WOOD PROCESSING AND WOODWORKING FACILITIES

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1.0 SCOPE

This data sheet gives guidelines for protecting wood processing and wood working facilities. Wood processing facilities manufacture basic construction materials (lumber, veneer, plywood and composite panels such as particleboard, fiberboard, hardboard and oriented strand board). Woodworking facilities remanufacture these basic products into other consumer products such as doors, windows, cabinets, furniture, paneling, etc.

NFPA 664 also covers these occupancies, and is in general agreement with this standard.

1.1 Changes

May 2010. Minor editorial changes were done for this revision.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Construction and Location

2.1.1 Noncombustible construction is preferred.

2.1.2 Process areas which are susceptible to wide-spread dust or resin accumulations on roof framing members should have draft curtains to define the sprinkler operating area. Typical areas with this problem are particleboard raw material screening and storage buildings, wood waste fuel houses, and ceiling areas above hot presses and plywood veneer dryers. Draft curtains should be at least 4 ft (1.2 m) deep, and fit flush with the underside of the roof. For laminated wood beam roof framing with decking flush with the top of the structural members, additional draft curtains are not needed.

2.1.3 Refer to Data Sheet 7-76, *Prevention and Migration of Combustible Dust Explosions and Fires*, for other general construction criteria for facilities which have a dust explosion potential.

2.2 Protection

2.2.1 Water supply quantity, flow, and pressure requirements will vary according to yard storage and special hazard protection needed at each facility. Thorough review of this and other referenced data sheets should be done to determine the greatest demand.

2.2.2 Two-way hydrants should be located throughout the plant site in accordance with Data Sheet 3-10, *Installation and Maintenance of Private Fire Service Mains and Their Appurtenances*. All hydrants should have repair gate valves, and hydrants in high traffic or yard storage areas should have substantial barriers to help prevent physical damage. Refer to Recommendation 2.2.8 for hydrant protection of log storage and chip pile areas.

2.2.3 Provide automatic sprinkler protection according to Table 1 throughout all general manufacturing areas (i.e., areas not identified elsewhere in this data sheet as needing special sprinkler protection). Refer to Section 2.3, Equipment and Processes, for sprinkler design criteria for lumber dry kilns, lumber sorters, hardboard humidifying and tempering ovens, or areas containing significant quantities of flammable liquids such as press pits, thermal oil process heating systems, and coating/spraying finishing operations.

Table 1. Sprinkler Demand for General Manufacturing Areas

Density[1,2] gpm/sq ft(mm/min)	*Type System*	*Head Temp[3] °F (°C)*	*Area[2] sq ft (sq m)*
.20 (8)	Wet	286 & 212 (141 & 100)	3000 (280)
		165 (71)	4000 (370)
	Dry	286 & 212 (141 & 100)	4000 (370)
		165 (71)	5000 (460)

NOTES:

[1] Sprinkler spacing should not exceed 100 sq ft (9.3 sq m). Calculations should include 500 gpm (1900 l/min) for hose streams. Duration is two hours.

[2] This table anticipates the presence of scattered, small hydraulic units (100 gal [378 cu dm/min] or less), localized dust accumulations, etc. which can result in sprinkler demands larger than those for low-piled product storage areas. Refer to Data Sheet 7-98, *Hydraulic Fluids*, if large hydraulic systems are present.

When draft curtains are needed (e.g., particleboard raw material screening and storage buildings, wood waste fuel houses, and ceiling areas above hot presses or plywood veneer dryers), the area to be calculated should be the curtained area if larger than the area in this table. When laminated wood beam roof framing is used in lieu of draft curtains, use the area defined by the major laminated beams (2 ft [0.6 m] or more in depth) as the curtained area.

[3] Roof areas over major equipment subject to cyclical heating (e.g., veneer dryers, hot presses, thermal oil systems, large ovens or dryers, etc.) should have sprinklers with glass bulb-type thermal elements. If maximum ambient temperatures are expected to exceed 150°F (66°C), use 286°F (141°C) rated heads. If these high temperatures are accompanied by high moisture content (e.g., dryer and hot press areas, etc.), *do not* use galvanized pipe.

2.2.4 Provide automatic sprinkler protection for indoor wood product storage areas according to Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*, using the commodity classifications listed in Table 2.

Table 2. Commodity Classification of Wood Products

Class I	All GREEN wood products (moisture content = 20 percent or more)[1]
Class II	All DRY wood products (moisture content less than 20 percent)[1]
Class III	All FLAMMABLE-COATED wood products (regardless of moisture content)[2]

[1] The storage configuration (e.g., stuck lumber vs. solid-piled) has little effect on the degree of hazard. The moisture content is the primary factor. If green wood products might be stored for extended periods allowing them to dry (one to three months, depending on climate), design protection for dry wood products (Class II).

[2] Typical products in this category are timbers treated with creosote or oil-based preservatives, asphalt saturated fiberboard (insulation board), etc.

2.2.5 Outdoor storage of wood products (e.g., lumber, veneer, etc.) should be arranged and protected as follows (See Recommendation 2.2.8 for chip and log storage areas):

a) The water supply from all sources combined, including fire department pumpers, should be able to provide the following demand flows at a residual pressure of 80 psi (5.5 bar):

Total yard storage (bd. ft×1000)	*Waterflow*		*Duration (hrs)*
	(gpm)	*(cu dm/min)*	
up to 1000	1000	3800	2
1000 to 2000	1500	5700	3
over 2000	2000	7600	4

b) Keep blocks of storage as small as possible so that all areas are accessible for manual fire fighting. Contiguous stack areas should be limited to approximately 10,000 sq ft (920 sq m) with 20 ft (6 m) separation between adjacent stack areas.

c) Provide clear space between large aggregate blocks of storage arranged as above so that no more than 2.5 million board feet is in any one aggregate area. Use Data Sheet 1-20, *Protection Against Exterior Fire Exposure (From Buildings or Yard Storage)*, to determine suitable separation distances between large aggregate blocks of storage.

d) Yard storage should not be located under important structures (e.g., conveyors). Storage is considered to be ‘‘under’’ a structure if it is less than 20 ft (6 m) away horizontally. Where this is unavoidable, provide automatic sprinkler protection beneath the structure on ordinary hazard pipe schedule using 165°F (74°C) heads located 12 ft (3.7 m) on centers. Yard storage should never be located below power lines.

e) Keep separation spaces and areas adjacent to storage free of weeds or other combustibles.

f) Mobile equipment should not be parked or refueled in storage areas.

2.2.6 Large wood chip and fine storage silos or bins should be protected according to Data Sheet 8-27, *Storage of Wood Chips*. Automatic water spray protection is an acceptable alternative to automatic sprinklers, and is preferred if there is a dust explosion potential. Small bins which can quickly dump their contents (e.g., ‘‘clam shell’’ type truck dump bins) do not need internal protection.

For important detached bins or silos where it is not economically practical to provide automatic protection, a fixed manual water spray system connected to a dry standpipe should be provided. A hose connection from the standpipe to a nearby hydrant can provide quick, effective fire fighting capability which is particularly beneficial if the stored material has a dust explosion potential.

Waterspray nozzles in dusty bins or silos should be protected from plugging (e.g., dust caps, plastic bags, or ‘‘poppet valve’’ style nozzles).

2.2.7 Buildings or other important structures should be protected from yard storage exposures by applying Data Sheet 1-20. A minimum separation of 5 ft (2 m) between large blocks of storage and important buildings should be maintained at all times for fire fighting access, even if Data Sheet 1-20 will permit less separation.

2.2.8 Refer to Data Sheet 8-27, *Storage of Chips* and Data Sheet 8-28, *Pulpwood and Outdoor Log Storage*, for protection recommendations for outdoor storage of wood fractions (chips, sawdust, shavings, bark, etc.) and logs, respectively. When storage separations are less than recommended in those data sheets, Data Sheet 1-20 can be used as an alternative method of exposure evaluation. Consider chips and similar materials as a Class I commodity, and logs as a Class II commodity.

2.3 Equipment and Processes

2.3.1 Lumber Sorters

The following recommendations should be completed:

1. Provide automatic sprinkler protection beneath sorters when the floor below is combustible, when the area is not kept clear of combustible debris or when there is a potential for a flammable liquid spill (e.g., hydraulic fluid). Use 165°F (74°C) rated heads on 100 sq ft (9.3 sq m) maximum spacing and ordinary hazard pipe schedule. To prevent damage from falling lumber, locate heads and piping under sorter structural members. Sidewall heads can be used if necessary. These heads do not need to be included in any calculations for ceiling sprinklers.

2. Provide 1½ in. (38 mm) small hose stations in all sorter buildings so that all sides of the sorter can be reached. If the sorter is under an open-sided canopy, adequate hydrant protection will suffice in lieu of small hose stations.

3. Sorters should be emptied as much as is practical during idle periods and debris on the floor below sorters should be removed regularly. Sorters should also be emptied, if practical, if a fire should occur in or adjacent to the sorter.

2.3.1.1 Horizontal Tray Sorters

2.3.1.1 Provide additional sprinkler protection for horizontal tray sorters according to one of the following options (see Fig. 1):

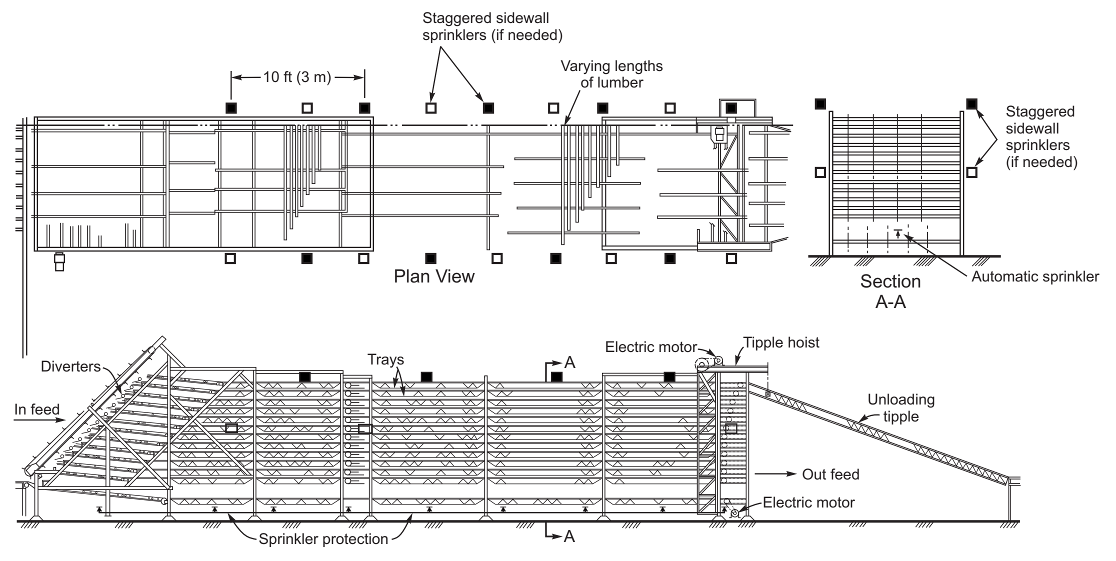


Fig. 1. Horizontal tray sorter

a) Provide automatic sprinklers at ceiling level designed to protect an ‘‘equivalent’’ height of lumber storage (see Section 2.2). An ‘‘equivalent’’ height is defined as one foot (0.3 m) for each tray. Use the appropriate commodity classification according to the type of lumber (green or dry) being sorted. In no case should this density/area be less than that recommended for general manufacturing areas as defined in Table 1.

OR

b) When the ‘‘equivalent’’ height in part a, above, is the limiting case and the required ceiling density cannot be met, provide ceiling sprinklers designed for general manufacturing areas per Table 1, and supplement them with automatic sprinklers along both sides of the sorter. Each side should have one line of heads at the top tray level, and additional lines spaced every six to eight trays vertically. Use ½ in. (12.7 mm) orifice, 165°F (74°C) rated, horizontal sidewall heads spaced no more than 10 ft (3 m) on lines and staggered vertically and side-to-side. Hydraulically design the sidewall heads to provide a minimum pressure of 20 psi (1.4 bar) when flowing the 10 most remote heads (five on each side). Balance this demand with the ceiling sprinkler demand.

c) The above ceiling protection should extend over and for 20 ft (6 m) beyond the sorter.

2.3.1.2 Diagonal and Vertical Bin Sorters

2.3.1.2.1 Provide ceiling-level automatic sprinkler protection designed to protect indoor lumber storage the same height as the maximum height of lumber which can accumulate in the vertical or diagonal bins (see Fig. 2). In no case should the ceiling density/area be less than that recommended for general manufacturing areas as defined in Table 1.

2.3.2 Dry Kilns

2.3.2.1 Provide automatic sprinklers throughout dry kilns as follows (see Fig. 3):

a) Provide sprinklers over the lumber loads to protect an *equivalent* height of dry indoor lumber storage. An *equivalent* height is the actual height of the lumber (excluding the kiln cart). The area of operation should be the entire kiln. Heads should be located such that the top and sides of the lumber loads are

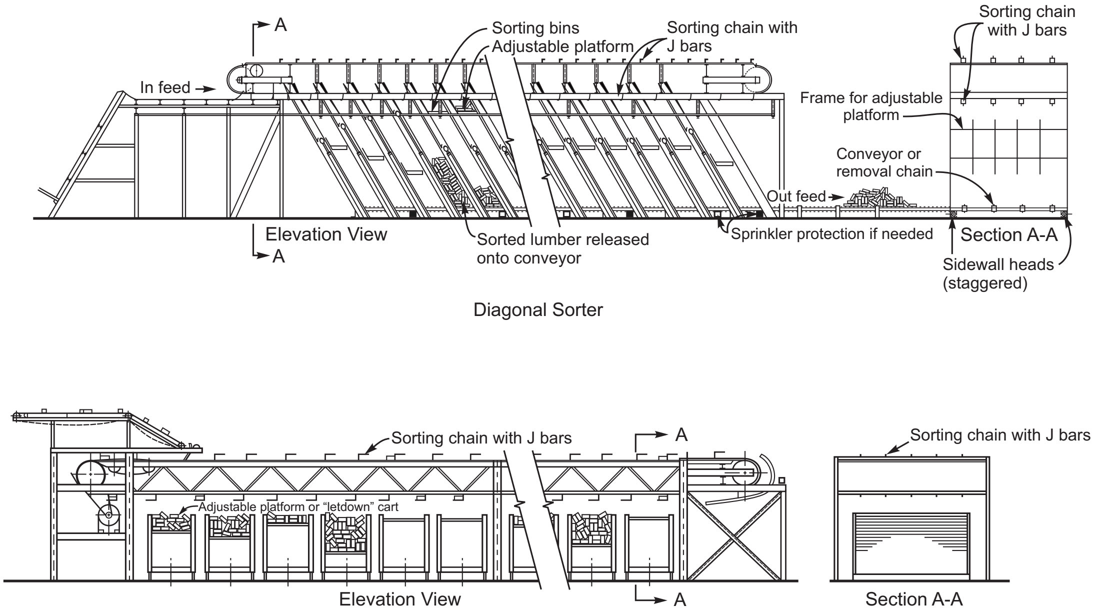


Fig. 2. Diagonal and vertical bin sorters

wetted. Consideration must be given to obstructions such as heating coils and movable airflow baffles which could block sprinkler discharge when the kiln is in operation. In no case should the density be less than .15 gpm/sq ft (6 mm/min).

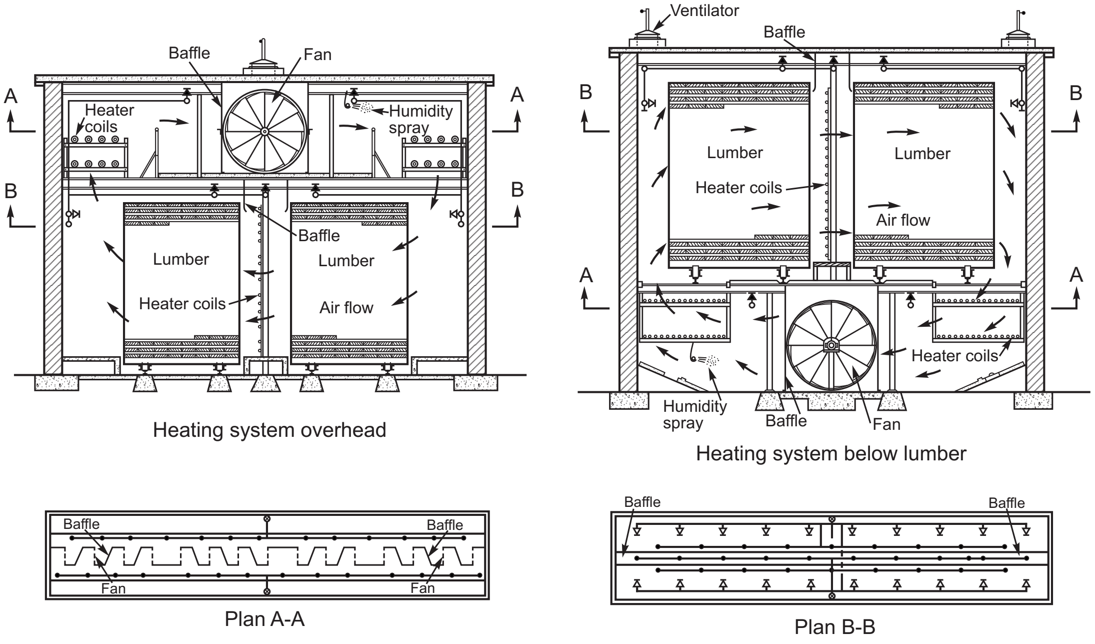


Fig. 3. Typical indirect-heated dry kilns

Exception: If the kiln is heated by a thermal oil system and the lumber load area is subject to an oil spill or spray fire, a .25 gpm/sq ft (10 mm/min) density should be used. Flow of thermal oil to the kiln should be automatically stopped on sprinkler waterflow or detection of oil loss in the kiln heating loop. Manual shutoff is acceptable where alarms for sprinkler waterflow and loss of oil annunciate at an on-site constantly attended location, the oil isolation valve is readily accessible and not exposed by a kiln fire, and the emergency response team includes a person assigned to this task.

b) Provide automatic sprinklers throughout the fan plenum space on 130 sq ft (12 sq m) maximum spacing. Hydraulically calculate these heads to provide .15 gpm/sq ft (6.1 mm/min) over the entire kiln.

Exception: If the kiln is heated by a circulating thermal oil system and the plenum space is subject to an oil spill or spray fire, a .25 gpm/sq ft (10 mm/min) density should be used.

Interlock flow of thermal oil to the kiln as described in Part a., above.

c) Assume simultaneous operation of the heads over the lumber and in the fan plenum space. Hydraulic calculations should be balanced for the two operating areas.

d) Calculations should include 500 gpm (1900 cu dm/min) for hose streams. Duration is 1½ hours. It is acceptable to include more than one pump or source to meet the total demand, if necessary.

e) A dry pipe system should be used if sprinkler piping is subject to freezing when the kiln is idle. *Do not* use galvanized piping since the high temperature and humidity will lead to accelerated pipe deterioration.

f) Use sprinkler heads with glass bulb-type thermal elements rated for approximately 50°F (nominal 30°C) above the maximum normal operating temperature.

2.3.2.2 Combustion controls and interlocks should be provided for burners supplying kiln heat in accordance with Data Sheet 6-9, *Industrial Ovens and Dryers*.

2.3.2.3 Roofs or canopies over kiln outfeed cooling areas (dry lumber) and infeed areas (green lumber) should have the same automatic sprinkler protection as indoor lumber storage of the same height. If no roof exists, evaluate the exposure to the kiln the same as any other yard storage.

2.3.3 Veneer and Fiberboard Dryers

2.3.3.1 Provide automatic deluge water spray protection for all multi-tiered (more than two tiers) dryers processing plywood veneer, fiberboard, etc., where the moisture content of the material being dried is reduced to 40 percent or less, or where fines and other combustible residues can collect on interior surfaces. (Small veneer dryers with only one or two tiers and good internal housekeeping do not need internal protection.) The following design criteria should be used (see Figs. 4 to 14):

a) Design systems to provide a minimum pressure of 20 psi (1.4 bar) for the end ¼ in. (6.4 mm) nozzles to ensure an adequate spray pattern. For the ½ in. (12.7 mm) orifice open sprinklers normally provided in air plenums and in exhaust stacks the end sprinkler pressure should be at least 7 psi (0.5 bar). Design by density is impractical because of the multi-tier nozzles arrangement in most dryers.

b) Where two or more deluge systems are provided in long units the water demand should be designed for two systems operating at one time. These units may have water demands in excess of 2000 gpm (7570 cu dm/min).

c) Provide strainers before the deluge valves for nozzles with orifices smaller than ⅜ in. (9.5 mm) to remove wood sawdust, chips or fibers. This is particularly important for system supplied from penstocks, flumes, ponds or rivers.

d) Provide heat detectors or a pneumatic pilot head system to actuate the deluge system. Figures 5, 6, 8 and 9 show suggested locations of the detectors or pilot heads. A pneumatic pilot system is preferred where moderate or heavy accumulation of resin is experienced and routine washdown is made using the deluge system or hoses.

e) Interlock the dryer fans and heat source to shut down when the deluge system(s) trip.

f) Provide water traps (Figs. 5, 6 and 9) to prevent air movement from plugging deluge piping with dust and resin.

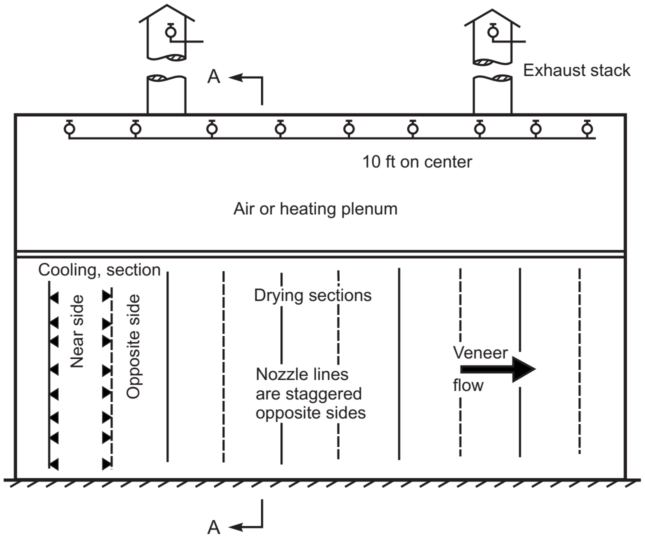


Fig. 4. Typical arrangement of deluge protection for standard veneer dryer. See Fig. 5 for additional protection details.

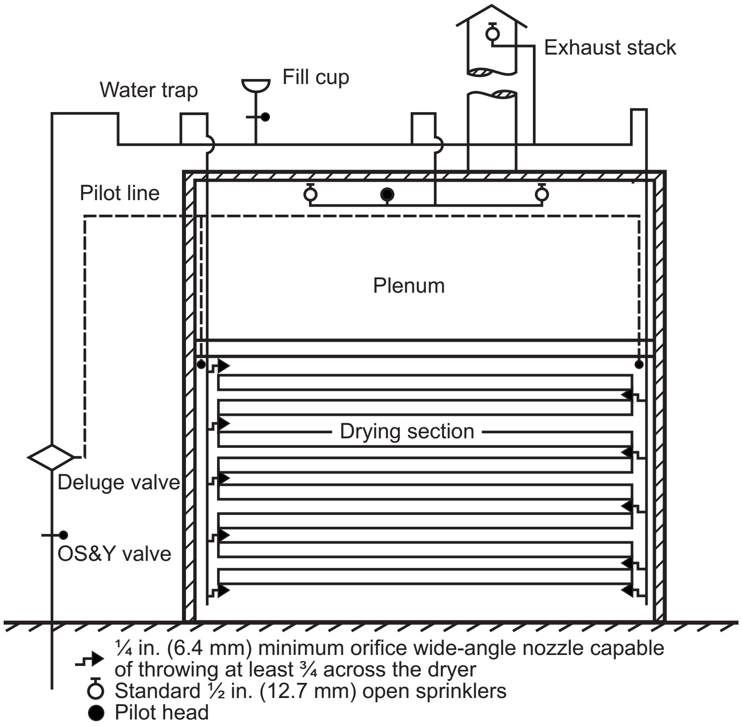


Fig. 5. Typical arrangement of deluge protection for standard veneer dryer. (Section A-A of Fig. 1.)

g) Provide inspection and fill top openings in the traps for weekly inspection of the water level. A mill-use hose should be provided for refill of the traps.

h) Provide open sprinklers in the exhaust stacks supplied by the deluge system.

i) For all deluge systems, locate the control valves for ready access by the operator.

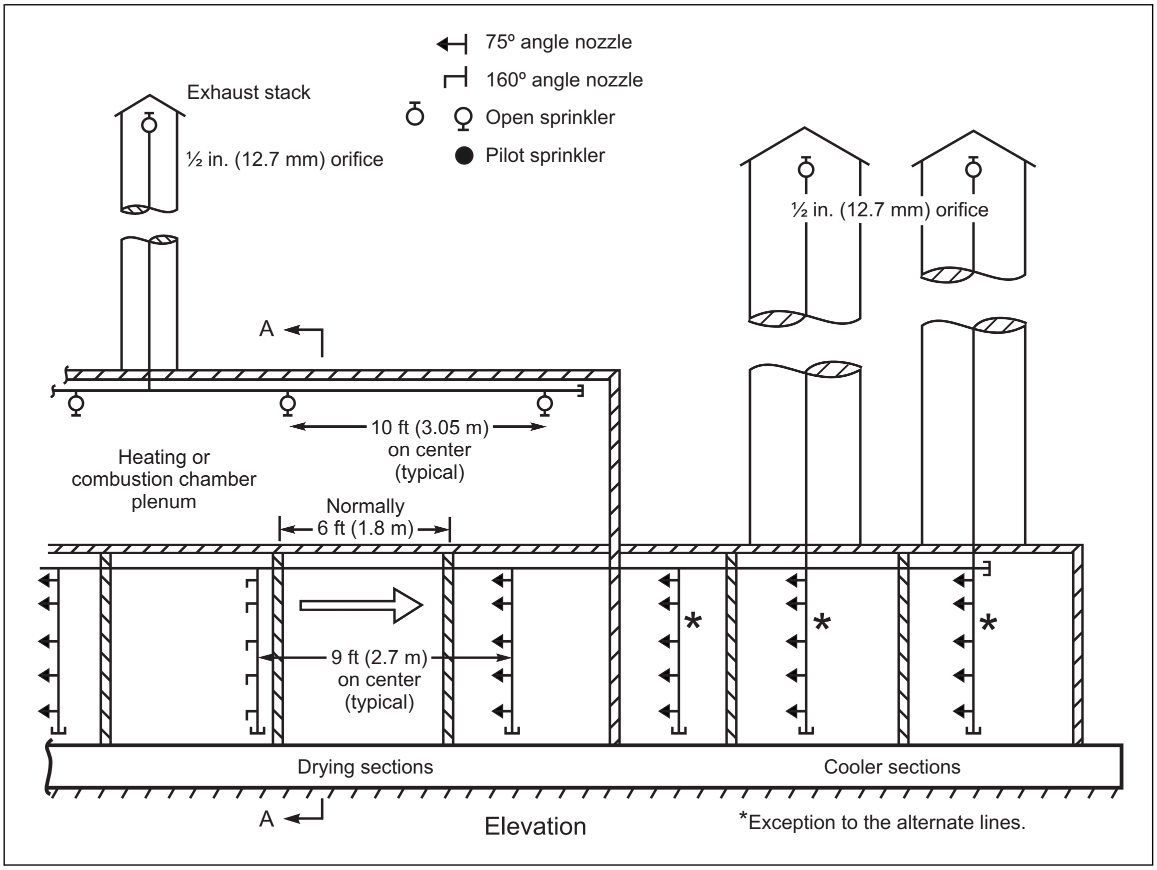


Fig. 6. Typical arrangement of deluge protection for vertical jet-type dryer. See Fig. 7 for additional protection details.

j) Trip test the deluge system regularly to remove accumulated lint and resins in the piping. This should preferably be done weekly as part of the dryer cleaning program, but may be extended to monthly as long as the tests show that nozzle plugging is not occurring.

k) Provide manual-pull stations for the deluge system on both sides of the dryer near opposite ends.

2.3.3.2 Standard multi-tier dryers (Fig. 4) should have nozzles on both sides so that one nozzle on each vertical line is at alternating tier levels and below the bottom tier. The nozzles should be arranged to spray at least ¾ of the way across the tier providing dual coverage in the middle of the unit. Nozzles should be wide angle spaced along the side of the unit providing overlapped coverage in the center of the dryer. The cooling section should have nozzles on each tier level.

2.3.3.3 Where nozzles are arranged to discharge from only one side of a vertical jet type dryer, one nozzle on each vertical line should be located at each tier and below the bottom tier. See Figures 6 and 7. Provide the same type of nozzle on each vertical line, with wide-angle nozzles on one vertical line and narrow-spray nozzles on the alternating line.

2.3.3.4 Provide standard upright open sprinklers in the top and side plenum chambers of both standard and vertical jet-type dryers spaced approximately 9×13 ft (3×4 m) or 120 sq ft (11 sq m) maximum.

2.3.3.5 Provide spray nozzle and open sprinkler deluge system for special vertical jet-type dryers as shown in Figures 8 and 9.

2.3.3.6 Provide roof level sprinkler systems for Wicket type dryers (see Fig. 10).

2.3.3.7 The ceiling areas above these dryers should receive regular cleaning to eliminate accumulations of dust and resin buildup. Particular attention should be given to ceiling exhaust fan openings since these areas will have the largest accumulations, and the fan drives are frequent ignition sources.

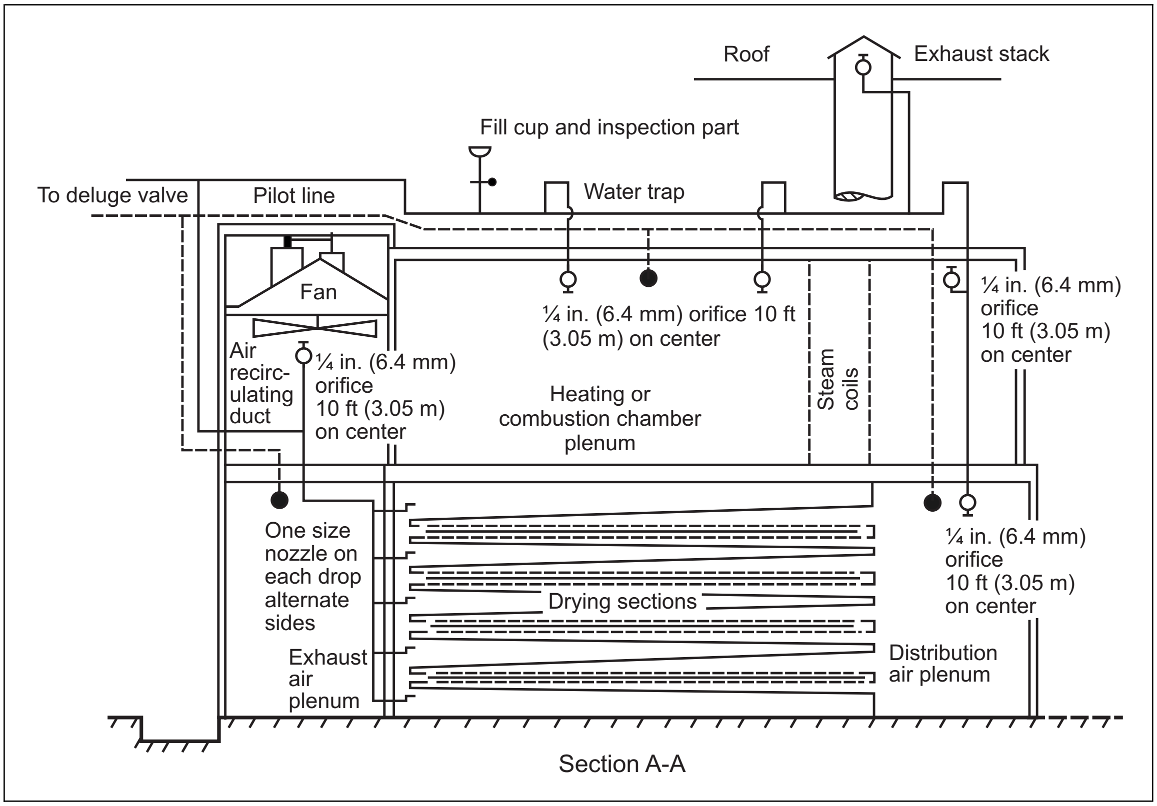


Fig. 7. Typical arrangement of deluge protection for vertical jet-type dryer. Section A-A of dryer shown in Fig. 6.

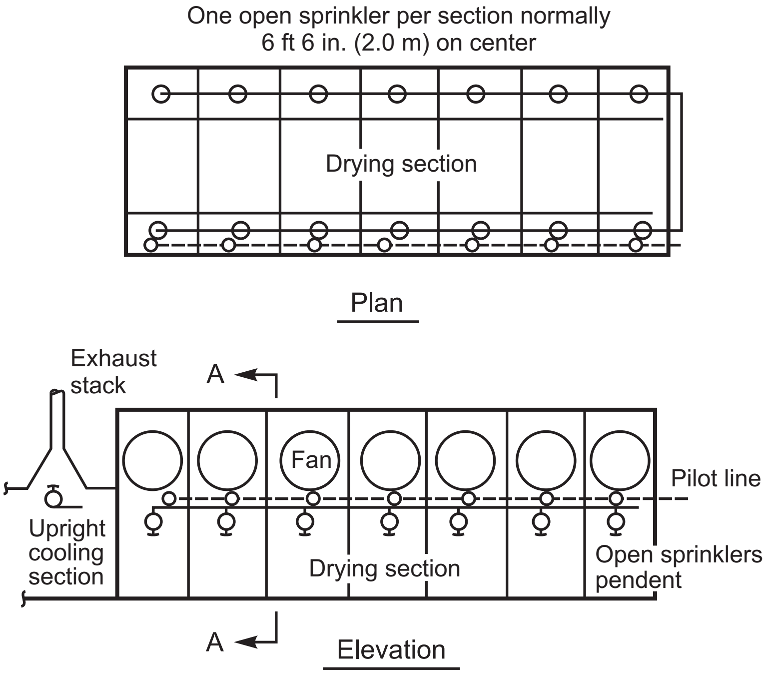


Fig. 8. Typical arrangement of deluge protection for special vertical jet-type dryer. See Fig. 9 for additional protection details.

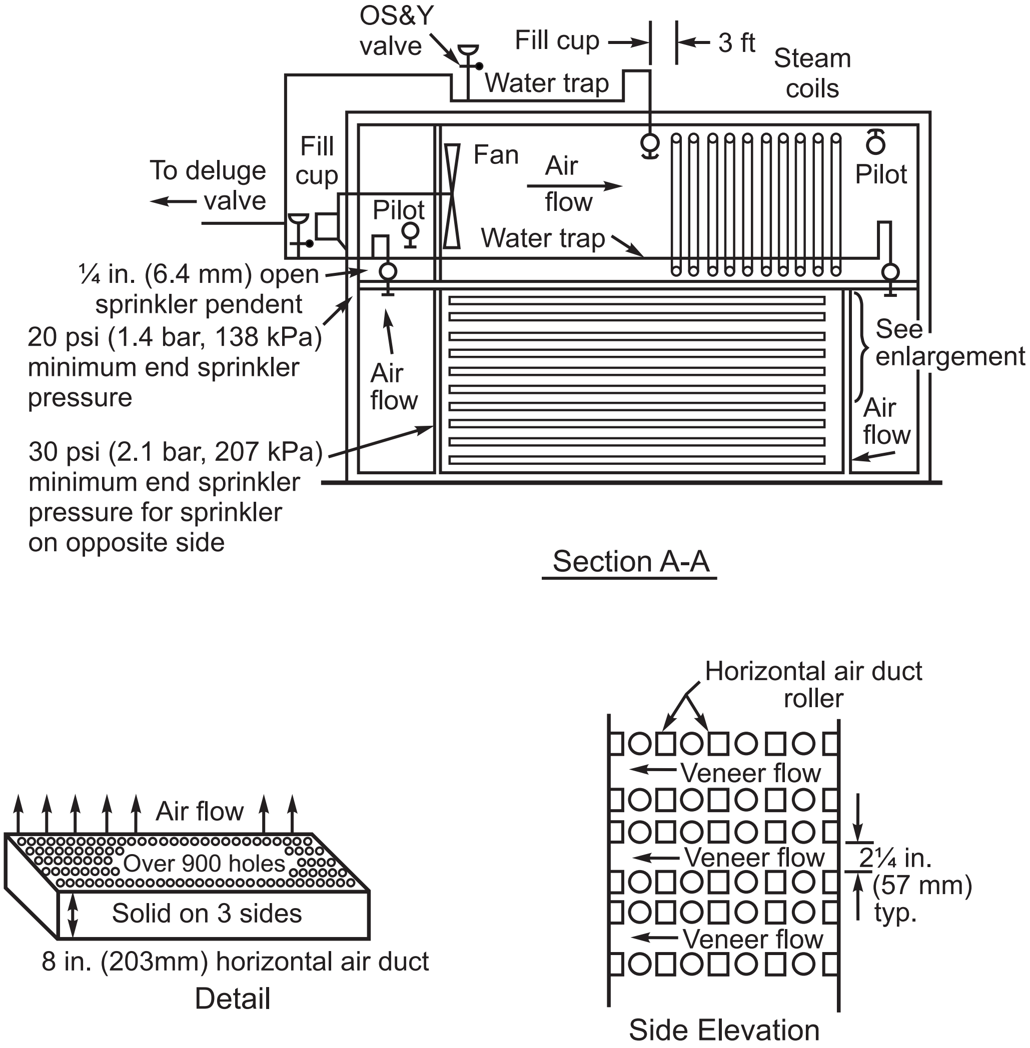


Fig. 9. Typical arrangement of deluge protection for special vertical jet-type dryer

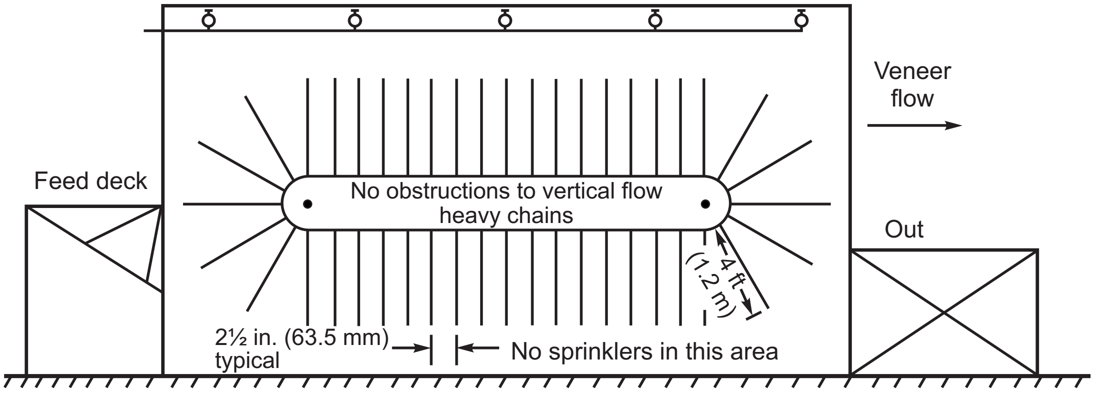


Fig. 10. Typical arrangement of automatic sprinkler protection for wicket-type veneer dryer

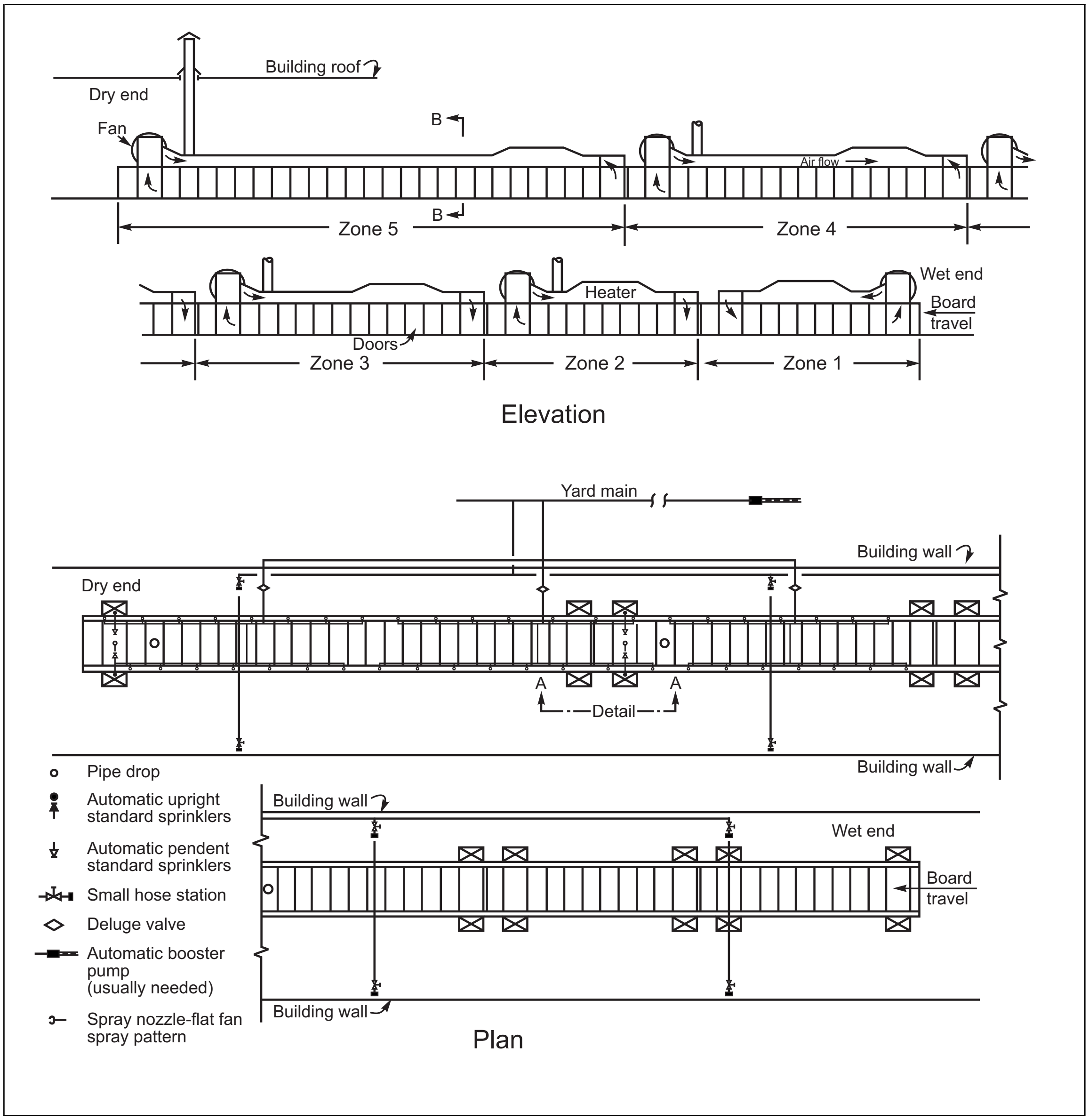


Fig. 11. *Typical arrangement of spray nozzle protection for multi-tier wood fiberboard or veneer dryer. Dryers, especially fiberboard dryers, can be up to 500 ft (153 m) long. Symbols apply also to Figs. 12–14 showing additional protection details.*

2.3.4 Humidifying and Tempering Ovens

Provide automatic waterspray deluge protection throughout the oven. Design the system similar to that used for standard veneer dryers.

2.3.5 Hot Presses

2.3.5.1 Refer to Data Sheet 7-98, *Hydraulic Fluids*, for protection guidelines for the hydraulic oil reservoir and pumps. Water-based (nonflammable) or FM Approved less-flammable hydraulic fluids should be used where feasible.

2.3.5.2 Provide automatic deluge sprinkler protection for all new press pits which utilize either flammable hydraulic fluid which is not FM Approved or thermal oil heat transfer fluid. Activation should preferably be by combination fixed temperature/rate-of-rise heat detectors, although wet or dry pilot lines are also acceptable. Provide manual trip stations on the operating floor on both sides of the press.

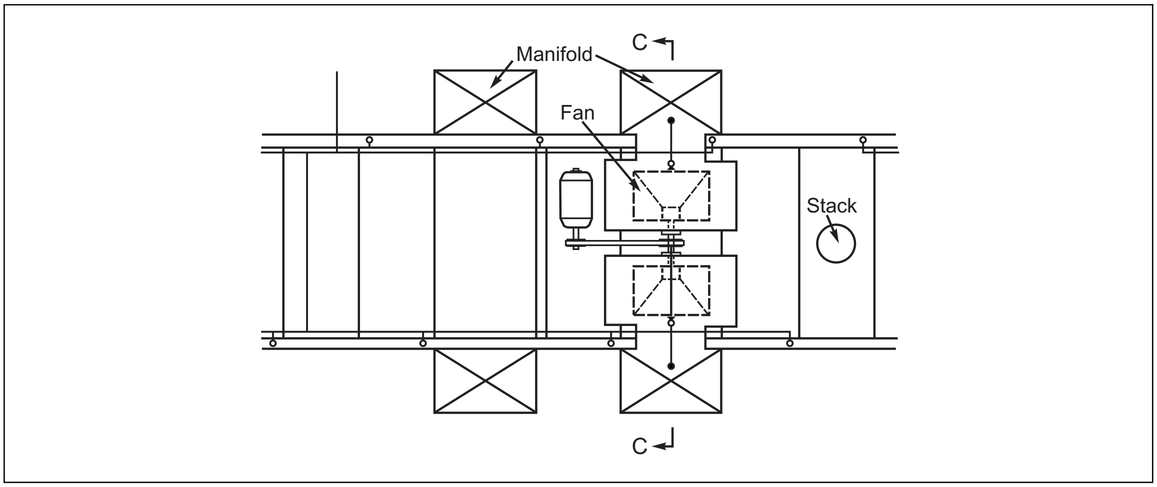


Fig. 12. Detail A-A of dryer shown in Fig. 11

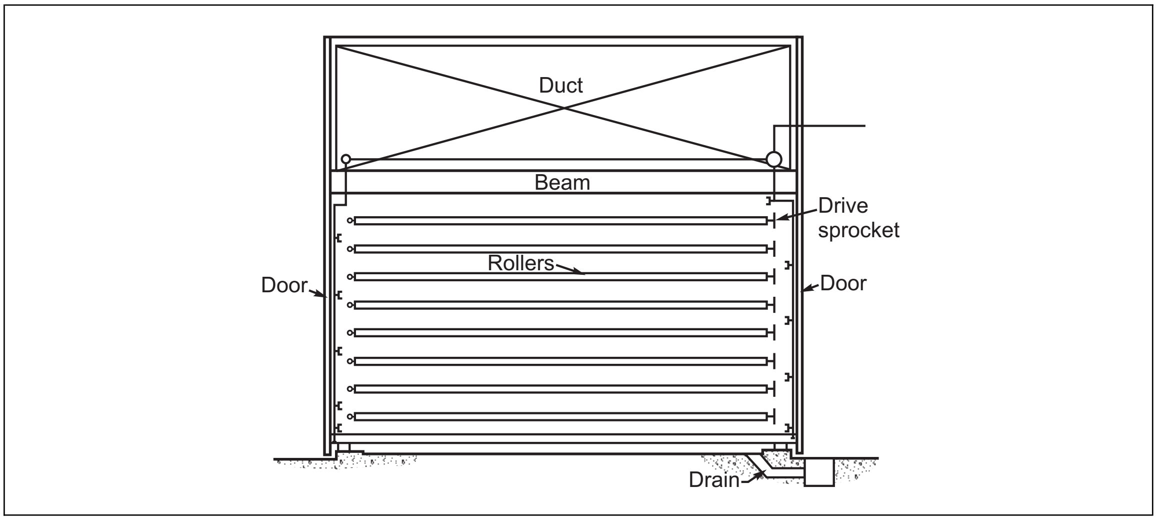


Fig. 13. Section B-B of dryer shown in Fig. 11

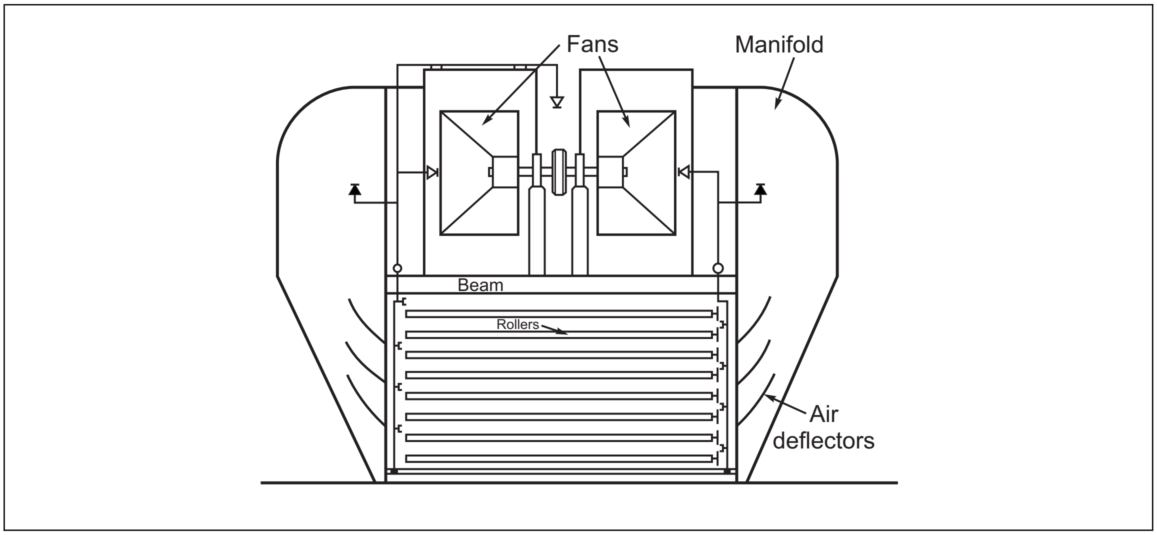


Fig. 14. Section C-C of dryer shown in Fig. 11

2.3.5.3 Automatic sprinklers on a closed head system are acceptable for existing or new press pits when water-based non-flammable or FM Approved less-flammable hydraulic fluid is used, there is no thermal oil heating, and the sprinkler design is otherwise in accordance with this standard.

2.3.5.4 Provide sidewall heads spaced 8 to 10 ft (2.4–3 m) apart around the perimeter of the press pit. Horizontal sidewall heads may be needed for larger pits to assure coverage at the center of the pit.

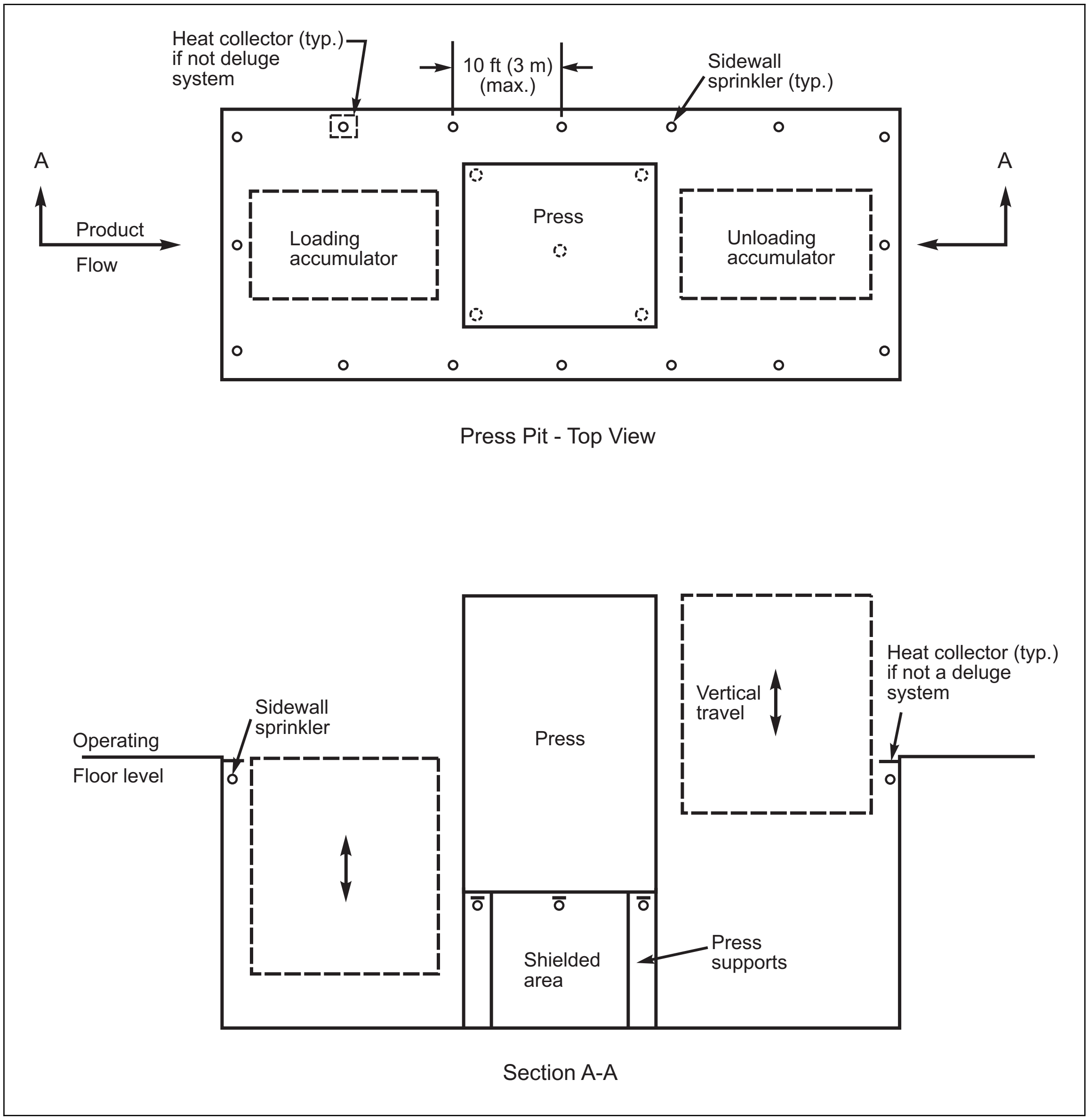


Fig. 15. Wood panel press pit protection

Provide additional heads in shielded areas under the press which cannot be protected by perimeter sprinklers (see Fig. 15). Open heads on deluge systems should be protected against plugging (e.g., loose fitting plastic bags).

2.3.5.5 Sprinklers should be hydraulically calculated to provide a minimum density of .20 gpm/sq ft (8 mm/min) over the entire pit area. If the press is heated by thermal oil, increase the density to .25 gpm/sq ft (10 mm/min). Include 500 gpm (1890 cu dm/min) in the calculations for hose streams. Duration is two hours.

Note: Presses utilizing flexible wire cauls can have very large pit areas and many shielded areas due to the caul return conveyor system. In these cases, the area requiring this special protection would be defined by the size of a potential oil spill, giving consideration to floor slope, curbing, drainage, etc.

2.3.5.6 Presses supported on steel columns should have column protection in the form or a sidewall sprinkler head pointing inward at the top of each steel column under the press or FM Approved fire resistive coating. Nearby adjacent heads cannot be relied upon to provide column protection.

2.3.5.7 Interlock the press hydraulic system to shutdown on sprinkler waterflow. Presses which will try to open via gravity can maintain pressure on the hydraulic system if the hydraulic pumps are shut off while the press is closed. In these cases it is acceptable to first open the press before the hydraulic system is shut off, but the sequence should be automatic and initiate without delay on waterflow.

Exception: Presses utilizing water-based nonflammable hydraulic fluids do not need this interlock.

For pits protected with dry pipe sprinkler systems, an acceptable alternative to interlocking on waterflow would be to use thermal detection in the pit. This should preferably be combination fixed temperature/rate-of-rise heat detectors, but other simple methods can be used. One such method is spring-loaded switches held open by cables routed around the press pit and under the press. The cables have fusible links no more than 10 ft (3 m) on centers. If a link fuses, the cable releases the spring-loaded switch and shuts down the press hydraulic system.

2.3.5.8 Interlock the press heating system to shut off on sprinkler water flow (i.e., stop flow of steam or thermal oil to the press, or de-energize RF energy heating systems). When the pit is protected by a dry pipe sprinkler system, the alternative methods for interlocking mentioned in Recommendation 2.3.5.7, above, can be used.

2.3.5.9 Press pits should be cleaned regularly to eliminate accumulations of wood waste or oil. Oil leaks should be promptly repaired.

2.3.5.10 The ceiling areas above presses should receive regular cleaning to eliminate accumulations of dust, oil and resin build- up. Particular attention should be given to exhaust fan openings since these areas will have the largest accumulations, and the fan drives are frequent ignition sources.

2.3.6 Thermal Oil Heating Systems

2.3.6.1 Refer to Data Sheet 7-99, *Heat Transfer Fluid Systems*, for recommendations for thermal oil heating systems.

2.3.7 Rotary Dryers

2.3.7.1 Dryers should preferably be located outdoors. If they must be inside, they should be in a separate building from the main production line, and the cyclone collection system should be located outdoors.

2.3.7.2 Provide a spark detection/extinguishing system and process interlocks arranged as follows:

a) Provide a spark detection/extinguishing system on the main airflow duct between the dryer drum and cyclone. The extinguishing system should activate every time a single spark is detected. It will reset after a few seconds (if no additional sparks have been detected) and the dryer can continue to operate. The spark counting features available in some Approved extinguishing systems can be used to shut down dryers when an excessive number of sparks are encountered, but should never be used as a measure of when to actuate the extinguishing spray.

b) Provide a second ‘‘fail-safe’’ detection point on the duct between the spark extinguishing nozzles and the cyclone collector. Detection at this location should be interlocked to safely shut down the dryer as follows:

i) Isolate the dryer cyclone outfeed to prevent smoldering material from being conveyed into downstream process areas. This should be accomplished by stopping rotary feeders or diverting material to a fire dump via reversing conveyors or diverter gates. Refer to Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fires*, for effective isolation techniques.

ii) Stop material infeed to the dryer and shut off all dryer heating sources.

iii) Initiate an automatic waterspray deluge in the dryer cyclone. Flush mounted, spring-loaded ‘‘poppet’’ nozzles (similar to those on the spark extinguishing system) are preferred because they are resistant to plugging and do not protrude into the airflow where dried material can collect or cause damage.

Automatic sprinklers are less desirable but can be accepted on existing installations. The second detection zone is still needed for isolation purposes, however. Be sure the water has a way to drain out if the cyclone and its supports cannot handle the weight of accumulated water. Steam should not be used as the sole extinguishing medium.

iv) The dryer conveying fan and dryer drum drive should be left running to purge material from the system and help prevent warping of the drum.

c) Rotary dryers which incorporate a ‘‘wind box’’ on the dryer outlet where the majority of the conveyed material drops out should have an additional spark detection zone, isolation measures, and waterspray deluge protection similar to the main cyclone.

d) When the dryer duct on which spark detectors are mounted is subject to resinous accumulations, test lights should be mounted across the duct from each detector. This will permit remote testing to be sure the detector lens has not become blinded by accumulations.

2.3.7.3 Provide high temperature limit switches on the inlet and outlet of the dryer drum interlocked to initiate all of the functions in 2, above, as well as actuate waterspray deluge in the dryer inlet and outlet.

2.3.7.4 For dryers processing particleboard furnish or other material having a similar high concentration of fines, provide explosion venting on the cyclone if it does not exhaust directly to atmosphere and on the windbox (if provided). A vent area equal to the full cross sectional area of the exhaust duct is normally sufficient for cyclone venting. Use Data Sheet 7-76 for windbox venting guidelines. Venting is not required on dryers processing furnish for waferboard or oriented strand board.

Figures 16 to 19 show typical protection schematics and interlock logic for rotary dryers.

2.3.8 Flash Dryers

2.3.8.1 Dryers should preferably be located outdoors. If they must be inside, they should be in a separate building from the main production line, and the cyclone collection system should be located outdoors. Dryer tube explosion vents should have relief ducts extending through the roof or walls to safely vent an explosion outdoors.

2.3.8.2 Protect flash dryers with spark detection/extinguishing systems, isolation methods, and automatic deluge systems in cyclones similar to Recommendation 2.3.7.2 for rotary dryers. Flash dryer protection differs only in that there is no dryer drum. The ‘‘fail-safe’’ detector should also initiate a waterspray deluge at the head end of the dryer tube in addition to the cyclone.

2.3.8.3 Provide high temperature limit switches on the dryer duct at the material inlet and entrance to the cyclone. These detectors will act as backup detection to the ‘‘fail-safe’’ spark detector and should initiate the same functions.

2.3.8.4 Flash dryers should have explosion venting on the dryer tube and cyclone. Vents should be smooth and flush fitting on the inside to prevent material build-up. Refer to Data Sheet 7-76 for venting guidelines.

2.3.8.5 If fiber buildup inside the dryer duct (and subsequent ignition) is a problem, a diverter on the fiber injection pipe to direct fiber to a dump area on initial startup of the material feed may help solve the problem.

2.3.8.6 The dryer duct should be regularly checked for fiber accumulations, and cleaned if needed.

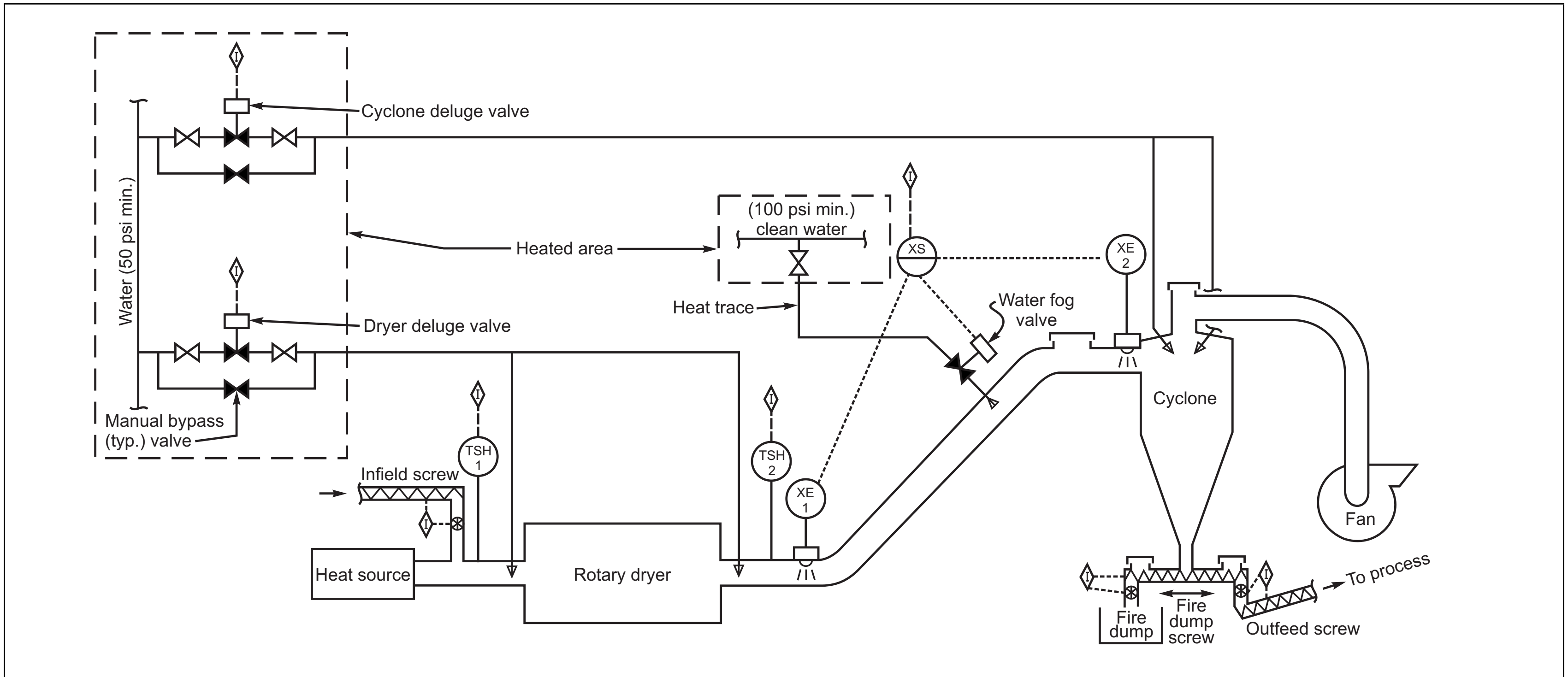
2.3.9 Particleboard Milling Equipment

2.3.9.1 Locate milling equipment in a building separate from the main production forming line building. It is acceptable to incorporate milling and drying equipment in a common facility, but the milling area should be separate from the drying area.

2.3.9.2 Provide explosion protection on each flaker, knife hog or hammermill used in particleboard, medium-density fiberboard, or dry process hardboard material preparation.

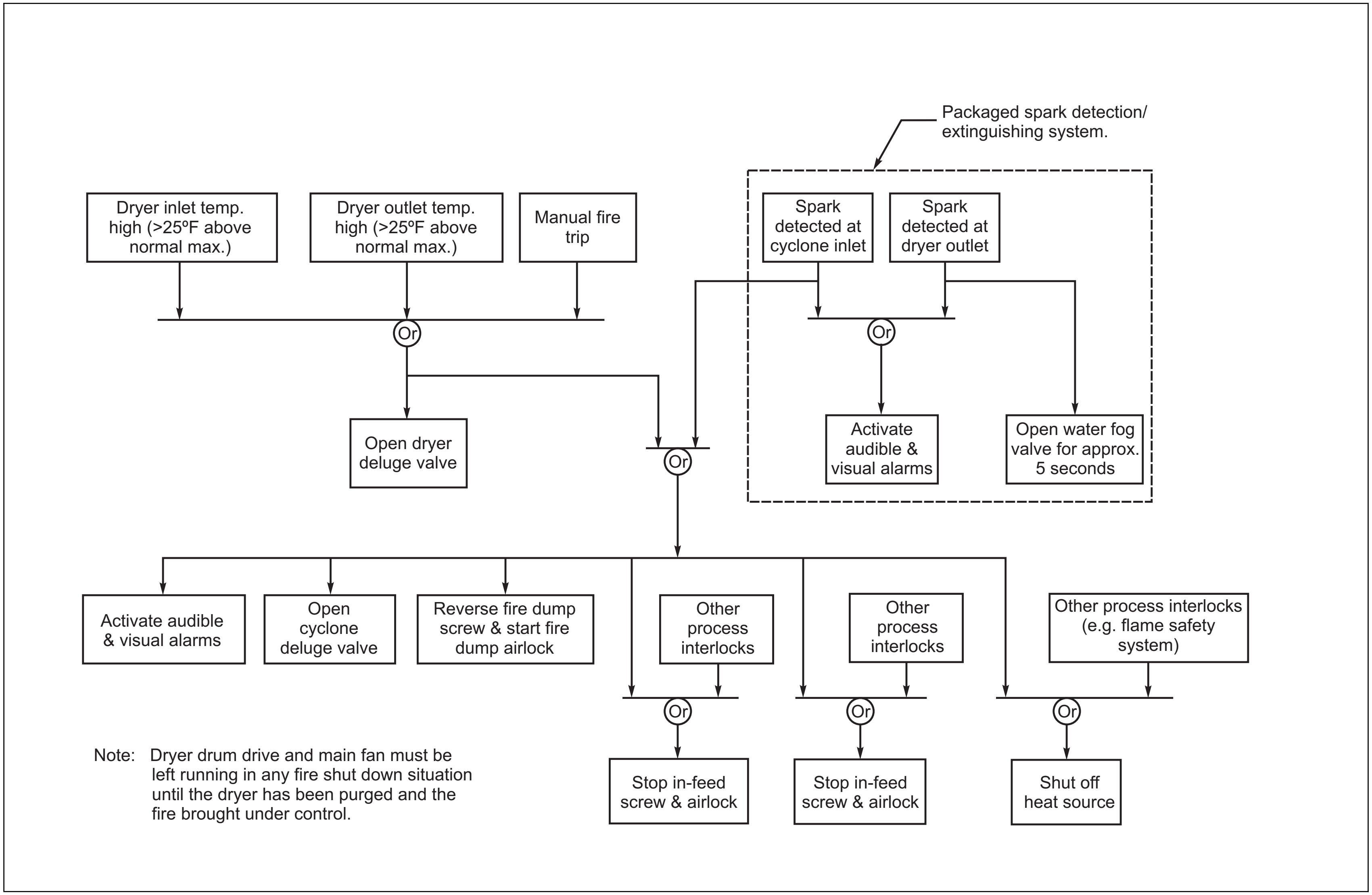
Exception: Disk refiners and steam aspirated flakers will not normally warrant this protection.

Protection should consist of either explosion suppression systems or explosion venting combined with spark detection to initiate process shutdown. Protection should extend upstream and downstream from this equipment to the point where a ‘‘choke’’ (e.g., rotary airlock) is provided to isolate the explosion. Refer to Data Sheet 7-76 for additional details.



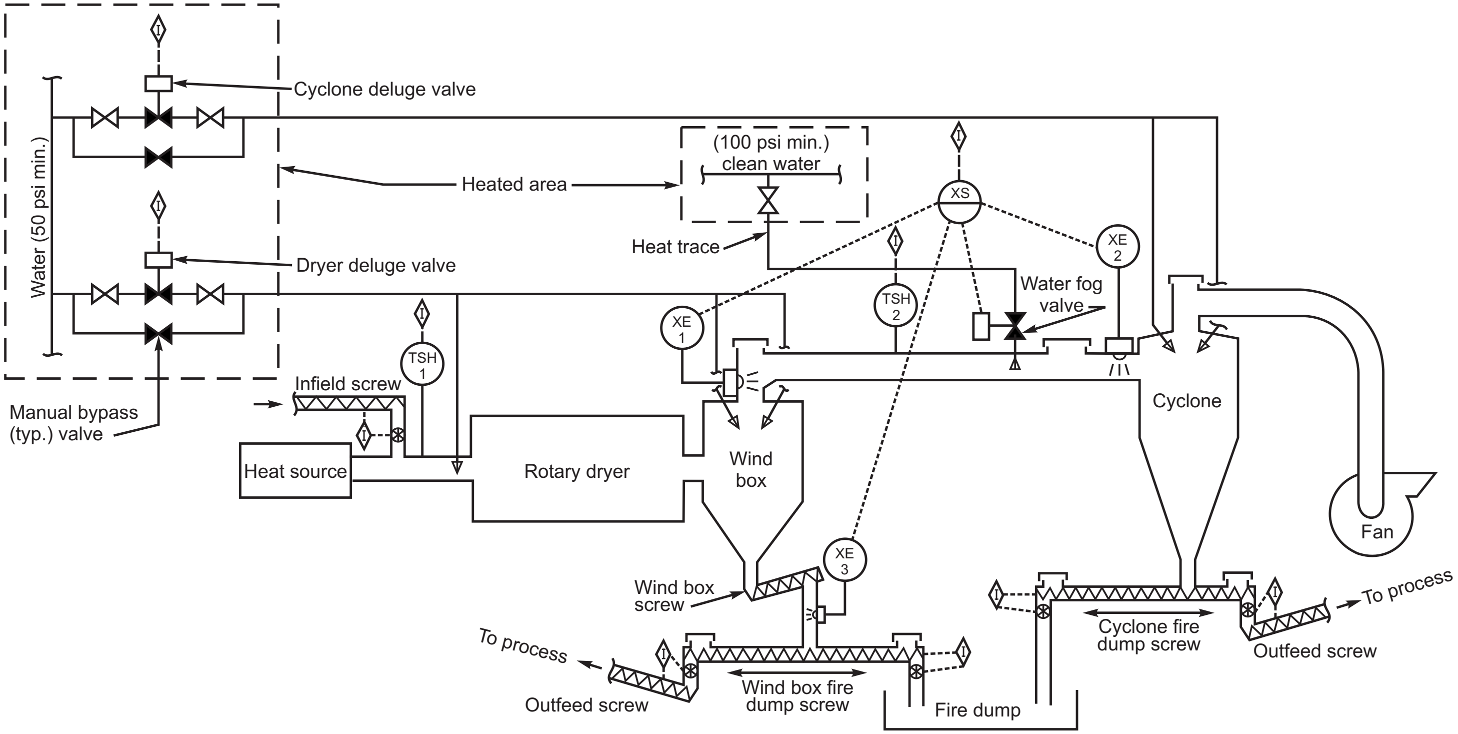
Symbol	Description	Location	Symbol	Description	Location
XS	Controller, infrared radiation detection/suppression system	Dryer operator's control room	TSH 1	Temperature switch, high limit	Dryer inlet
—◁	Nozzle, water fog	Duct between dryer and cyclone	TSH 2	Temperature switch, high limit	Dryer outlet
XE 1	Infrared radiation (spark) detector	Dryer outlet	→	Nozzle, water spray	Dryer inlet and outlet, cyclone
XE 2	Infrared radiation (spark) detector	Cyclone inlet	⌐¬	Explosion vent	Cyclone inlet & exhaust outlet, fire dump screw
◇I	System interlock	Numerous			

Fig. 16. Dryer without windbox



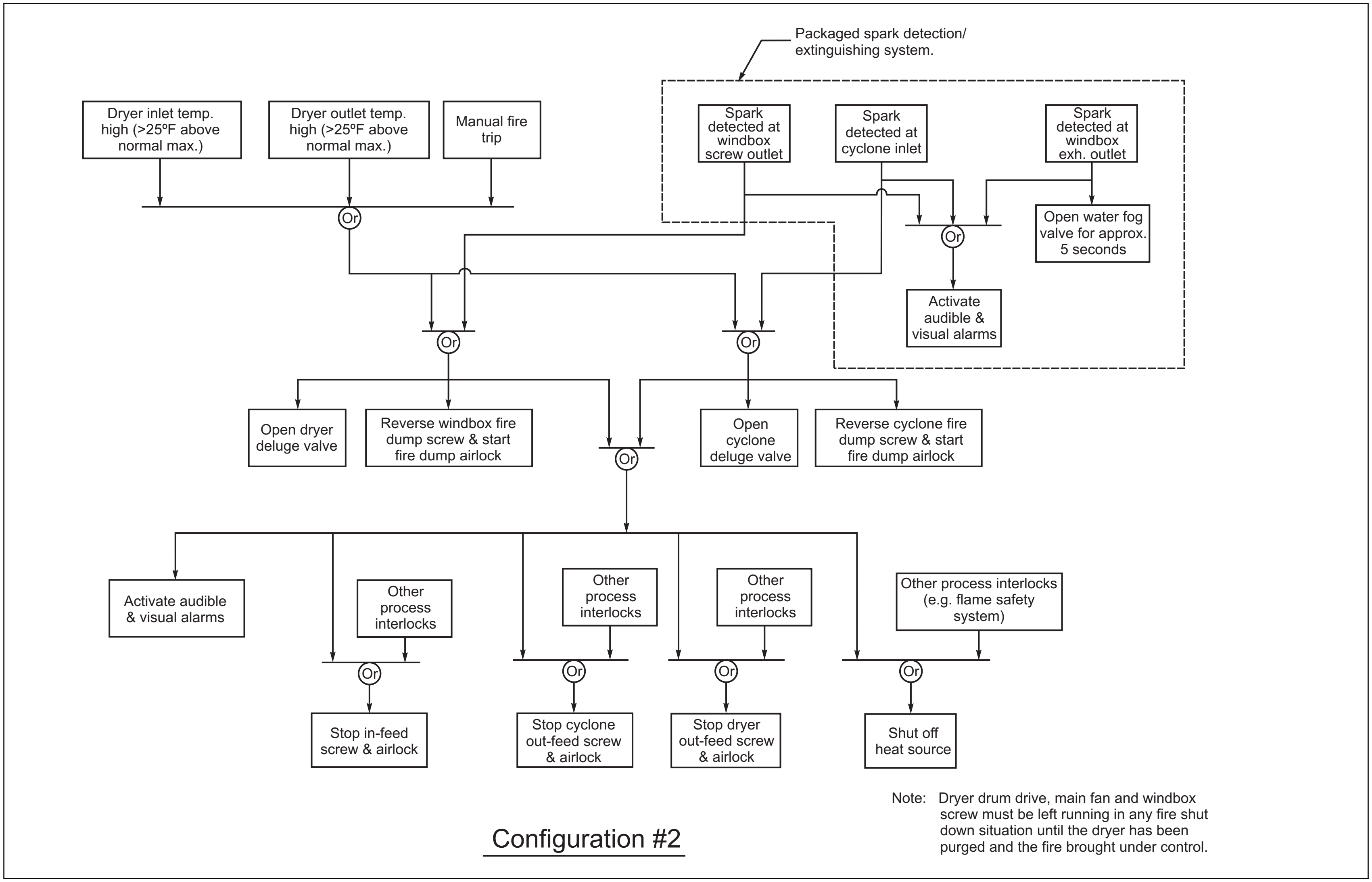
Note: Dryer drum drive and main fan must be left running in any fire shut down situation until the dryer has been purged and the fire brought under control.

Fig. 17. Dryer without windbox-interlock logic



Symbol	Description	Location	Symbol	Description	Location
XS	Controller, infrared radiation detection/suppression system	Dryer operator's control room	TSH 1	Temperature switch, high limit	Dryer inlet
—◁	Nozzle, water fog	Duct between dryer and cyclone	TSH 2	Temperature switch, high limit	Dryer between dryer and cyclone
XE 1	Infrared radiation (spark) detector	Windbox air outlet	→	Nozzle, water spray	Dryer inlet and outlet, cyclone
XE 2	Infrared radiation (spark) detector	Cyclone inlet	⊓	Explosion vent	Cyclone inlet & exhaust outlet, fire dump screw
XE 3	Infrared radiation (spark) detector	Windbox screw outlet	◇ I	System interlock	Numerous

Fig. 18. Dryer with windbox.



Note: Dryer drum drive, main fan and windbox screw must be left running in any fire shut down situation until the dryer has been purged and the fire brought under control.

Fig. 19. Dryer with windbox-interlock logic

2.3.10 Composite Panel Formers

2.3.10.1 Install automatic sprinklers or waterspray nozzles to protect the inside of formers. Heads should be located at the top of the former. When the formers are in view of an operator who is properly trained to respond, manual waterspray systems are acceptable.

2.3.10.2 Install explosion suppression systems on formers (felters) used to produce medium-density fiberboard and dry-process hardboard.

2.3.11 Hazardous Dust Collection and Dust Handling Systems

Refer to Data Sheet 7-73, *Dust Collectors and Collection Systems,* and Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fires*.

2.3.12 Raw Material and Wood Waste Fuel Storage Buildings

2.3.12.1 Provide explosion-relieving construction for new buildings. Venting should be designed in accordance with Data Sheet 7-76. Conventional lightweight, pre-engineered metal panel on steel frame buildings will meet the intent of this recommendation.

2.3.12.2 Construction should minimize horizontal ledges where dust can accumulate.

2.3.12.3 Sprinkler piping should be protected against explosion damage according to Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.3.12.4 Buildings which store *only green* wood waste should have electrical equipment suitable for Class II, Div. 2 hazardous areas.

Any areas handling *dry* wood waste should have Class II, Div. 1 electrical equipment.

2.3.12.5 Diesel powered front-end loaders used for material reclaim in Class II, Div. 1 classified buildings should have the following provisions:

a) Protect the engine and hydraulic oil compartments with fixed, automatic dry chemical extinguishing systems.

b) Loaders rated for use in ‘‘DY’’ classified hazardous areas should be used, but are not readily available and may not be practical if the loader must have electrical equipment such as lights for night-time operation. As an alternative, the following safeguards are acceptable:

i) Only essential electrical equipment should be used, and wiring should be in metal conduit. Air operated starting is preferred, but batteries may be used if they are mounted in enclosures rated for Type EX hazardous areas.

ii) Where practical, a water-cooled manifold and muffler should be used.

iii) Loaders which are certified to meet the Mining Enforcement and Safety Administration’s Schedule 31 criteria are also acceptable in lieu of i & ii above.

c) Loaders should have a high degree of maintenance and cleaning. Frequent cleaning (daily in some cases) of the engine compartment with compressed air may be necessary. Periodic steam cleaning should also be done.

d) Loaders should never be parked or left unattended in the storage building.

2.3.13 Wood Waste Burners (Incinerators)

2.3.13.1 Wood waste burners should be located as far as practical from yard storage and important buildings of combustible construction. A separation of 400 ft (120 m) is desirable.

2.3.13.2 The screen on the burner top should be kept in good repair to minimize the chance of escaping embers.

2.3.13.3 Where sparks from wood waste burners could reach roof areas of important combustible buildings that are not readily accessible using hydrant hose streams, provide 1½ in. (38 mm) hose stations in each building on a dry pipe system so that all such areas can be reached.

2.3.13.4 When dry wood fines, such as planer shavings or sander dust, are burned in wood waste burners, the burner should be at full operating temperature before the fines are introduced. This can be accomplished by manual observation if an operator is present at the burner to control the introduction of fines. If fines can be introduced into the burner by remote control without a local operator to confirm the status of the burner, a temperature interlock should be provided to assure the burner is ready to receive the material. This will assure an explosive dust cloud cannot form in the burner and be subsequently ignited.

2.3.14 Finishing Operations Using Flammable Liquids

2.3.14.1 Finishing operations using flammable sealers, coatings, paints, etc. should be protected in accordance with the applicable parts of Data Sheets 7-9, *Dip Tanks, Flow and Roll Coaters and Oil Cookers*; 7-32, *Ignitable Liquid Operations*; and 7-27, *Spray Application of Flammable and Combustible Materials*. These operations should be cut off from other manufacturing areas, preferably in a separate building.

2.3.14.2 Ovens or dryers used in these operations should be protected in accordance with Data Sheet 6-9, *Industrial Ovens and Dryers.*

2.4 Operation and Maintenance

2.4.1 Sprinkler System Flushing

Dry-pipe sprinkler systems that are prone to frequent nuisance tripping (several times per year) should receive the following routine maintenance:

a) Perform annual trip tests by opening the inspector’s test connection with the control valve wide open, allowing the water to flow until it is clear (one minute minimum).

b) Sprinkler systems fed from open water supplies (e.g., ponds, rivers, etc.) should have flushing investigations every five years. Based on the results of the investigations, flushing frequency should be adjusted as needed to assure piping does not become obstructed. In no case should the flushing frequency be longer than that for systems with clean water supplies.

c) Sprinkler systems fed from public water systems or other clean supplies should have flushing investigations on the following frequencies after being placed in service:

Galvanized Pipe	*Plain Pipe*
15 years	10 years
25 years	20 years
every 5 years thereafter	every 5 years thereafter

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Loss History

Recent losses involving wood processing facilities utilizing thermal oil heat transfer fluids have illustrated the need for adequate separation, protection and interlocks. A recent loss exceeded $10 million.

During the period 1980–1989, there were 1,583 F&EC/DIC losses. They totaled $178.5 million net insurance company liability (indexed to 1990 dollars). There were 725 fire losses that amounted to $113.6 million. A complete breakdown of losses involving wood processing facilities is provided in Table 3 and Figure 20.

Table 3. 1980–1989 Wood Processing/Working F&EC/DIC Losses By Engineering Peril (1990 $)

Engineering Peril	*No. of Losses*	
	No.	*%*
Fire	725	45.8
Collapse	57	3.6
Explosion	89	5.6
Wind or Hail	198	12.5
Flood	10	0.6
Riot & Civil Commotion	25	1.6
Water Damage	40	2.5
Miscellaneous	74	4.7
Sprinkler Leakage	114	7.2
Lightning	54	3.4
Impact	5	0.3
Vehicle	45	2.8
Burglary & Theft	56	3.6
Transportation	36	2.3
Rigging	11	0.7
Other	44	2.8
Total	1,583	100.0

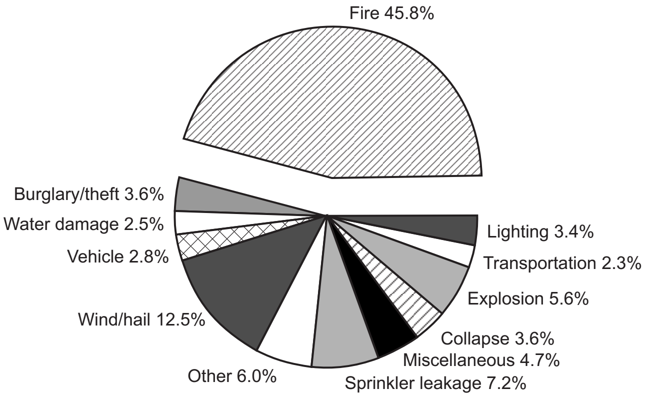


Fig. 20. Wood processing/working F&EC/DIC losses by peril (percent number of losses [1583])

Lacking or obstructed sprinkler systems or defective water supplies were considered a prime factor in 27.6 percent of the losses. These losses represent 80 percent of the total reported loss amount (over $88 million). A complete breakdown of prime factors in fire losses is provided in Table 4.

Table 4. 1980–1989 Wood Processing/Working Fire By Prime Factor (1990 $)

Prime Factor	No. of Losses	
	No.	%
Sprinklers Needed[1]	109	21.0
Sprinklers Out-of-Service (ICVs)[2]	10	1.9
Sprinkler System Defects[3]	19	3.7
Water Supply Defects[4]	5	1.0
Inadequate Housekeeping	57	11.0
Combustible Building Construction	6	1.2
Miscellaneous Human Element	67	12.9
Inadequate Cut/Weld Procedures	16	3.1
Inadequate Dust Handling	30	5.8
Defective Electrical Equipment	23	4.4
Inadequate Flammable Liquid Handling	11	2.1
Inadequate Maintenance	40	7.7
Defective Protective/Safety Equip.	11	2.1
Other	115	22.1
Total—Factors Recorded	519	100.0
Unknown/No Data	206	
Total—All Losses	725	

Cutting and welding activities were considered the probable cause of 10 percent of the reported fires. These losses represent 33 percent of the total reported loss amount (over $36 million). A complete breakdown of reported probable causes is provided in Table 5 and Figure 21.

Table 5. 1980–1989 Wood Processing/Working Fires By Cause (1990 $)

Cause	No. of Losses	
	No.	%
Cutting/Welding	56	10.5
Misc. Electricity	121	22.8
Incendiarism	48	9.0
Firebox Spark	12	2.3
Smoking	10	1.9
Spont. Ignition/Chem. Action	39	7.3
Gas Burner Flame	6	1.3
Chimney Spark	9	1.7
Hot Electric Motor Surface	2	0.4
Overheated Dryer, Kiln, Oven	15	2.8
Manufacturing Process Friction	40	7.5
Lightning	8	1.5
Exposure	13	2.4
Mechanical Spark	28	5.3
Other	124	23.3
Total—Cause Recorded	531	100.0
Unknown/No Data	194	
Total—All Losses	725	

Table 6 provides a comparison of losses with sprinkler system presence and effectiveness. For example, fires involving out-of-service sprinkler systems resulted in an average insurance company liability of $1,986,000. Fires controlled by adequate sprinkler protection resulted in an average liability of $168,000.

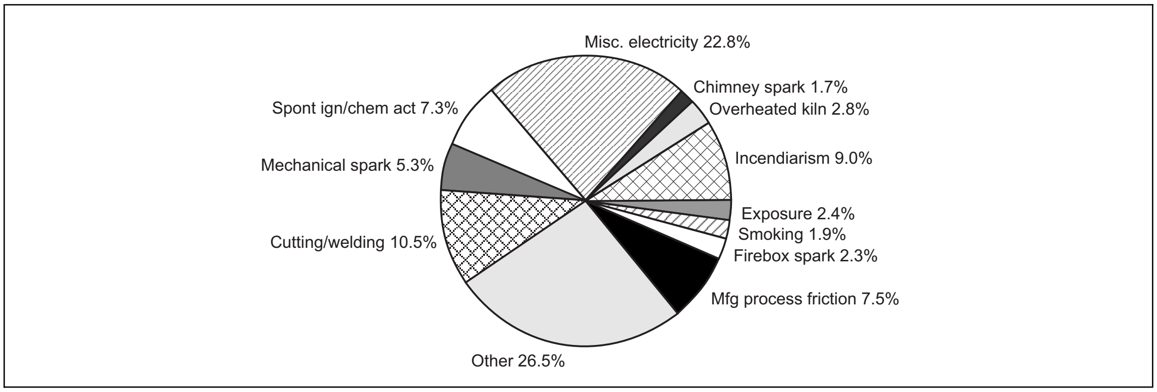


Fig. 21. Wood processing/working fires by cause (percent number of losses [531])

Table 6. 1980–1989 Wood Processing/Working Fires Sprinkler Protection Analysis (1990 $)

Sprinkler Protection	*No.of Losses*
Out-of-Service (ICV)[1]	13
Sprinkler Equipment Deficiency	23
Water Supply Deficiency	11
None—Sprinklers Needed	65
Yes—More Sprinklers Needed	76
Yes—Protection Adequate	180
None—None Needed	7
Total	375

[1] Improperly closed valves.

4.0 REFERENCES

4.1 FM

Data Sheet 1-20, *Protection Against Fire Exposure (From Buildings or Yard Storage*).
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers.*
Data Sheet 3-10, *Installation/Maintenance of Private Service Mains and Their Appurtenances*.
Data Sheet 6-9, *Industrial Ovens and Dryers*.
Data Sheet 7-9, *Dip Tanks, Flow/Roll Coaters and Oil Cookers*.
Data Sheet 7-27, *Spray Application of Flammable and Combustible Materials*.
Data Sheet 7-32, *Ignitable Liquid Operations*.
Data Sheet 7-73, *Dust Collectors and Collection Systems*.
Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fires*.
Data Sheet 7-98, *Hydraulic Fluids*.
Data Sheet 7-99, *Heat Transfer Fluid Systems*.
Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.
Data Sheet 8-27, *Storage of Wood Chips*.
Data Sheet 8-28, *Pulpwood and Outdoor Log Storage*.

4.2 NFPA Standards

NFPA 664 *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*.

APPENDIX A GLOSSARY OF TERMS

Approved: references to ''Approved'' in this data sheet means the product and services have satisfied the criteria for FM Approval. Refer to the *Approval Guide*, a publication of FM Approvals, for a complete listing of products and services that are FM Approved.

Composite Panels: comprise a wide range of products manufactured from wood fractions bonded with resin and pressed into panels. The term ''particleboard'' has been used as a generic name for many of these products; however, this is misleading. There is not even consistency within the industry in defining these various products, but the following descriptions give a general differentiation of the major products:

> *Particleboard:* a non-structural pressed panel product made primarily from small, non-fibrous wood particles or flakes such as planer shavings, sawdust, and wood scrap processed through hogs, hammermills, or special ''flakers.'' Particle size runs from wood dust up to flakes of about ¼ in. (6.3 mm) across and 1/16 in. (1.6 mm) thick. The boards are usually formed with the coarser material in the core and finer material on the surface layers, with finished boards ranging from ¼ in. (6.3 mm) to 1½ in. (3.8 mm) thick. Principal uses include floor underlayment in wood frame construction and core stock to be laminated with a veneer (wood or plastic laminate) for furniture, cabinets, paneling, etc. Panel density ranges from 25 to 70 lbs/cu ft (400–1120 kg/cu m) and may also be referred to as flakeboard or chipboard.
>
> *Waferboard:* a structural pressed panel product made of wafers cut from logs by special rotating knife chippers, or ''waferizers''. Wafers can be rectangular or nearly square shaped, about an inch long (25 mm) and 1/16 in. (2 mm) thick, with the grain running in the plane of the wafer, like a small piece of veneer. The boards are usually homogeneous with random wafer orientation, although they may be formed in layers. Rectangular wafers may be somewhat aligned to give higher strength. Typical uses are for underlayment, soffits, or as a substitute for plywood sheathing for the stronger waferboards.
>
> *Oriented Strand Board (OSB):* a structural pressed panel product similar to waferboard except the strands are longer and narrow, nearly finger-sized in dimension. Forming is in three or five layers, with strands on the surface layers oriented along the long dimension of the finished board, and internal layers at 90° orientation to adjacent layers. The orientation of layers give this product greater strength than waferboard, and equivalent to plywood in most cases. Typical uses are similar to softwood plywood.
>
> *Fiberboard:* a non-structural light-weight panel manufactured from small needle-like resinated wood fibers produced by defiberization of wood chips in rotating disc refiners. Panels are formed by flowing a thick fiber slurry onto a moving forming wire. Panels have a finished density of 10 to 30 lbs/cu ft (160–180 kg/cu m) with 4 by 8 ft (1.2×2.4 m) by ½ in. (12.7 mm) thick being a standard size. The most common use is insulating sheathing for standard wood frame construction. Fiberboard is sometimes coated with hot asphalt to act as a vapor barrier.
>
> *Medium-Density Fiberboard (MDF):* a non-structural pressed panel product formed from fibers similar to those in fiberboard, however the panels are formed dry in formers like particleboard, and pressed to final thickness in a hot press. Density ranges from 31 to 55 lbs/ft^3 (496–880 kg/m^3). Most common end uses are in furniture and cabinet manufacture. This product is commonly referred to as MDF within the industry.
>
> *Hardboard:* non-structural dense pressed panel product which can be formed in a wet process like fiberboard or in a dry process like medium-density fiberboard. Density ranges from 31 to 90 lbs/ft^3 (486–1440 kg/m^3). Common end uses are for paneling and siding in standard wood frame construction. Panel thickness is commonly between ⅛ and ½ in. (3.2–13.0 mm). Specialty products can be made by in special presses to produce molded products such as decorative door skin panels.

Plywood: a structural panel made by gluing together multiple layers of wood veneer. A primary use for softwood plywood is sheathing for walls, floors, and roofs in conventional wood frame construction. Another common use is for furniture, cabinets, decorative wall panels, etc., where hardwood veneers may be used for appearance. The standard size is a 4×8 ft (1.2×2.4 m) sheet.

Sawmill: a plant which reduces logs to standard-sized dimensional lumber and timbers for use in conventional wood frame joisted construction, or into boards for other construction or specialty use. Dimensional lumber is usually made of conifer softwood species such as fir and pine. Boards for construction use are also made of similar species, while hardwood such maple and oak may be cut into boards to be used in furniture manufacture, wood trim, or other specialty uses.

Wood Processing: manufacture of basic construction materials (lumber, veneer, plywood and composite panels such as particleboard, fiberboard, hardboard and oriented strand board) from whole logs.

Woodworking: remanufacture of basic construction products from wood processing plants into a wide variety of consumer products such as doors, windows, cabinets, furniture, paneling, or other commodities which use wood components as the basic construction material.

APPENDIX B DOCUMENT REVISION HISTORY

May 2010. Minor editorial changes were done for this revision.

September 2000. This revision of the document has been reorganized to provide a consistent format.

April 1991. Complete rewrite.

September 1998. Reformatted.

APPENDIX C MAJOR OCCUPANCIES AND PROCESS HAZARDS

This section gives descriptive information of typical processes and special equipment found in sawmills and panel products (plywood and composite panels) manufacturing facilities. Wood working facilities which re-manufacture these basic commodities into consumer products are too numerous and varied to describe here, but some of the process hazards are similar to those found in the facilities described below. This is especially true for dust collection systems used on all the specialty finishing planers, molders, sanders, etc.

Flammable liquid operations such as paint spraying and roll or flow coating are much more prevalent in wood working facilities than in wood processing facilities. This is perhaps the most significant loss exposure, but is not covered in detail here since protection for the various hazards are covered in other FM data sheets.

C.1 Process Descriptions

C.1.1 Sawmills

Older softwood sawmills were designed to cut very large logs, up to 6 ft (1.8 m) in diameter in some cases. Modern softwood forestry practices harvest trees at a fairly young age to get maximum yield. Southern softwood trees grow very fast, and may be cut after only 20 years of growth. Newer sawmills are designed to cut only small logs of about 18 in. (457 mm) maximum diameter. Common sizes of dimensioned lumber runs from 2×4 in. (51×102 mm) up to 2×14 in (51×356 mm). Common timbers run from 4×4 in. (102×102 mm) up to 6×14 in. (152×356 mm). All dimensions are nominal, and actual sizes are about ½ in. (13 mm) less than nominal. Laminated wood beams are a specialty product made by gluing standard lumber together. Special sizes, shapes and strengths can be engineered to order.

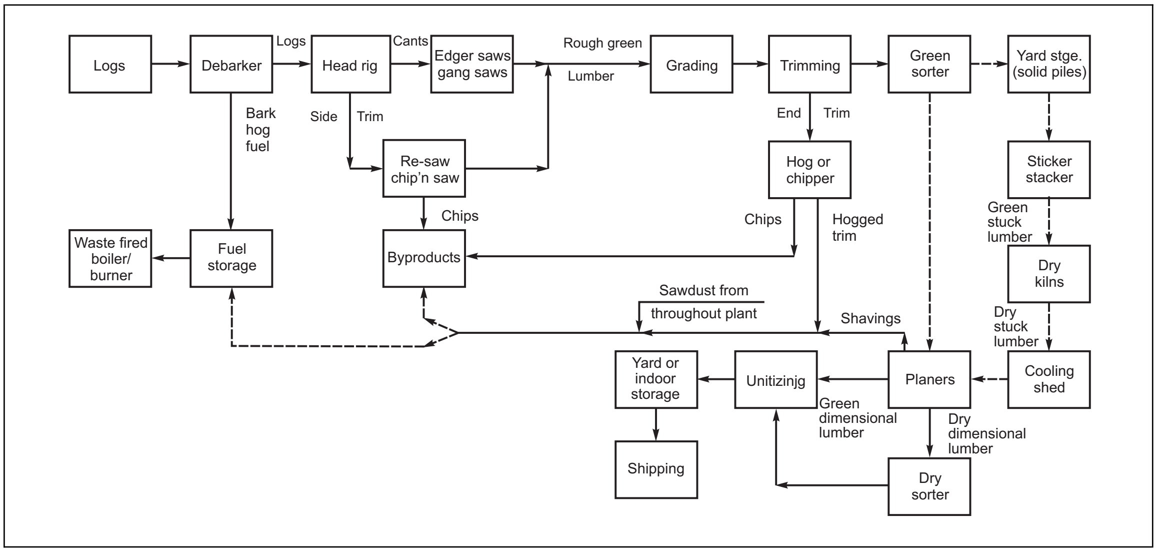


Fig. 22. Typical sawmill process flow schematic

Figure 22 shows a process flow schematic of a typical sawmill producing both green and dry dimensional lumber. Logs are reclaimed from yard storage by large mobile stackers and fed into the debarker. Debarkers remove bark from the logs either mechanically via rotating rings with toothed claws or hydraulically via jets of high pressure water. Slasher saws cut the logs to the desired length. Bark is reduced in size by mechanical ‘‘hogs’’ to be burned as ‘‘hog fuel’’ in waste fired boilers or incinerated in ‘‘tepee’’ burners.

Debarked logs move to the ‘‘head rig’’ which cuts them longitudinally into large rectangular ‘‘cants.’’ Head rigs are usually large band saws, but rotary saws may be used for smaller logs. In older mills, logs are positioned in the head rig manually by skilled sawyers. Modern facilities use laser scanning equipment to do this automatically. The side trim from the head rig is re-sawn to recover usable lumber with the remainder reduced to chips for pulp/paper mills. Special equipment (Chip ’n Saw is a common term) can do this in one operation. Cants are further reduced by edger saws and then ‘‘gang’’ saws which produce several pieces of lumber cut to rough final dimension in one pass.

Rough cut lumber is graded (usually manually) according to species and quality, then cut to length. Trimmed ends are either chipped to be sold as by-product, or hogged for use as fuel or by-product for composite panels raw material. Green lumber is sorted to length and sent to the planer operation for final dimensioning or to yard storage to await processing through the dry kilns.

Lumber sorters convey lumber on chain conveyors, detect the length of each piece, and divert it into a bin or tray with similar sized pieces. Figure 1 shows a horizontal tray sorter. Figure 2 shows both diagonal bin and vertical bin sorters, also referred to as ‘‘drop’’ sorters or ‘‘J-bar’’ sorters in the industry. Another variety of vertical bin sorter is the ‘‘sling’’ sorter which collects lumber in fabric slings.

Lumber which is to be dried is first prepared by stacking in uniform loads with each layer of lumber separated by a ‘‘sticker’’ of wood approximately 1 in. (25.4 mm) square. The loads of ‘‘stuck lumber’’ are stacked on wheeled carts which run on tracks to convey the loads into each dry kiln. Kilns may be heated indirectly by steam or thermal oil heat exchangers, or directly by fossil fuel or wood dust fired burners (refer to Data Sheet 7-99, *Heat Transfer Fluid Systems*, for a discussion of hot oil systems).

Figure 3 shows two typical indirect heated dry kilns. Once the drying cycle is complete, kiln loads are removed and placed in a cooling shed (usually just a canopy) to cool before the stickers are removed. Some plants may dry lumber by ‘‘air drying’’ rather than kilns. This is done by simply leaving the stuck lumber outside until it is dried to the desired moisture content. This typically takes from one to three months, depending on the ambient temperature, humidity and rainfall.

Following drying, lumber is passed through rotating knife planers for final dimensioning. Sometimes high-speed belt sanders similar to wood panel sanders are used for final dimensioning. This is most common on boards such as pine where the knots tend to be chipped out by conventional knife planers. Planer shavings are collected for use as fuel or as a by-product material for composite panel products.

Lumber is sorted again, if necessary, prior to ‘‘unitizing’’ for final shipment. Lumber loads are usually secured with a metal band, and an end sealer applied to the exposed lumber ends to prevent water penetration. Dry lumber may also be wrapped if it is to be stored outside. Handling by mobile equipment usually limits storage to about 16 ft (5 m) in height. Indoor storage using cranes can reach 30 ft (9 m) in height before pile stability becomes a concern.

C.1.2 Panel Products

Panel products include both plywood and composite panels made of small wood fractions held together by resin binders. The processes which manufacture these products have as many similarities as they do differences. The pressing and finishing operations are very similar for all panel products. The forming of the panels constitutes the primary differences. Figure 23 shows typical process flows for all these products on one schematic to highlight these similarities and differences.

C.1.3 Plywood

Logs are debarked in equipment similar to the debarking operation of a sawmill. Slasher saws cut the logs to length, usually just over 8 ft (2.4 m) long. These “peeler logs” are thawed (in cold climates) and/or softened in steam or hot water vats. Once softened, the peeler logs are conveyed to the veneer lathe. In older mills, the lathe operator uses his or her experience to position the log in the lathe spindle for maximum yield. Modern facilities use laser scanning equipment to assist in the positioning. Veneer from the lathe is trimmed to square up the edges. The peeler core remaining from each log after all usable veneer is removed is either

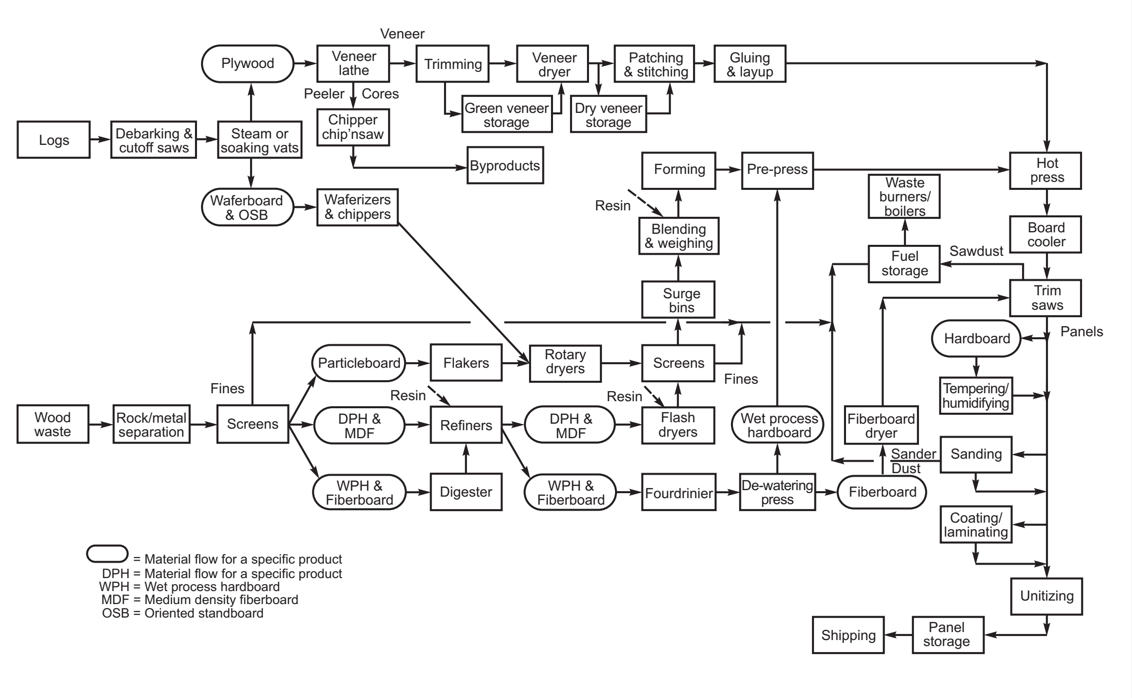


Fig. 23. Typical panel products process flow schematic

chipped or processed through a Chip 'N Saw to recover lumber from the center and chips from the sides. Green veneer may be stored to await drying. Piles are usually flat on-side, up to a height about 12 ft (4 m), but occasionally veneer may be stacked vertically.

Refer to the Section 2.3.3, Veneer and Fiberglass Dryers, for a description of veneer dryers.

Dried veneer may be stored before further processing such as patching and gluing or stitching to join smaller pieces together. The layup process prepares the veneer for pressing. Successive layers of veneer are coated with glue and laid on top of each other, with the veneer grain alternately placed lengthwise and crosswise for panel strength. The quality of outside face sheets of veneer depends of the end use for the panels. Plywood to be used for furniture or cabinetry may have a solid lumber core. Plywood glue is typically urea formaldehyde resin for indoor applications and phenol formaldehyde resin for exterior grades, although new resins are being sought to eliminate consumer concerns (such as formaldehyde emission) with the finished products. The glued veneer is then conveyed to the hot press to cure the resin, forming rigid panels.

Refer to the Section 2.3.5, Hot Presses, for a discussion of hot presses.

Pressed panels may be processed through a board cooler which is little more than a hood with a high induce airflow. The hood area creates a shielded space, which usually warrants automatic sprinkler protection. Panels are trimmed to final dimension, and if their end use dictates, sanded to final thickness or surface smoothness. Panel sanders are large high-speed belt sanders causing frequent sparks and fires in their dust collection systems due to belt breakage, jammed panels, and bearing failure. Further machining (e.g., tongue-and-groove edging, face grooving for paneling, decorative painting) may be done depending on end use. Finished products are unitized, usually by metal banding, and stored flat up to 20 ft (6 m) in height.

C.1.4 Particleboard

Dry wood waste material (called ‘‘furnish’’) is stored in large silos or open bay buildings, often referred to as RMS (raw material storage) buildings. RMS buildings have an inherently dusty atmosphere due to the free-fall formation of piles from over head conveyors or pneumatic conveying systems. ‘‘Green’’ sawdust may be stored outside. Diesel front end loaders are commonly used to reclaim material from the piles. Magnets and air separators are used to remove foreign material from the furnish prior to milling.

Screens may be also be used to remove the very fine dust for use as fuel. Special rotating-ring knife flakers are used to reduce the furnish to acceptable size. The furnish is then dried to the desired moisture content, usually less than 10 percent (dry basis), in rotary drum dryers.

Dried material is screened again to remove additional fines, and conveyed to surge bins. Material from the surge bins is convey to blenders where resin, and sometimes wax, is added. Urea formaldehyde is the common resin, but like plywood, alternate resins are being sought which do not have an emission problem. The blended resin is weighed and metered into formers which distribute the free-falling furnish onto a moving belt. There are usually at least three formers, two for surface material and one for core material. The material is normally deposited on metal ‘‘caul’’ plates to carry the furnish into the hot press, but is sometimes done without using a using a caul and pre-press roll instead to help the mat stay together as it’s loaded into the hot press.

Refer to Section 2.3.5 for a discussion of hot presses. Following pressing, the finishing line is similar to that described for plywood.

C.1.5 Waferboard

Whole logs are the primary raw material in waferboard manufacturing. Log preparation is identical to that described for plywood. Waferboard is commonly produced in the northern United States and Canada in areas where softwood is less prominent, allowing local hardwoods (aspen is a common species) to be used. Hot water soaking vats are common to thaw logs and soften then prior to processing in special wafer chippers called ‘‘waferizers.’’ Following waferizing, the furnish is processed through rotary dryers, forming, pressing, and finishing similar to particleboard as described above. Because large wafers are used as furnish, the process is much less dusty than particleboard. Once fines are screened out of the furnish, the process has about the same hazard as plywood manufacturing.

C.1.6 Oriented Strand Board (OSB)

The process and its hazards are virtually identical to waferboard. Oriented is the newest composite panel product in North America. Powdered resins (usually phenol formaldehyde, a combustible dust) are sometimes used instead of liquid resins. The handling of powdered resins can present some additional dust explosion hazards. Also, this process usually forms and presses very large panels (nominally 8 ft wide by 24 ft [2.4×7.3 m] long) which are subsequently cut into standard 4 by 8 ft (1.2×2.4 m) sheets.

Refer to the Section 2.3.5 for a discussion of hot presses.

C.1.7 Fiberboard

Like particleboard, wood waste is the primary raw material. Since fiberboard is formed in a wet process, the material does not need to be dried and can be stored outdoors. The initial removal of foreign material and screening is similar to particleboard. Processing of the furnish is different in that it passes through a pressurized steam digester to help soften the furnish, and then is reduced to fibers in rotating disk refiners, which may also be pressurized. Resin is added during the refining process. The fiber flows from the refiners as a wet slurry, similar to thermo-mechanical pulp. Also like pulp, the slurry is formed into a mat on a moving-wire former (‘‘Fourdrinier’’ is a common former manufacturer). Water is removed from the formed mat by vacuum and de-watering press rolls.

The mat is then cut into individual panels and dried in a multi-tier dryer (see Section 2.3.3, Veneer and Fiberglass Dryers, for a discussion of these dryers.) The dried fiberboard is trimmed to final size, usually 4 by 8 ft (1.2×2.4 m) panels, and unitized for storage prior to shipping. Some fiberboard products are coated with hot asphalt in a roll-coating process (refer to Data Sheet 7-9, *Dip Tanks, Flow Roll Coaters, and Oil Cookers,* for hazards and protection details).

C.1.8 Medium-Density Fiberboard (MDF)

MDF furnish is also formed from wood waste, but the forming process is dry and raw material which is not ‘‘green’’ is usually stored in large open bay buildings like particleboard. Reclaim using diesel front-end loaders is also common. Following the usual foreign material separation and screening, raw material is broken down into fibers by rotating disc refiners, which are usually steam pressurized. The damp fibers are dried to final moisture content (usually less than 10%) in ‘‘flash’’ dryers (see Section 2.3.8, Flash Dryers, for a discussion of these dryers.) Some processes inject resin (usually urea formaldehyde) into the furnish as it is enters the flash dryer. This is known as *blowline blending*.

Dried fiber may be further screened before it is conveyed (usually pneumatically) to surge bins. Fiber is conveyed from the surge bins (again, commonly by pneumatic blowlines) to blenders for resin addition (unless resin was added in the drying process), then to weigh belts before dropping into formers (commonly called *felters* in this process). Like other dry formers, the material free-falls onto a moving belt. In this process, the belt is usually a wire mesh with suction applied to the underside to help form the mat. Although the mat is usually formed by at least three felters laying down successive layers of fiber, there is usually little difference between the surface and core material, resulting in a homogeneous board. The fiber used in this process is typically fine enough to be explosive.

From the forming line, the mat is cut in panel lengths and run through pre-press rolls before entering a hot press for final pressing and resin curing (see Section 2.3.5 for a discussion of hot presses). The finishing line operations are similar to those described above for particleboard.

C.1.9 Hardboard

The raw material preparation and forming of wet process hardboard is similar to fiberboard as described above, except that the mat is processed through a hot press rather than a multi-tier dryer. Dry process hardboard manufacturing is virtually identical in equipment and hazards to medium-density fiberboard.

The finishing process for hardboard products usually has one additional step to temper or stabilize the moisture content in the panels. This consists of processing the panels in steam heated batch humidifying ovens which are similar in size to lumber dry kilns. Panels are typically placed horizontally separated by thin ‘‘stickers’’ on wheeled carts much like stuck lumber. Carts are loaded into the ovens in very close arrays, such that sprinkler penetration into the loads is difficult. The hazard is more like a multi-tier fiberboard or veneer dryer, and waterspray deluge protection should be used for that reason. Additional cutting of hardboard panels may be done to make lap-siding products.

C.2 Special Hazards

C.2.1 Veneer and Fiberboard Dryers

Dryers and ovens having multi-tiers are used for drying plywood veneer and fiberboard as well as other similar combustible material. The tiers very from three to twelve inches apart.

Generally, dryers have one or two zones and are protected by a single deluge system. Long units where the water demand is high (e.g., 2000 gpm or 7560 cu dm/min) may require two or more deluge systems. Figure 11 (top) shows the elevation view of a typical five zone dryer. Figure 11 (bottom) shows a general plan view. Detailed sketches of the deluge system installation are shown in Figures 12 to 14.

In wicket type veneer dryers (see Fig. 10), sheets are placed on horizontal arms, lifted to a vertical position, dried passing through the unit and then fall out when the arms slope downward. There are no obstructions to roof level sprinkler protection.

Vertical jet-type dryers have airflow plenum arm extensions which extend across the dryer. These extensions have openings along their length which cause jets of hot air to impinge vertically on the top and bottom of the veneer. This airflow can help support the veneer sheet and assist its travel through the dryer. The normal design will only accommodate spray nozzles along one side of the dryer (see Figs. 6 and 7). One special design is very similar to an airborne pulp dryer, with such restricted internal configuration that it is only practical to locate deluge heads in the main inlet and outlet plenum on both sides of the dryer (see Figs. 8 and 9).

C.2.2 Hot presses

Hot presses are used to cure the resins in panel products and press them to their approximate final thickness. The most common presses have multiple openings, perhaps 15 or more, to press many boards in one press cycle. Single opening continuous presses utilizing top and bottom platen segments on revolving tracks (much like the tracks on a bulldozer) exist, but are rare in North America. Presses (and the forming line equipment) are commonly of European manufacture, with lead time for replacement of a year or more.

Press platens were traditionally heated by flowing steam through them, but newer presses are using hot oil instead of steam. Some presses do not heat the platens at all, but rather use radio-frequency energy to heat and cure the resin (much like a microwave oven).

Hot presses typically have loading and unloading panel accumulators which move vertically to quickly load and unload boards from the press. Sprinkler protection in these portions of the pit are practical around the perimeter only. Horizontal sidewall heads may be needed to reach the center pit areas. Solid metal caul plates used in composite panel manufacturing usually progress through the press along with each panel. They are separated from the panels upon unloading and are returned to the forming line at operating floor level along the side of the press. Newer presses which use flexible wire cauls recirculate them underneath the press. This can result in very long, deep pit areas below the press with areas shielded by the caul conveyors.

Multi-opening presses are closed during the press cycle by large hydraulic cylinders in the pit directly below the press. The hydraulic system contains thousands of gallons of hydraulic fluid on larger presses. The press pit provides natural containment for an hydraulic or thermal oil spill, but exposes the press to a severe fire hazard.

C.2.3 Rotary Dryers

Rotary dryers used in composite panel manufacturing consist of steel drums which are oriented horizontally and rotate on trunion bearings, similar to a kiln. Dryer drums are commonly 8 to 10 ft (2.4–3 m) in diameter and 30–50 ft (9–15 m) long. The drums have internal baffles, or ‘‘flights’’ which lift the material and advance it through the dryer as the drum rotates. Dryers are either *single-pass* or *triple-pass* design. In single-pass designs, the material enters one end and exist the other end after traversing the dryer once. Triple-pass types have a labyrinth of drum passages inside the outer drum, such that material enters one end and traverses the length of the dryer three times before exiting the far end. Heated air is induced through the dryer to dry the furnish and assist movement through the system.

Material exiting the drum is collected in a fall-out chamber called a *wind box* (if the dryer has one), or in a cyclone. Dryer exit temperature is used to control the firing rate of the burner. Direct firing of the dryer is typical, with gas, oil, or wood dust used as fuel. Occasionally, waste heat from boilers or thermal oil heaters may be ducted to rotary dryers as a base-load heat source.

C.2.4 Flash Dryers

Flash dryers used in composite panels manufacturing are little more than pneumatic transport blowpipes 3–5 ft (0.9–1.5 m) in diameter, with the conveying air heated to dry the material as it is conveyed. Occasionally, vertical sections of duct with increased diameter may be used to increase the dwell time in the dryer (similar to pulp flash dryers). Fuel and firing rate control are similar to rotary dryers, with the exception that indirect heating using steam or hot oil heat exchangers are sometimes used.

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