10.6.1 Waferboard/Oriented Strandboard Manufacturing

10.6.1.1 General[1]

Waferboard (WB) and oriented strandboard (OSB) belong to the subset of reconstituted wood panel products called flakeboards. They are structural panels made from wood wafers specially produced from logs at the plant. When waferboard was developed in the 1950s, the wafers were not intentionally oriented. However, by 1989 most waferboard plants were producing oriented waferboard (OWB). Oriented strandboard originated in the early 1980s. The relatively long and narrow flakes (strands) are blended with resin and formed into a 3- or 5-layered mat. Aligning the strands in each layer perpendicular to adjacent layers gives OSB flexural properties superior to those of randomly oriented waferboard. Oriented waferboard and OSB are suitable for markets in which softwood plywood still dominates. They are chiefly used as sheathing, single-layer flooring, and underlayment in light-frame construction.

10.6.1.2 Process Description[1-3]

Figure 10.6.1-1 presents a typical process flow diagram for a WB/OSB plant. WB/OSB manufacturing begins with whole logs, which are cut to 254-cm (100-in.) lengths by a slasher saw. In northern plants, these logs are put in hot ponds maintained at a temperature between 18E and 43EC (80E and 120EF). This pretreatment prepares the logs for the waferizer by thawing them during winter operations. The logs then are debarked and carried to stationary slasher saws, where they are cut into 84-cm (33-in.) lengths, called bolts, in preparation for the waferizer. Some mills do not slash debarked logs into bolts, but instead feed whole debarked logs into the waferizer. The waferizer slices the logs into wafers approximately 3.8 cm (1.5 in.) wide by 7.6 cm (3 in.) long by 0.07 cm (0.028 in.) thick. The wafers may pass through green screens to remove fines and differentiate core and surface material, or they may be conveyed directly to wet wafer storage bins to await processing through the dryers.

Triple-pass rotary drum dryers are typical in WB/OSB plants. The dryers are normally fired with wood residue from the plant, but occasionally oil or natural gas also are used as fuels. The wafers are dried to a low moisture content (generally 4 to 10 percent, dry basis) to compensate for moisture gained by adding resins and other additives. Generally, dryers are dedicated to drying either core or surface material to allow independent adjustment of moisture content. This independent adjustment is particularly important where different resins are used in core and surface materials.

After drying, the dried wafers are conveyed pneumatically from the dryer, separated from the gas stream at the primary cyclone, and screened to remove fines (which absorb too much resin) and to separate the wafers by surface area and weight. The gas stream continues through an air pollution control device and is emitted to the atmosphere. Undersized material is sent to a storage area for use as fuel for dryer burners or boilers. The screened wafers are stored in dry bins.

The dried wafers then are conveyed to the blender, where they are blended with resin, wax, and other additives. The most commonly used binders are thermosetting urea-formaldehyde, phenol-formaldehyde, and isocyanate resins, all of which require the application of heat for curing. From the blender the resinated wafers are conveyed to the former, where they are metered out on a continuously moving screen system. The mat forming process is the only step in the manufacturing process in which there is any significant difference between WB and OSB production. In WB production, the wafers are allowed to fall randomly to the moving screen below to form a mat of the required thickness. In OSB production, the wafers are oriented electrostatically or mechanically in one direction as they fall to the screen below. Subsequent forming heads form distinct layers in which the wafers are oriented perpendicular to those in the previous layer. The alternating oriented layers result in a structurally superior panel.

In the mat trimming section, the continuous formed mat is cut into desired lengths by a traveling saw. The trimmed mat then is passed to the accumulating press loader and sent to the hot press. The press applies heat and pressure to activate the resin and bond the wafers into a solid reconstituted product. In most hot presses, heat is provided by steam generated by a boiler that burns plant residuals. Hot oil and hot water also can be used to heat the press. After cooling, the bonded panel is trimmed to final dimensions, finished (if necessary), and the product is packaged for shipment.

10.6.1.3 Emissions And Controls[1-55]

The primary emission sources at WB/OSB mills are wafer dryers and hot press vents. Other emission sources may include boilers, log debarking, sawing, waferizing, blending, forming, board cooling, and finishing operations such as sanding, trimming, and edge painting. Other potential emissions sources ancillary to the manufacturing process may include wood chip storage piles and bins (including wood fuel), chip handling systems, and resin storage and handling systems.

Operations such as log debarking, sawing, and waferizing, in addition to chip piles and bins, and chip handling systems generate particulate matter (PM) and PM less than 10 micrometers in aerodynamic diameter (PM-10) emissions in the form of sawdust and wood particles.

Emissions from dryers that are exhausted from the primary recovery cyclone include wood dust and other solid PM, volatile organic compounds (VOCs), condensible PM, and products of combustion such as carbon monoxide (CO), carbon dioxide (CO_2), and nitrogen oxides (NO_x), if direct-fired units are used. The condensible PM and a portion of the VOCs leave the dryer stack as vapor but condense at normal atmospheric temperatures to form liquid particles or mist that creates a visible blue haze. Both the VOCs and condensible PM are primarily compounds evaporated from the wood, with a minor constituent being combustion products. Quantities emitted are dependent on wood species, dryer temperature, fuel used, and other factors including season of the year, time between logging and processing, and wafer storage time.

Calculating PM-10 emissions from the wood products industries is problematic due to the relationship between PM-10 (or PM) emissions and VOC emissions from these processes. Because the Method 201A train (PM-10) operates with an in-stack cyclone and filter, organic materials that are volatile at stack gas temperatures but that are condensed at back half impinger temperatures (-20EC [-68EF]) are collected as condensible PM-10. However, these materials will also be measured as VOC via Methods 25 and 25A, which operate with a heated or an in-stack filter. Hence, if PM-10 is calculated as the sum of filterable and condensible material, some pollutants will be measured as both PM-10 and VOC emissions. However, if only filterable material is considered to be PM-10, the PM-10 emission factors will be highly dependent on stack gas temperature. In this AP-42 section, PM-10 is reported as front half catch only (Method 201A results only; not including Method 202 results). However, condensible PM results are also reported, and these results can be combined with the PM-10 results as appropriate for a specific application. Measured VOC emissions may be affected by the sampling method and by the quantity of formaldehyde and other aldehydes and ketones in the exhaust; formaldehyde is not quantified using Method 25A. Other low molecular weight oxygenated compounds have reduced responses to Method 25A. Therefore, when VOC emissions are measured using Method 25A, the emission rates will be biased low if low molecular weight oxygenated compounds are present in significant concentrations in the exhaust stream. A more extensive discussion of these sampling and analysis issues is provided in the Background Report for this section.

Emissions from board hot presses are dependent on the type and amount of resin used to bind the wood particles together, as well as wood species, wood moisture content, wax and catalyst application rates, and press conditions. When the press opens, vapors that may include resin ingredients such as formaldehyde, phenol, methylene diphenyl diisocyanate (MDI), and other VOCs are released. The rate at which formaldehyde is emitted during pressing and board cooling operations is a function of the amount of excess formaldehyde in the resin, board thickness, press temperature, press cycle time, and catalyst application rates.

Only limited data are available on emissions of the organic constituents included in the exhaust streams from WB/OSB dryers and presses. However, speciated organic emission data for particleboard and medium density fiberboard (MDF) may provide an indication of the types of organic compounds emitted from WB/OSB dryers and presses. Emission factors for speciated organic emissions from particleboard and MDF dryers and presses are included in AP-42 Sections 10.6.2 and 10.6.3, respectively.

Emissions from finishing operations for WB/OSB products are dependent on the type of products being finished. For most WB/OSB products, finishing involves trimming to size and possibly painting or coating the edges. Trimming and sawing operations are sources of PM and PM-10 emissions. No data specific to WB/OSB panel trimming or sawing are available. However, emission factors for general sawing operations may provide an order of magnitude estimate for similar WB/OSB sawing and trimming operations, bearing in mind that the sawing of dry OSB panels may result in greater PM and PM-10 emissions than the sawing of green lumber. It is expected that water-based coatings are used to paint WB/OSB edges, and the resultant VOC emissions are relatively small.

PM and PM-10 emissions from log debarking, sawing, and waferizing operations can be controlled through capture in an exhaust system connected to a sized cyclone and/or fabric filter collection system. Emissions of PM and PM-10 from final trimming operations can be controlled using similar methods. These wood dust capture and collection systems are used not only to control atmospheric emissions, but also to collect the dust as a by-product fuel for a boiler or dryer.

Electrostatic control devices provide highly efficient control of PM and PM-10, but lesser control of condensible organic pollutants in the exhaust streams from dryers. Two devices commonly used to control emissions from dryers are the electrified filter bed (EFB) and the wet electrostatic precipitator (WESP). The EFB is a popular PM control device in the wood products industry for controlling dryer exhaust gases because it is a dry type of control that produces an effluent stream that requires no further treatment. These units also are relatively small and do not require a large amount of floor space. The EFB is effective at solid PM removal but not as efficient at removing condensible aerosols in that it cannot remove any material it cannot condense. Also, the sticky liquid particles generated by drying softwoods cause the EFB to require frequent maintenance.

WESPs are used on effluent gas streams containing sticky, condensible hydrocarbon pollutants. Gases exiting the dryer enter a prequench to cool and saturate the gases before they enter the WESP. The prequench is essentially a low-energy scrubber that sprays water into the incoming gas stream. Some fraction of the highly water soluble compounds, such as formaldehyde and methanol, may be scrubbed by the prequench and collected. The gas that exits the prequench is nearly saturated; therefore, further cooling in the precipitator will condense and capture more of the condensible hydrocarbons, mainly the sticky resins. The WESP collects only particles and droplets that can be electrostatically charged; vaporous components of the gas stream that do not condense are not collected by the device. One disadvantage of the WESP is that it generates a wastewater effluent. Because OSB mills are generally designated as zero discharge facilities, they must treat their own spray water and/or consume it internally. Mills that operate boilers or other wet cell burners can apply some of the spent spray water to the fuel. Some or all of the remaining spray water may be used as makeup water in hot ponds or in debarkers for dust control.

A VOC control technology gaining popularity in the wood products industry for controlling both dryer and press exhaust gases is regenerative thermal oxidation. Thermal oxidizers destroy VOCs, CO, and condensible organics by burning them at high temperatures. Regenerative thermal oxidizers (RTOs) are designed to preheat the inlet emission stream with heat recovered from the incineration exhaust gases. Up to 98 percent heat recovery is possible, although 95 percent is typically specified. Gases entering an RTO are heated by passing through preheated beds packed with a ceramic media. A gas burner brings the preheated emissions up to an incineration temperature between 788E and 871EC (1450E and 1600EF) in a combustion chamber with sufficient gas residence time to complete the combustion. Combustion gases then pass through a cooled ceramic bed where heat is extracted. By reversing the flow through the beds, the heat transferred from the combustion exhaust air preheats the incoming gases to be treated, thereby reducing auxiliary fuel requirements.

Another control technology drawing the attention of the WB/OSB industry is biological air filtration, or biofiltration. Biofiltration systems can be used effectively for control of a variety of pollutants including organic compounds (including formaldehyde and benzene), NO_x, CO, and PM from both dryer and press exhaust streams. In biofiltration, exhaust streams are vented through a moist bed of composted wood bark or other biologically active material. Pollutants are adsorbed from the exhaust stream onto the filter media and converted by microbiological degradation to CO_2, water, and inorganic salts. Typical biofilter design consists of a three- to six-foot deep bed of media suspended over an air distribution plenum. Exhaust gases entering the plenum are evenly distributed through the moist biofilter media.

Another promising technology for the control of OSB dryer VOC and CO emissions is exhaust gas recycle. This technology uses an oversized combustion unit that can accommodate 100 percent recirculation of dryer exhaust gases. The recirculated dryer exhaust is mixed with combustion air and exposed directly to the burner flame. VOC emissions from burner combustion are incinerated in the second stage of the unit. High temperature exhaust from the combustion unit passes through a heat exchanger, which provides heat for dryer inlet air, and then through an add-on device for PM emission control.

Other potential control technologies for OSB dryers and presses include regenerative catalytic oxidation (RCO), and absorption systems (scrubbers).

Fugitive emissions from road dust and uncovered bark and dust storage piles may be controlled in a number of different ways. These methods include enclosure, wet suppression systems, and chemical stabilization. Control techniques for these sources are discussed more fully in AP-42 Chapter 13, Miscellaneous Sources.

Table 10.6.1-1 presents emission factors for dryer emissions of PM, including filterable PM, filterable PM-10, and condensible PM. Table 10.6.1-2 presents an emission factor for dryer emissions of chromium. Table 10.6.1-3 presents emission factors for dryer emissions of SO_2, NO_x, CO, and CO_2. Table 10.6.1-4 presents emission factors for dryer emissions of VOC and speciated organic pollutants. Table 10.6.1-5 presents emission factors for press emissions of PM, including filterable PM, filterable PM-10, and condensible PM. Table 10.6.1-6 presents emission factors for press emissions of SO_2, NO_x, CO, and CO_2. Table 10.6.1-7 presents emission factors for press emissions of VOC and speciated organic compounds.

Emission factors for mixed hardwood and softwood species are not reported in this section. Emission factors for specific mixes of wood species may be calculated by combining emission factors for individual wood species in the ratio specific to a given application, as emission data for those species become available. For example, an uncontrolled VOC emission factor for a direct wood-fired rotary dryer processing 60 percent pines and 40 percent hardwoods may be calculated using the uncontrolled VOC emission factors for pines (8.6 lb/ODT) and hardwoods (1.6 lb/ODT), and the ratio of 60 percent to 40 percent. The resultant emission factor, rounded to two significant figures, would be 5.8 lb/ODT.

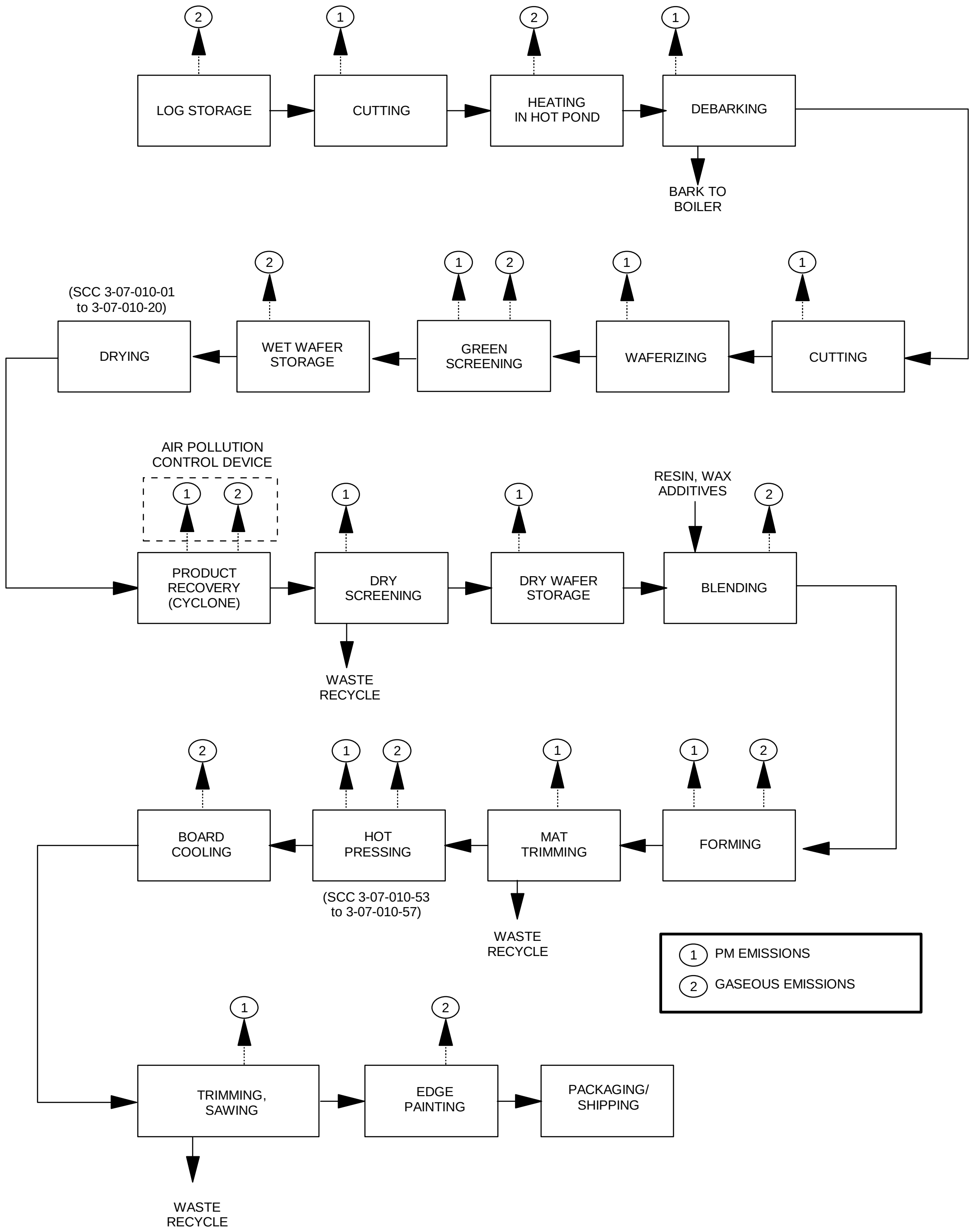

Figure 10.6.1-1. Typical process flow diagram for a waferboard/oriented strandboard plant.

Table 10.6.1-1. EMISSION FACTORS FOR OSB DRYERS--PARTICULATE MATTER[a]

Source	Emission Control Device[c]	Filterable[b]				Condensible[d]	EMISSION FACTOR RATING
		PM	EMISSION FACTOR RATING	PM-10	EMISSION FACTOR RATING		
Rotary dryer, direct wood-fired							
Unspecified pines (SCC 3-07-010-01)	None[e]	3.9[f]	D	ND		1.9[f]	D
	MCLO	2.1[g]	C	2.5[h,j]	C	0.41[k]	B
	EFB	0.61[m]	D	ND		0.49[m]	D
	WESP	0.20[f]	E	ND		0.83[f]	E
	RTO	0.17[n]	D	ND		0.12[n]	D
Aspen (SCC 3-07-010-08)	EFB	1.1[m]	D	1.2[m]	D	0.35[m]	D
Hardwoods (SCC 3-07-010-10)	None[e]	ND		ND		1.9[u]	E
	MCLO	6.9[p]	D	ND		0.50[q]	D
	EFB	0.92[r]	C	1.0[m]	D	0.40[s]	C
	WESP	0.20[t]	D	ND		0.30[t]	D
	RTO	0.036[u]	E	ND		0.12[u]	E

[a] Emission factor units are pounds of pollutant per oven-dried ton of wood material out of dryer (lb/ODT). One lb/ODT = 0.5 kg/Mg (oven-dried). Factors represent uncontrolled emissions unless otherwise noted. SCC = Source Classification Code. ND = no data available.
[b] Filterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train. Filterable PM-10 is that PM collected on the filter, or in the sample line between the cyclone and filter of an EPA Method 201 or 201A sampling train.
[c] Emission control device: MCLO = multiclone; EFB = electrified filter bed; WESP = wet electrostatic precipitator; RTO = regenerative thermal oxidizer.
[d] Condensible PM is that PM collected in the impinger portion of a PM sampling train.
[e] Cyclones are used as product recovery devices and are not considered to be emission control equipment.
[f] References 15-16.
[g] References 6-9.
[h] Multiclones are used for PM; effects on PM-10 are considered negligible.
[j] References 4,7-9.
[k] References 4,6-9.
[m] Reference 12.
[n] References 15-16,44.
[p] References 12,43.
[q] Reference 43.
[r] References 12,48,50.
[s] References 12,50.
[t] References 34,38,43.
[u] Reference 38.

Table 10.6.1-2. EMISSION FACTORS FOR OSB DRYERS--CHROMIUM[a]

Source	Emission Control Device[b]	Emission Factor	EMISSION FACTOR RATING
Rotary dryer, direct wood-fired			
Unspecified pines (SCC 3-07-010-01)	RTO	0.000063[c]	E

[a] Emission factor units are pounds of pollutant per oven-dried ton of wood material out of dryer (lb/ODT). One lb/ODT = 0.5 kg/Mg (oven-dried). SCC = Source Classification Code.
[b] Emission control device: RTO = regenerative thermal oxidizer.
[c] Reference 44.

Table 10.6.1-3. EMISSION FACTORS FOR OSB DRYERS--SO_2, NO_x, CO, AND CO_2[a]

Source	SO_2	EMISSION FACTOR RATING	NO_x	EMISSION FACTOR RATING	CO	EMISSION FACTOR RATING	CO_2	EMISSION FACTOR RATING
Rotary dryer, direct wood-fired (3-07-010-01, -08, -10)								
Uncontrolled[b]	ND		0.65[c]	B	5.8[d]	B	600[e]	B
RTO[f]	0.014[g]	E	0.60[h]	C	2.1[h]	C	760[j]	B
Rotary dryer, direct natural gas-fired (3-07-010-20)								
Uncontrolled[b]	ND		0.68[k]	E	0.72[m]	D	330[n]	E

[a] Emission factor units are pounds of pollutant per oven-dried ton of wood material out of dryer (lb/ODT). One lb/ODT = 0.5 kg/Mg (oven-dried). Factors represent uncontrolled emissions unless otherwise noted. SCC = Source Classification Code. ND = no data available.
[b] Emission controls used are for PM; effects on gaseous emissions are considered negligible.
[c] References 10,12,15-19,23,27,29,38-39,43-44,48,50-52,55.
[d] References 6-8,10,12,15-17,19,23,27,29,34,36,38-39,41,43-44,48,50-52.
[e] References 6-8,10-11,15-19,23,36,38,40-41,43,47-48,50-52,55.
[f] RTO = regenerative thermal oxidizer.
[g] Reference 38.
[h] References 15-17,19,22-23,27,29,38,44.
[j] References 15-17,19,22-23,38,44.
[k] Reference 20.
[m] References 20,39.
[n] Reference 39.

Table 10.6.1-4. EMISSION FACTORS FOR OSB DRYERS--ORGANICS[a]

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Rotary dryer, direct wood-fired					
Unspecified pines (SCC 3-07-010-01)	None[d]		VOC[e]	8.6[f]	C
		50-00-0	Formaldehyde *	0.067[g]	D
	RTO		VOC[e]	0.33[h]	D
		50-00-0	Formaldehyde *	0.034[j]	E
Aspen (SCC 3-07-010-08)	None[d]		VOC[e]	2.2[k]	D
		50-00-0	Formaldehyde *	0.11[k]	E
Hardwoods (SCC 3-07-010-10)	None[d]		VOC[e]	1.6[m]	B
		50-00-0	Formaldehyde *	0.084[n]	D
		71-43-2	Benzene *	0.0016[p]	E
		50-32-8	Benzo-a-pyrene*	0.0000030[p]	E
		108-95-2	Phenol *	0.0050[p]	E
	RTO		VOC[e]	0.036[q]	E
		50-00-0	Formaldehyde *	0.017[q]	E
Rotary dryer, direct natural gas-fired					
Hardwoods (SCC 3-07-010-20)	None[d]	50-00-0	Formaldehyde *	0.036[r]	E

[a] Emission factor units are pounds of pollutant per oven-dried ton of wood material out of dryer (lb/ODT). One lb/ODT = 0.5 kg/Mg (oven-dried). Factors represent uncontrolled emissions unless otherwise noted. SCC = Source Classification Code. * = hazardous air pollutant as listed in Section 112(b) of the Clean Air Act.
[b] Emission control device: RTO = regenerative thermal oxidizer.
[c] CASRN = Chemistry Abstracts Service Registry Number.
[d] Emission controls used are for PM; effects on gaseous emissions are considered negligible.
[e] Factors for VOC on a propane basis. Formaldehyde has been added.
[f] References 6-9,12,15-16,44.
[g] References 5,7-9,15-16.
[h] References 15-16,44.
[j] References 15-16.
[k] Reference 12.
[m] References 12,24,34,38,48,50.
[n] References 12,34,38,43,48,50.
[p] Reference 43.
[q] Reference 38.
[r] Reference 20.

Table 10.6.1-5. EMISSION FACTORS FOR OSB PRESSES--PARTICULATE MATTER[a]

Source[c]	Emission Control Device[d]	Filterable[b]				Condensible[e]	EMISSION FACTOR RATING
		PM	EMISSION FACTOR RATING	PM-10	EMISSION FACTOR RATING		
Hot press, PF resin (SCC 3-07-010-53)	None	0.12[f]	D	0.10[f]	E	0.25[f]	D
Hot press, MDI resin (SCC 3-07-010-55)	None	0.16[g]	D	ND		0.046[g]	D
Hot press, PF/MDI resins (SCC 3-07-010-57)	None	0.37[h]	B	0.11[f]	E	0.14[j]	B
	RTO	0.049[k]	D	ND		0.082[k]	D

[a] Emission factor units are pounds of pollutant per thousand square feet of 3/8-inch thick panel (lb/MSF 3/8). One lb/MSF 3/8 = 0.5 kg/m^3. Factors represent uncontrolled emissions unless otherwise noted. SCC = Source Classification Code. ND = no data available.
[b] Filterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train. Filterable PM-10 is that PM collected on the filter, or in the sample line between the cyclone and filter of an EPA Method 201 or 201A sampling train.
[c] PF = phenol formaldehyde; MDI = methylene diphenyl diisocyanate; PF/MDI = PF resin in surface layers, MDI resin in core layers.
[d] Emission control device: RTO = regenerative thermal oxidizer.
[e] Condensible PM is that PM collected in the impinger portion of a PM sampling train.
[f] Reference 12.
[g] References 12,18,24,38.
[h] References 9,12,21,25-26,30,34-36,39,41-43,45-46.
[j] References 9,12,21,25-26,30,34-36,39,41-43.
[k] References 15-17,21,23,25-26,30,35,44.

Table 10.6.1-6. EMISSION FACTORS FOR OSB PRESSES--SO_2, NO_x, CO, AND CO_2[a]

Source	SO_2	EMISSION FACTOR RATING	NO_x	EMISSION FACTOR RATING	CO	EMISSION FACTOR RATING	CO_2	EMISSION FACTOR RATING
Hot press (SCC 3-07-010-53, -55, -57)								
Uncontrolled	0.037[b]	E	0.038[c]	D	0.10[d]	B	12[e]	B
RTO[f]	ND		0.28[g]	D	0.26[h]	D	42[j]	C

[a] Emission factor units are pounds of pollutant per thousand square feet of 3/8-inch thick panel (lb/MSF 3/8). One lb/MSF 3/8 = 0.5 kg/m^3. Factors represent uncontrolled emissions unless otherwise noted. SCC = Source Classification Code. ND = no data available.
[b] References 31-32.
[c] References 12,15-17,23-24,30-33,38.
[d] References 12,15-17,21,23-24,30-33,38-39,42-43.
[e] References 15-16,18,21,24-26,31-32,35-36,38-39,41-43,45-52,54.
[f] RTO = regenerative thermal oxidizer.
[g] References 15-17,23,30,33,35,44.
[h] References 15-17,21,23,30,33,35,44.
[j] References 15-17,21,23,35,44.

Table 10.6.1-7. EMISSION FACTORS FOR OSB PRESSES--ORGANICS[a]

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Hot press, PF resin (SCC 3-07-010-53)	None		VOC[e]	0.52[f]	D
		50-00-0	Formaldehyde *	0.043[f]	E
		91-20-3	Naphthalene *	0.0030[f]	E
		108-95-2	Phenol *	0.053[f]	E
Hot press, MDI resin (SCC 3-07-010-55)	None		VOC[e]	0.45[g]	D
		50-00-0	Formaldehyde *	0.064[h]	E
		101-68-8	MDI *	0.0017[h]	E
Hot press, PF/MDI resins (SCC 3-07-010-57)	None		VOC[e]	0.56[j]	B
		50-00-0	Formaldehyde *	0.063[k]	D
		101-68-8	MDI *	0.0021[m]	D
		108-95-2	Phenol *	0.019[n]	D
	RTO		VOC[e]	0.040[p]	D
		50-00-0	Formaldehyde *	0.0043[q]	E
		101-68-8	MDI *	0.000078[r]	E
		108-95-2	Phenol *	0.0026[s]	E

[a] Emission factor units are pounds of pollutant per thousand square feet of 3/8-inch thick panel (lb/MSF 3/8). One lb/MSF 3/8 = 0.5 kg/m^3. Factors represent uncontrolled emissions unless otherwise noted. SCC = Source Classification Code. * = hazardous air pollutant as listed in Section 112(b) of the Clean Air Act.

[b] PF = phenol formaldehyde; MDI = methylene diphenyl diisocyanate; PF/MDI = PF resin in surface layers, MDI resin in core layers.

[c] Emission control device: RTO = regenerative thermal oxidizer.

[d] CASRN = Chemistry Abstracts Service Registry Number.

[e] Factors for VOC on a propane basis. Formaldehyde has been added.

[f] Reference 12.

[g] References 12,18,24,38.

[h] References 12,38.

[j] References 9,12,15-17,21,23,25-26,30-32,34-36,41,44-52.

[k] References 9,12,15-16,21,31-34,36,41,43,45-48,50-52.

[m] References 12,21,31-32,34,36,41,45-48,50-52,54.

[n] References 12,15-16,21,43,45-48,50-52.

[p] References 15-17,21,23,25-26,30,35,44.

[q] References 15-17,21,23,30,33,35.

[r] References 15-17,21,30,35.

[s] References 15-16,21,30.

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29. *Report Of Air Emissions Tests And VOC Removal Efficiency For Louisiana-Pacific Corporation, Corrigan OSB Facility, Corrigan, Texas, June 2, 1995*, prepared for Louisiana-Pacific Corporation, by Environmental Monitoring Laboratories, Inc., July 1995.

30. *Oxidizer Efficiency Sampling, Kirby Forest Products, Silsbee, Texas, July 11-14, 1995*, prepared for Louisiana-Pacific Corporation, by Armstrong Environmental, Inc., Project No. W-1713-95, July 1995.

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32. Letter from E. Smith to L. Kesari, USEPA, Washington, D.C., VOC control efficiency calculation for August 30-31, 1995 test at Louisiana-Pacific Corp., Dungannon, Virginia, December 28, 1995.

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39. *Results Of The July 11-13, 1995 Air Emission Compliance Tests At The Louisiana-Pacific Waferboard Plant In Tomahawk, Wisconsin*, prepared for Louisiana-Pacific Corporation, by Interpoll Laboratories, Inc., Report No. 5-6006, July 1995.

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41. *Results Of The March 29-31, 1994 Air Emission Compliance Tests At The Louisiana-Pacific OSB Plant In Montrose, Colorado*, prepared for Louisiana-Pacific Corporation, by Interpoll Laboratories, Inc., Report No. 4-2558, April 1994.

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