PRESSBOARD MANUFACTURING

INTRODUCTION

More pressboard than solid board can be made from the same amount of trees. With increasing limitations being placed on harvesting trees, the pressboard industry is becoming more and more important.

Pressboard is a generic term for any board made from wood pieces that are glued together and pressed. Pressboard includes plywood, chipboard, particleboard and fiberboard.

Plywood is made by peeling logs with a long, sharp cutting blade. A large, lathe-like machine turns the logs against the blade to make veneer. Sheets of veneer are then glued together.

Both chipboard and particleboard are made by gluing together mixtures of chips and sawdust. Chipboard includes waferboard and oriented strand board (OSB). Particleboard is similar to chipboard but contains more fine particles from wood scraps and sawdust.

Fiberboard is made from fiber obtained by cooking wood chips, shavings and scraps. Medium density fiberboard (MDFB) has become very popular for making wood paneling. This product can be made as strong as desired, even stronger than solid wood.

Making pressboard involves some very serious hazards, including the use of hot oil heat transfer systems to heat the presses (some units use hot water heat exchanger systems supplied from a boiler instead of hot oil), large hydraulic systems for presses, the cyclone dryers that dry small wood pieces, various material handling systems such as enclosed conveyors, bins and silos, and the dust collection systems that collect dust from the trimming, sawing and sanding operations. Other hazards include fuel-fired equipment and combustible liquids.

The remainder of this PRC Guideline is divided into three parts:

- PROCESSES
- HAZARDS
- LOSS PREVENTION AND CONTROL

The first part separately describes the processes for making each type of pressboard. Because the process equipment for making all types of pressboard is similar, the remaining parts describe the hazards and recommended protection for all the pressboard processes.

PROCESSES

Plywood

Figure 1 shows a flow chart for plywood manufacturing. Logs are debarked, cut to the required length and mounted on a log-lathing machine. The lathe turns the logs against a long, sharp cutting blade, which peels off the veneer. The veneer is clipped to a specified width, dried, cut to length and patched.

Adhesive is spread on the sheets of veneer, and the sheets are glued together to make the boards. The plywood boards are next pressed in an oil-heated press. The boards are then cooled, trimmed and sanded.

Chipboard And Particleboard

Figure 2 shows a flow chart for chipboard and particleboard manufacturing. Some chipboard manufacturing facilities buy chips and some make their own by debarking logs and feeding the logs into chippers. Magnetic separators remove tramp metal, and the chips are ground to the desired size in hammer mills, knife hogs and flakers. The chips are screened and separated, then dried in a rotary dryer.

Next, chip flakes are mixed with shavings and other fine wood particles, including sawdust. The wood particles are screened, separated and dried much like the chips.

Glue and other additives are blended with the wood chips and particles, and the mixture is formed into sheets. Forming machines are one of two types. The tray type uses a vacuum to shape the board; the extrusion type forces the mixed materials between heated plates.

Boards are next pressed in an oil-heated or hot water-heated press. On multilevel presses, sheets are first trimmed to the proper size. On continuous belt presses, trimming is not required. To increase their resilience, the boards are sometimes humidified in oven-like chambers. After cooling, the sheets are sawed to the desired size and sanded.

Particleboard is made primarily from ground wood scrap. Such scrap might come from chips that were too small to be used in chipboard, shavings from trimming other boards, and sawdust. The scraps are mixed with glue and appropriate additives, formed, trimmed, pressed, cooled, sawed and sanded. As a final step, particleboard is often laminated.

Fiberboard

Figure 3 shows a flow chart for fiberboard manufacturing. Magnetic separators remove tramp metal from wood chips, shavings and sawdust. The wood pieces are cooked and ground into fiber in a steam-heated vessel called a refiner.

After refining, the fiber is dried and blended with glue and other additives. The fiber mixture is formed and pressed on oil-heated presses. As with particleboard, fiberboard is trimmed when multilevel presses are used.

The boards are then cooled, sawed and sanded. Fiberboard is usually laminated.

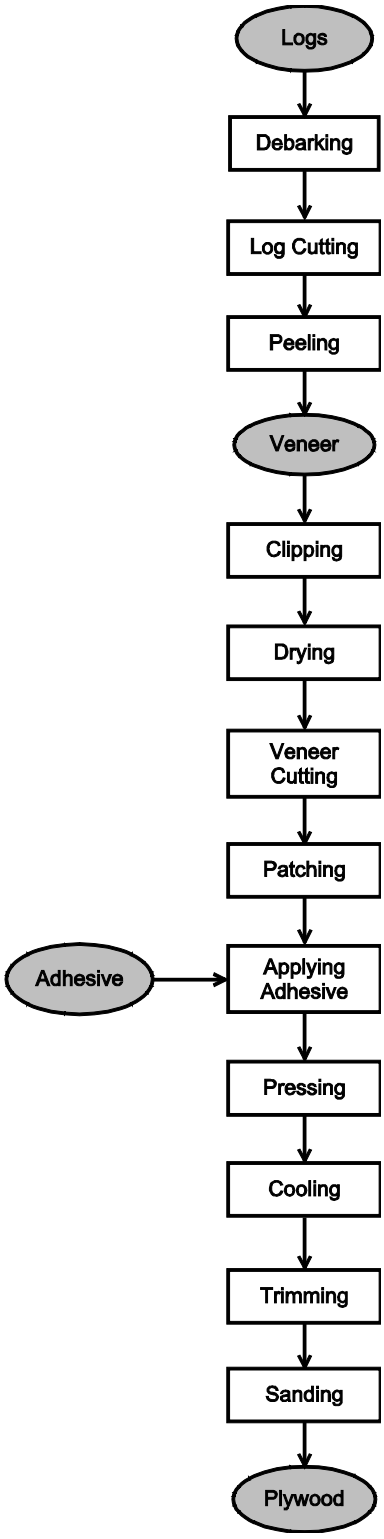

Figure 1. Flow Chart For Plywood Manufacturing.

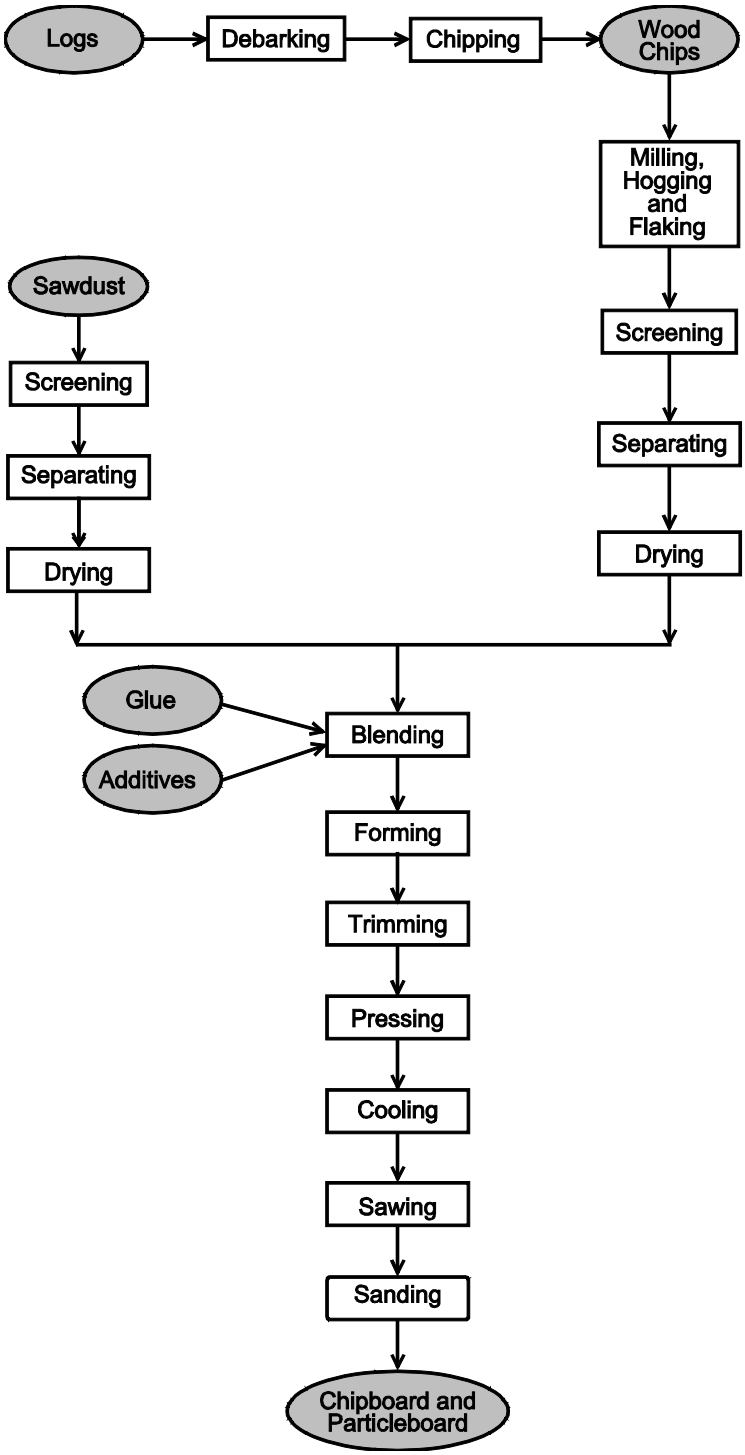

Figure 2. Flow Chart For Manufacturing Chipboard And Particleboard.

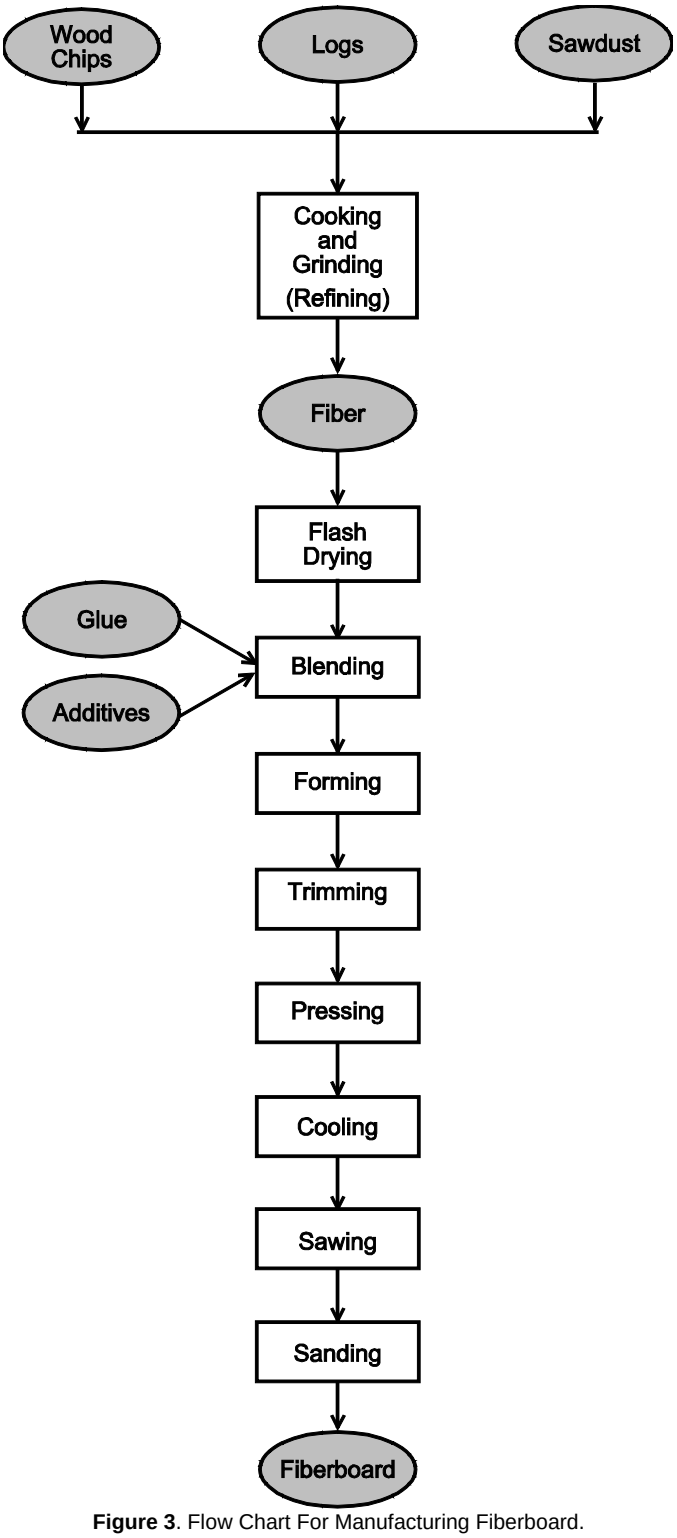

Figure 3. Flow Chart For Manufacturing Fiberboard.

HAZARDS

Log And Chip Storage

Logs are stored in piles, or in some cases, log ponds. Logs are not easily ignited. However, once a fire in a log pile has become well established, it is very difficult to extinguish. Chips are more easily ignited, and fires in chip piles can be just as difficult to extinguish as those in log piles.

Debarking

Debarking is done in a rotating, inclined cylinder with water flowing through it. Debarkers are usually about 15 ft (4.5 m) in diameter and over 100 ft (30 m) long. Logs are fed into the high end. They rotate against bars inside the debarker and against each other, and come out the low end without bark.

Debarkers are large and expensive pieces of equipment that are important to production. The main hazards of debarkers are electrical breakdown of the motors and mechanical breakdown of the gears.

Peeling

Before peeling, logs are placed in steam chests or hot water vats for thawing and softening. Log lathing machines then peel a continuous sheet of veneer off the logs.

Veneer ranges from 1/16 in. – 1/4 in. (2.6 mm – 6.4 mm) thick. The log-peeling lathes operate under a heavy load. Motors driving the lathes are commonly subject to electrical breakdown. Lathes are also subject to mechanical breakdown.

Chipping

Chippers use large drive motors, which are subject to electrical breakdown. Rotating parts, particularly chipper disks, are subject to mechanical breakdown. Production of sparks in a chipper can start a fire in the chips or in hydraulic oil residue.

Milling, Hogging And Flaking

Mills, hogs and flakers use large drive motors, which are subject to electrical breakdown. These pieces of equipment are also subject to mechanical breakdown.

Tramp metal or other foreign objects in the wood materials being processed could damage equipment, start a fire, or both. Sparking of moving parts can also start a fire. Loss of mills, hogs or flakers can result in long, expensive downtimes in a pressboard manufacturing facility.

Conveying And Material Handling

Pressboard manufacturing facilities use various types of conveyors to move logs, chips, boards and wood scraps. The conveyors are usually necessary for production. They are all subject to fires and to electrical and mechanical breakdown.

Some facilities use diesel powered front end loaders to move wood chips. The loaders present a source of ignition to the fine particles that may become airborne while chips are being moved.

Most facilities use drag, belt or pneumatic conveyors. Belt conveyors move boards through the process. Closed pneumatic conveying systems move dried wood pieces to the forming process. These conveying systems present serious fire and explosion hazards.

Material handling systems may also include a variety of silos and enclosed receiving bins at several points along the system which are interconnected by enclosed conveyors. Typically the receiving bins are elevated high above floor level, making them difficult and dangerous to access for manual firefighting efforts. A dust explosion may readily propagate via a series of chain reaction secondary explosions along the system, resulting in severe damage and igniting fires within difficult to access bins and silos. In the event of a fire, opening access hatches in silos or receiving bins introduces oxygen that may result in additional explosions and/or further intensify the fire.

Dust Collection

Dust collection systems collect sawdust and wood shavings from many processes in a pressboard manufacturing facility. These include the log cutting, veneer clipping, veneer cutting, patching, trimming and sanding processes. The dust collection systems are needed to keep the accumulation of wood dust and shavings to a minimum and to reprocess waste.

These dust collection systems present serious fire and explosion hazards. They are one of the most frequent sources of fire in pressboard manufacturing facilities. Such fires have averaged about $350,000 PD and $120,000 per day BI, with a two-week shutdown being typical.

Separating

Cyclones separate wood pieces the proper size for making chipboard and particleboard. Cyclone separation systems present fire and explosion hazards. The fans and fan motors used to airvey the wood pieces through the separation system are subject to mechanical and electrical breakdown.

Drying

Plywood

Before being glued together, sheets of veneer are dried in rotary dryers very much like kilns. The dryers are usually steam heated. They normally run at a temperature of about 400°F (200°C), very near the autoignition temperature of wood.

Drive motors for rotating the dryer are subject to electrical breakdown. The drive gears are subject to mechanical breakdown. The dryer itself is subject to warping and fire damage.

Chipboard And Particleboard

Dryers for chips, shavings and sawdust are also rotary dryers. They can be heated by oil or hot water heat exchange systems, or they can be sawdust or bark fired. These dryers present an explosion hazard from the small particle sizes being dried.

Drive motors for rotating the dryer are subject to electrical breakdown. The drive gears are subject to mechanical breakdown. The dryer itself is subject to warping and fire damage.

Fiberboard

Fiberboard is dried in flash dryers. Wet fiberboard passes through the dryer in duct-like enclosures indirectly heated by hot air. The major moving parts of a flash dryer are the fans and fan motors used to airvey the fiberboard through the dryer enclosure. These parts are subject to mechanical and electrical breakdown.

Humidifying

Humidification chambers hold boards in an atmosphere with controlled moisture content. By design, these chambers provide little accessibility, making manual firefighting difficult. Opening a chamber introduces oxygen, which would increase the intensity of any fire inside.

Applying Adhesive

In making plywood, the adhesive is spread on a sheet of veneer, then the sheet is fed through a dielectric heater to set the adhesive. Another sheet of veneer is placed at right angles to the sheet just set. Repeating these steps builds up the board to the desired thickness.

In making other types of pressboard, a glue resin is added to the mixture to be formed into sheets. Other materials such as wax and ammonia sulfate solution may also be added to increase strength or to achieve other characteristics in the boards.

The adhesives and glues used to make pressboard are usually formaldehyde-based combustible liquids. The dielectric heater used to set the adhesive on plywood veneers is a potential source of ignition for both the adhesive and the veneer.

Pressing

Many pressboard facilities may have a single large board press through which all production output is dependent. These presses can be very expensive and have extensive lead-times to obtain major replacement parts, particularly if the equipment is foreign made. In some cases, the press may be very old with a history of major rebuilds and the original manufacturer may no longer be in business. Preventive and predictive maintenance is critical, as well as having proper spare parts inventories and arrangements with appropriate suppliers and vendors to obtain major parts or perform repairs in a timely fashion.

Boards are pressed at pressures up to 400 psi (26 bar) and temperatures up to 300°F (150°C). The presses are typically heated by a thermal oil heat transfer system. The oil is combustible, with a flashpoint ranging from 300°F–400°F (150°C–200°C). To press the boards at 300°F (150°C), the heat transfer oil must be maintained around 500°F (260°C). Some presses use a hot water heat exchanger system supplied from a boiler in lieu of hot oil.

The presses use hydraulic oil to exert pressure on the boards. The hydraulic oil is used at up to 4000 psi (275 bar). The press operates under very high mechanical stresses, and if not properly maintained, can warp or break down.

Hydraulic oil is usually combustible. Oil storage tanks and pumps may be located in a pit below the press or in a nearby cutoff room. In addition, any leaks of thermal oil on the press would drain into the pit. The accumulation of combustible residues in the pit is a serious fire problem. Residues can also accumulate in press enclosures.

Thermal oil systems are subject to large losses. A common scenario is ignition of finely atomized oil spraying from a pinhole leak in the oil piping. This results in a severe torch fire. Losses involving unprotected thermal oil systems commonly cost between $25 million and $30 million. The largest known loss in such a system exceeded $600 million.

LOSS PREVENTION AND CONTROL

Management Programs

Implement effective management programs for loss prevention and control in all the areas discussed in *OVERVIEW.* Incorporate all practices and procedures relevant to pressboard manufacturing operations into these programs. Place special emphasis on the following areas:

Maintenance

Implement preventive maintenance programs for the following equipment:

- Transformers, in accordance with PRC.5.4.5 and PRC.5.9.1;
- Motors and electrical equipment, in accordance with PRC.1.3.1;
- Rotating equipment, such as debarkers, chippers, mills, refiners, dryers and roll presses;
- Gear sets;
- Lubricating systems;
- Hydraulic systems, in accordance with PRC.9.2.4;
- Thermal oil systems, in accordance with PRC.7.1.5.

Conduct nondestructive testing of the highly stressed parts of the board presses. Regularly check the press for proper alignment.

Conduct regular dye penetrant or magnetic particle testing of chipper disks.

Also see PRC.1.3.0.

Employee Training

Teach employees about the hazards of the equipment they operate, and train them to take appropriate action upon notification of unsafe conditions. These conditions should include excessive dust accumulation, high temperature of the press thermal oil, and unacceptable vibration in rotating equipment.

In the event of a dust or wood fire, have operators clamp the press in the closed (pressing) position, to prevent distortion of the platens. In the event of fire in the hydraulic system, have them turn off and bypass the hydraulic system.

Pre-Emergency Planning

Provide spares for equipment critical to production and for equipment that is obsolete or otherwise hard to replace. This equipment should include large motors, such as motors for log lathing, and gear sets for dryers and roll presses.

Provide training for the local fire department and employees who may be responsible for responding to a fire or explosion incident, including how and when to operate manually-operated fire protection systems that may be present. They should also be made aware of the hazards and necessary precautions to be taken before opening any enclosed wood chip/sawdust bins or silos where a smoldering fire may be present, as this will introduce oxygen and air movement that may stir up dust resulting in an explosion.

Housekeeping

Keep all areas in the facility free of accumulations of sawdust and wood shavings. Pay particular attention to debarkers, chippers and saws, and to all conveying and dust collection systems. Provide dust collection systems capable of controlling the dust produced by each piece of process equipment.

Keep equipment using hydraulic, lubricating or thermal fluids, and the areas near this equipment, free of oil residues. Repair any oil leaks as soon as possible after discovery.

Log Storage

Restrict log piles to 100 ft (30 m) wide by 500 ft (150 m) long by 25 ft (7.5 m) high. Separate log piles by at least 100 ft (30 m).

Locate hydrants on all sides of the log piles spaced no more than 300 ft (90 m) apart. Provide a water supply capable of delivering 1000 gpm (3780 L/min) at 100 psi (6.9 bar) to 4 hydrants for 4 hours.

Debarking, Peeling And Chipping

Monitor debarkers, peelers and chippers for excessive vibration. Conduct infrared inspections in accordance with PRC.1.3.1, and perform insulation resistance testing. Perform wear particle analysis on lubricating oil.

Provide sprinklers over lubrication oil systems inside buildings. Design the sprinkler protection in accordance with NFPA 13 and PRC.12.1.1.0 for Extra Hazard, Group 1 occupancies.

Milling, Hogging And Flaking

Monitor mills, hogs and flakers for excessive vibration. Perform wear particle analysis on lubricating oil.

Install tramp metal separators to separate any metal pieces before wood chips enter mills, hogs or flakers. Shut down operations if power is lost to the separators.

Conveyors

Arrange and protect conveyors in accordance with NFPA 91, NFPA 654 and NFPA 664, as applicable. Also follow PRC.9.3.1 for belt conveyors.

Interior Protection

Provide closed head, wet pipe sprinkler systems with 165°F (74°C) rated heads at the ceiling throughout the heated areas of the facility. Design the systems in accordance with NFPA 13 and PRC.12.1.1.0 for a density of 0.25 gpm/ft² (10.2 L/min/m²) over the most hydraulically remote 4000 ft² (372 m²) area. Use dry pipe systems in unheated areas, increasing the area of application to 5200 ft² (483 m²).

Install 1 in. (25 mm) hose connections throughout the facility, spaced at approximately 100 ft (30 m) intervals. Equip the hose connections with 100 ft (30 m) of 1½ in. (40 mm) woven-jacketed, lined fire hose and adjustable spray nozzles. Install hose connections on roofs having dust collection equipment.

Provide electrical equipment suitable for Class II, Division 1 and 2 locations, as appropriate, wherever dust can accumulate.

Saws And Sanders

Install mechanical limit switches to detect misalignment of boards in both the horizontal and vertical planes. In addition, provide an excess current interlock on the drive motors.

Provide sprinkler protection for saw and sander enclosures. Design the sprinkler protection in accordance with NFPA 13 and PRC.12.1.1.0 for 0.25 gpm/ft² (10.2 L/min/m²) over the enclosure area.

Dust Collection

Provide dust collection systems for all parts of the process that generate dust or other small wood particles. Arrange and protect dust collection systems in accordance with PRC.9.3.2.0.

Provide either venting for deflagrations or an explosion suppression system in dust collectors. Install venting for deflagrations in accordance with NFPA 68. Design explosion suppression systems in accordance with NFPA 69.

Consider providing spark extinguishing systems where each dust-producing process is connected to the dust collection system. Arrange spark extinguishing systems and their related protection features specifically for forced and induced draft dust collection systems, as described under Chipboard, Particleboard and Fiberboard Dryers. See PRC.13.9.1.

Drying

Plywood Dryers

Install deluge sprinkler systems inside plywood dryers designed for 0.50 gpm/ft² (20 L/min/m²) over the protected area. Include the dryer entrance and exit in the protected area. Operate the deluge systems with fixed temperature heat detectors. Design and install deluge systems in accordance with NFPA 15.

Provide combustion safeguards for fossil fuel-, sawdust-, and bark-fired boilers supplying steam to dryers in accordance with NFPA 85 and PRC.4.0.1. Provide combustion safeguards for direct fuel-fired dryers in accordance with NFPA 86 and PRC.4.0.1. Protect hot oil systems heating dryers in accordance with PRC.7.1.5.

Chipboard, Particleboard And Fiberboard Dryers And Separators

For each dryer and cyclone, provide separate fire dumps that can safely receive materials in process in the event of an upset.

Install deluge systems inside dryers designed for 0.50 gpm/ft² (20 L/min/m²) over the protected area. Include in the protected area the dryer entrance, dryer exit, dryer and cyclone fire dumps and cyclone separators. Operate the deluge systems with fixed temperature heat detectors. Design and install deluge systems in accordance with NFPA 15.

Arrange the water flow switch and the dryer and cyclone high temperature limit switches to empty the contents of the dryer and cyclone into the fire dumps, stop the blowers, and shut off the fuel supply.

Provide a spark extinguishing system with two detection zones between the dryer exit and the cyclone separator. For forced draft systems, arrange the spark extinguishing system for “detect-spray-detect-divert.” That is, if the first zone detects a spark, operate the extinguishing spray. If the second zone detects a spark, divert the air flow from the cyclone separator to a safe outside location. It may also be necessary to shut off the fuel supply. If fire is detected in the dryer, empty the contents of the dryer into the fire dump, stop the blowers, and shut off the fuel supply.

For induced draft systems, arrange the spark extinguishing system for “detect-spray-detect-spray-deluge.” That is, if the first zone detects a spark, operate the extinguishing spray. If the second zone detects a spark, operate the extinguishing spray and the deluge system. Also empty the contents of the dryer and cyclone into the fire dumps, stop the blowers, and shut off the fuel supply.

Install venting for deflagrations for the cyclones in accordance with NFPA 68.

Provide an independent, reliable backup electrical power supply for the dryer drive motor or provide a backup drive that does not depend on electrical power. Either should be able to keep the dryer rotating if electrical power from the utility is lost.

Provide proper combustion safeguards for fossil fuel-, sawdust-, and bark-fired boilers supplying steam to dryers in accordance with NFPA 85 and PRC.4.0.1. Provide combustion safeguards for direct fuel-fired dryers in accordance with NFPA 86 and PRC.4.0.1. Protect hot oil systems heating dryers in accordance with PRC.7.1.5.

Humidification

Install sprinkler protection inside humidification chambers in accordance with NFPA 13 and PRC.12.1.1.0. Design the system for 0.25 gpm/ft² (10.2 L/min/m²) over the entire chamber area.

Adhesive Storage And Handling

Store and dispense adhesives, glue resins, and any combustible additives in accordance with the applicable provisions of NFPA 30.

Pressing

Install foam-water deluge systems above all hot oil-heated presses, under continuous belt presses, in press pits and over hot oil transfer pumps. Design the foam-water deluge systems for 0.25 gpm/ft² (10.2 L/min/m²) over the protected area. Actuate the systems with fixed temperature heat detectors. Install foam-water deluge systems in accordance with NFPA 16 and PRC.12.3.1.1.

High expansion foam systems with connected reserves are also acceptable if sprinkler protection is provided. Design these systems in accordance with NFPA 11 and PRC.12.3.2.1.

Arrange the water flow switch on a foam-water deluge system, the sprinkler system water flow alarm, or the heat detection circuit actuating a high expansion foam system, to shut off the thermal oil system for the press. Operators should also take the appropriate manual actions, as described under Employee Training.

Use noncombustible hydraulic fluids wherever possible. Protect thermal oil systems, including oil storage tanks, in accordance with NFPA 664 and PRC.7.1.5. Provide a backup power supply for the press hot oil pumps.

Burning Vapors

Some pressboard facilities burn off vapors from the process to reduce emission of volatiles to the atmosphere. Protect the fuel-fired equipment used for burning vapors in accordance with NFPA 86 and PRC.4.0.1.