Draft curtains in noncombustible buildings should be made of noncombustible materials. In sprinklered, combustible buildings, combustible materials such as plywood may be used. It's not a good idea to use steel sheeting thinner than 26 gauge (0.0179 in. [0.455 mm]), aluminum, fiberglass reinforced plastic (FRP) or other plastic materials as draft curtains in sprinklered or unsprinklered buildings.

Design sprinklers for the fire area. Make sure the required sprinkler discharge for the protected area is available from all sprinklers that might operate. Make sure sprinklers are located over the largest curtained area if draft curtains are provided, or entire area of dust deposits if draft curtains are not provided.

Thermal Oil Can Pose New Harzard in Modern Mills

A thermal oil spill can have horrific consequences. And because this hazard is fairly new to the industry, it is not always addressed with sufficient understanding or precaution.

If you've ever seen a small spill of gasoline ignite, it's not hard to envision the flammability of heat transfer fluid (HTF) like thermal oil. Once HTF spills and ignites, it erupts into fire sweeping an area in seconds. Can this defeat the ability of an automatic sprinkler system to control it? Absolutely.

Consider three factors of HTF systems–flash point of the thermal oil, potential spill size, and pumping flow rate.

***Flash point*.** All flammable liquids have a flash point--the minimum temperature at which enough flammable vapors have evaporated from the liquid surface to form a flammable mixture with air. Fluids commonly used in HTF systems have very high flash points, usually between 300 to 450°F, and at room temperature are not easily ignited. But, HTF are frequently heated to as much as 100°F above their flash points in process heaters.

So, the only way to reliably extinguish an HTF pool fire with water is to cool the entire spill surface below the flash point of the HTF. The amount of water needed varies, depending on the properties of the HTF (i.e., flashpoint temperature, heat content, and operating temperature) and the amount spilled.

Spill size. One gallon of spilled HTF will typically spread out and cover about 15 to 20 sq. ft. of floor area. A typical heating system might contain 10,000 to 20,000 gallons of HTF. Even if only 500 gallons spill onto the floor, it's enough to fuel a fire spanning a 10,000-square-foot area. Even with automatic sprinkler protection, your property might not survive such a fire because sprinkler systems for engineered wood product facilities are typically designed for smaller operating areas (3,000 to 5,000 square feet).

Flow rate. A major HTF pipe rupture could spill flammable liquid into a fire four or five times faster than the water flow used to extinguish it. HTF fluids may be pumped at flow rates of 7,000 to 8,000 gallons per minute (gpm) in heating loops for large OSB presses. By comparison, water typically flows from a fire hose at 250 gpm and discharges about 1500 gpm from a sprinkler system designed for this hazard.

Solving the Problem

It is essential to consider HTF hazards when designing new buildings and arrange processing with HTF hazards in mind.

1. Isolate the HTF heater and pumps from other manufacturing areas. Locate the HTF heater and pumps in separate buildings detached from the main plant facility. Where this is not feasible, an alternative is to locate heater and pumps at an exterior wall of the main building and install two-hour rated fire walls to separate the HTF system from adjacent manufacturing areas.

2. Provide containment areas for possible HTF spills. Use curbs or dikes around pumps or other sources of possible leaks. Or, include a room with a lower floor grade than adjacent areas, or a floor slope or drainage that does not expose major equipment or structures to the spill.

3. Design sprinkler protection for the higher HTF spill hazard. Engineered wood product facilities are normally designed with a 0.20-gpm-per-square-foot sprinkler density over 3000 square feet for a wet pipe system (4000 square feet for a dry system). Areas subject to an HTF spill need a 0.25 density over 3000 square feet for wet systems (5000 square feet for dry), assuming you are providing oil leak detection and loop isolation.

In addition, consider using special protection for important HTF process equipment. For example:

HTF heater internal fire suppression. Automatic waterspray activated by two separate fire risk indicators (to minimize false tripping) is recommended. For example, loss of oil from the system and high flue gas temperature or combustibles indicate a likely HTF spill fire in the heater.

Provide gaseous suppression such as CO_2 as an alternative to waterspray. But be aware that it lacks cooling ability and needs to have a very long extended discharge period (many hours with refractory lined heaters) to inert the heater volume until surfaces cool well below the oil flash point.

HTF leak detection and automatic isolation of secondary loops. You can monitor loss of fluid in secondary loops by using differential flow detection across the loop supply and return piping. Although this can identify which loop is leaking oil, it cannot detect small leaks. Leaks could drain the entire HTF expansion tank before a low-level interlock can stop the pumping or close the loop isolation valves.

Continuous level detection in the HTF expansion tank using a hydrostatic pressure probe is becoming a popular way to detect both small and large HTF leaks. This method detects leaks more quickly, but because it does not identify which loop is leaking, it becomes necessary to shut down pumps and close isolation valves on all secondary loops.

Press pit fire suppression that covers all shielded areas. Press pits provide excellent containment for an HTF spill. Unfortunately, the spill will be directly below the press, and the press is a critical piece of equipment that can take up to a year to replace.

Because the entire surface of an HTF spill fire must be cooled in order to extinguish the fire, be aware of obstructions in the pit that might block the sprinkler spray pattern. Automatic waterspray with a 0.25-gpm-per-square-foot density is needed over the entire pit floor area where an oil spill could accumulate. A sprinkler is also needed at each steel column supporting the press, loader, unloader, or floor above.

A ring of sprinklers located only around the pit perimeter is usually insufficient protection because a large oil spill can flow into shielded areas under the press and under the flexible caul return conveyor commonly present in OSB press pits. Other common obstructions, such as piping and cable trays, must be carefully considered in the design stage. Pay attention to how and where these are routed. If some obstructions still exist, reposition them or add more sprinklers to assure that the entire spill surface is cooled.

Minimize HTF spill potential. Use welded pipe for HTF wherever possible. Eliminate unnecessary use of direct HTF heating. For example, don't heat buildings by pumping HTF to space heaters throughout a facility. Instead, use the HTF to heat a water/glycol mixture through a central heat exchanger in a cutoff room, and pump the non-hazardous water/glycol solution throughout the plant.

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