10.5 Plywood Manufacturing

10.5.1 General

Plywood is a building material consisting of veneers (thin wood layers or plies) bonded with an adhesive. There are two types of plywood: softwood plywood and hardwood plywood. Softwoods generally correspond to coniferous species. The most commonly used softwoods for manufacturing plywood are firs and pines. Hardwoods generally correspond to deciduous species. For hardwood plywood, commonly used wood species include oak, poplar, maple, cherry, and larch.

Softwood plywood is manufactured by gluing several layers of dry softwood veneers together with an adhesive. Softwood plywood is used for wall siding, sheathing, roof decking, concrete formboards, floors, and containers. Softwood plywood is classified under Standard Industrial Classification (SIC) code 2436, and North American Industrial Classification System (NAICS) code 321212 for "Softwood Plywood and Veneer".

Hardwood plywood is made of hardwood veneers bonded with an adhesive. The outer layers (face and back) surround a core which is usually lumber, veneer, particleboard, or medium density fiberboard. Hardwood plywood may be pressed into panels or plywood components (e.g., curved hardwood plywood, seat backs, chair arms, etc.). Hardwood plywood is used for interior applications such as furniture, cabinets, architectural millwork, paneling, flooring, store fixtures, and doors. Hardwood plywood is classified under SIC code 2435 and NAICS code 321211, for "Hardwood Plywood and Veneer".

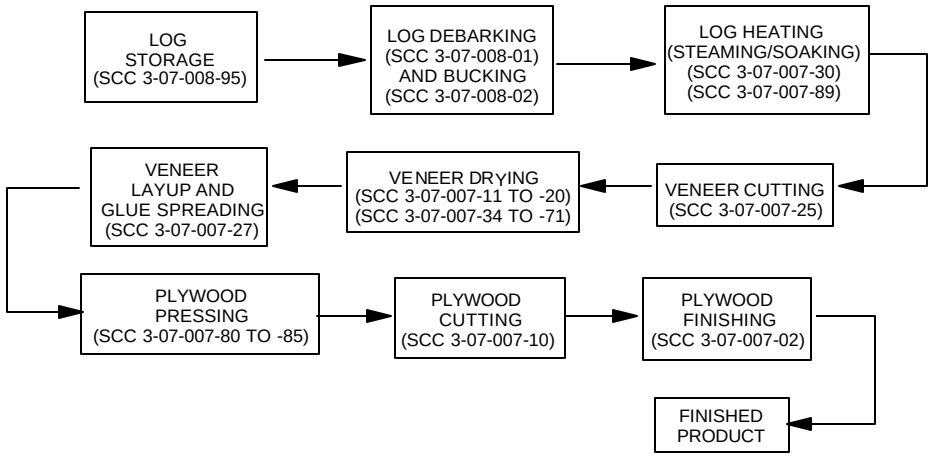
Softwood plywood plants typically produce softwood veneers and softwood plywood on the same plant site. However, most hardwood plywood and veneer plants either produce hardwood plywood or hardwood veneer. Hardwood veneer plants cut and dry hardwood veneers. Hardwood plywood plants typically purchase hardwood veneers and press the veneers onto a purchased core material.

10.5.2 Process Description[1-4, 22]

The manufacture of softwood or hardwood plywood consists of nine main processes: log storage, log debarking and bucking, heating the logs, peeling the logs into veneers, drying the veneers, gluing the veneers together, pressing the veneers in a hot press, plywood cutting, and other finishing processes such as sanding. Figure 10.5-1 provides a generic process flow diagram for a plywood mill.

The initial step of debarking is accomplished by feeding logs through one of several types of debarking machines. The purpose of this operation is to remove the outer bark of the tree without substantially damaging the wood. After the bark is removed, the logs are cut to appropriate lengths in a step known as bucking.

The logs (now referred to as blocks) then are heated to improve the cutting action of the veneer lathe or slicer, thereby generating a product from the lathe or slicer with better surface finish. Blocks are heated to around 93°C (200°F) using a variety of methods--hot water baths, steam heat, hot water spray, or a combination of the three.



Additional Source Classification Codes for Combined Operations:

- SCC 3-07-007-88: Hardwood plywood combined dust baghouse (includes trim saw, composer, core saw, dry hog, hammermill, and sander)
- SCC 3-07-007-90: Softwood plywood, dry veneer trim chipper (trimmed veneer from layup line)
- SCC 3-07-007-91: Softwood plywood, dry plywood trim chippers (trim from panel saws)
- SCC 3-07-007-92: Softwood plywood sander (includes sanders and specialty saw)
- SCC 3-07-007-93: Softwood plywood saws (includes 3 saws, hog, and sander)

Figure 10.5-1. Generic process flow diagram for a plywood mill.
(SCC = Source Classification Code.)

After heating, the logs are processed to generate veneer. For most applications, a veneer lathe is used, but some decorative, high quality veneer is generated with a veneer slicer. The slicer and veneer lathe both work on the same principle; the wood is compressed with a nosebar while the veneer knife cuts the blocks into veneers that are typically 3 mm (1/8 in.) thick. Decorative hardwood veneers are usually sliced much thinner than 3 mm (1/8 in.) thick. The veneer pieces are then clipped to a usable width, typically 1.37 m (54 in.), to allow for shrinkage and trim.

Veneers are taken from the clipper to a veneer dryer where they are dried to moisture contents that range from around 1 to 15 percent, dry basis. Face veneer moisture contents can range up to 25 percent, dry basis. Target moisture content depends on the type of resin used in subsequent gluing steps. The typical drying temperature ranges from 150° to 200°C (300° to 400°F). The veneer dryer may be a longitudinal dryer, which circulates air parallel to the veneer, or a jet dryer. The jet dryers direct hot, high velocity air at the surface of the veneers in order to create a more turbulent flow of air. The increased turbulence provides more effective use of dryer energy, thereby reducing drying time. Veneer dryers may be either direct-fired or indirect-heated. In direct-fired dryers, hot combustion gases from an onsite boiler are blended with recirculated exhaust from the dryer to lower the gas temperature. In indirect-heated veneer dryers, air is warmed over steam coils and circulated over the veneer. Veneer dryers typically have one to three heated zones followed by a cooling zone or section. Each heated zone has a hot air source, fans to move the warm air, and an exhaust vent or stack. The cooling section circulates ambient air over the veneer to reduce the veneer temperature just before it exits the dryer. The veneers must be cooled to prevent glue from curing on the veneers during the layup and glue spreading operations before they reach the plywood press.

Veneer may also be dried in veneer kilns, which resemble lumber kilns. Kiln drying is a batch operation, where the veneers are stacked with stickers (narrow wood strips) and dried in the kiln.

Veneer moisture is checked against the target moisture level as the veneer exits the veneer dryer. Veneer redryers may be used to redry the veneer that did not reach the target moisture content. Veneer redryers are typically heated by radio frequency (RF) and are designed to handle only a fraction of the throughput from full-scale veneer dryers. Conventional veneer dryers may also be used for redrying veneer. When used for redrying veneer, conventional veneer dryers are operated at faster than normal speeds (i.e., the redry veneer passes through the dryer more quickly than does green veneer).

After drying, veneers sometimes are glued together on the edges to form larger sheets of veneer. This process is called composing. Narrow veneer slices must be composed before they are used in plywood panels or other products requiring wider veneer sheets.

When the veneers have been dried to their specified moisture content, they are conveyed to a layup operation, where a thermosetting resin is spread on the veneers. The two main types of resins are phenol-formaldehyde, which is used for softwood plywood and exterior grades of hardwood plywood, and urea-formaldehyde, which is used to glue interior grades of hardwood plywood. The resins are applied by glue spreaders, curtain coaters, or spray systems. Spreaders have a series of rubber-covered grooved application rolls that apply the resin to the sheet of veneer. Generally, resin is spread on two sides of one ply of veneer, which is then placed between two plies of veneer that are not coated with resin.

Assembly of the plywood panels must be symmetrical on either side of a neutral center in order to avoid excessive warpage. For example, a five-ply panel would be laid up in the following manner. A back, with the grain direction parallel to the long axis of the panel, is placed on the assembly table. The next veneer has a grain direction perpendicular to that of the back, and is spread with resin on both sides. Then, the center is placed, with no resin, and with the grain perpendicular to the previous veneer (parallel with the back). The fourth veneer has a grain perpendicular to the previous veneer (parallel with the short axis of the panel) and is spread with resin on both sides. The final, face, veneer with no resin is placed like the back with the grain parallel to the long axis of the plywood panel.

The laid-up assembly of veneers then is sent to a hot press in which it is consolidated under heat and pressure. Hot pressing has two main objectives: (1) to press the glue into a thin layer over each sheet of veneer; and (2) to activate the thermosetting resins. Typical press temperatures range from 132° to 165°C (270° to 330°F) for softwood plywood, and 107° to 135°C (225° to 275°F) for hardwood plywood. Press times generally range from 2 to 7 minutes. The time and temperature vary depending on the wood species used, the resin used, and the press design.

The plywood then is taken to a finishing process where edges are trimmed; the face and back may or may not be sanded smooth. The type of finishing depends on the end product desired.

10.5.3 Emissions and Controls[2-22]

The primary emissions from the manufacture of plywood include filterable particulate matter (PM) and PM less than 10 micrometers in aerodynamic diameter (PM-10) from log debarking and bucking, and plywood cutting and sanding; filterable and condensible PM/PM-10 from drying and pressing; organic compounds from steaming and drying operations; and organic compounds, including formaldehyde and other hazardous air pollutants (HAPs), from gluing and hot pressing. However, trace

amounts of combustion by-products, which may include HAPs, may be present in direct-fired veneer dryer exhausts as a result of fossil fuel or wood combustion gases being passed through the dryer. Fuel combustion for material drying also can generate carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen oxide (NO_x) emissions.

The main source of emissions is the veneer dryer, which emits significant quantities of organic compounds. The quantity and type of organic compounds emitted varies depending on the wood species, the dryer type, and its method of operation. Emissions from dryer heated zones and cooling sections typically are ducted through separate stacks. In addition to emissions from the heated zones and cooling section stacks, veneer dryer fugitive emissions may be emitted from the dryer ends and doors. The two discernible fractions released from the dryer are condensibles and volatiles. As the condensible compounds cool after being emitted from the stack, they often combine with water vapor to form aerosols, which can cause a blue haze.

Measurement of VOC and condensible PM emission rates are highly dependent on stack gas and sampling train filter temperatures. When the sampling train filter temperature is higher than the stack gas temperature, the rate of VOC and condensible PM emissions measured will increase with increasing filter temperature, because, as filter temperature increases, less organic material will condense on the sampling train filter. The available data are inadequate to determine the effect on emissions of recirculating the exhaust from wood-fired veneer dryers to a combustion gas blend box.

The hot pressing operation is also a source of organic emissions. The quantity and composition of emissions from this operation are expected to vary with wood species and resin components. Plywood pressing operations are typically uncontrolled.

Significant quantities of sawdust and other small wood particles are generated by plywood cutting and sanding operations. Sanders and trim saws typically have control devices to recover the material for use as a fuel in the dryer or boiler. However, small amounts of PM may be released from cutting and sanding. Log debarking, log bucking, and sawdust handling are additional sources of PM emissions. Wood storage piles are sources of fugitive PM and VOC emissions. Log debarking, log peeling, and other minor operations are also sources of fugitive VOC emissions.

Methods of controlling PM emissions from veneer dryers include absorption systems (wet scrubbers), electrified filter beds (EFBs), wet electrostatic precipitators (WESPs), and oxidation systems (discussed below). The EFB uses electrostatic forces to attract pollutants to an electrically charged gravel bed. The WESP uses electrostatic forces to attract pollutants to either a charged metal plate or a charged metal tube. The collecting surfaces are continually rinsed with water to wash away the pollutants. Wet PM control systems such as wet scrubbers and WESPs may achieve short-term reductions in emissions of some water-soluble organic compounds (such as formaldehyde). However, the ability of these wet systems to absorb water-soluble compounds diminishes as the recirculating scrubbing liquid becomes saturated with these compounds.

A VOC control technology commonly used in the wood products industry for controlling veneer dryer exhaust gases is regenerative thermal oxidation. Thermal oxidizers destroy VOCs and condensible organics by burning them at high temperatures. Thermal oxidizers also reduce CO emissions in direct-fired dryer exhausts by oxidizing the CO in the exhaust to CO_2 (a product of complete combustion). 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 pre-heated beds packed with a ceramic media. A gas burner brings the preheated emissions up to an incineration temperature between 788° and 871°C (1450° and 1600°F) 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 gases to be treated, thereby reducing auxiliary fuel requirements.

Regenerative catalytic oxidizers (RCOs) are also used to control VOCs from veneer dryers. Regenerative catalytic oxidizers function similar to RTOs, except that the heat recovery beds in RCOs contain catalytic media. The catalyst accelerates the rate of VOC oxidation and allows for VOC destruction at lower temperatures than in an RTO, typically 316° to 538°C (600° to 1000°F), which reduces auxiliary fuel usage.

In addition to add-on thermal or catalytic oxidizers, exhaust gases from veneer dryers may be routed to the combustion chamber of an onsite boiler or process heater. The VOC and CO emissions in the process exhaust may be incinerated in the combustion chamber provided that the system is designed to allow for sufficient mixing and residence time.

Fugitive PM emissions from road dust and uncovered bark and dust storage piles may be controlled in a number of different ways. Some of these methods include enclosure, wet suppression systems, and chemical stabilization.

Calculating PM-10 emissions from wood products industry emission sources 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 (~20°C [~68°F]) 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 (Reference 15) for this section.

Guidance from EPA's Emission Factor and Inventory Group (EFIG) indicates that when it is possible, VOC emission factors should be reported in terms of the actual weight of the emitted compound. However, when an actual molecular weight (MW) of the emitted stream is not feasible (as is the case with the mixed streams emitted from wood products industry sources), the VOC should be reported using an assumed MW of 44, and reported "as propane." Each VOC-as-propane emission factor is estimated by first converting the THC from a carbon basis to a propane basis. Propane (MW = 44) includes 3 carbon atoms (total MW of 36) and 8 hydrogen atoms (total MW of 8). Every 36 pounds of carbon

measured corresponds to 44 pounds of propane. The ratio of the MW of propane to the MW of carbon in propane is 44/36, or 1.22. The conversion is expressed by the following equation:

$$\text{THC as pounds carbon} \times \frac{\text{44 pounds propane}}{\text{36 pounds carbon}} = \text{THC as pounds propane}$$

or

$$\text{THC as pounds carbon} \times 1.22 = \text{THC as pounds propane}$$

After the THC emission factor has been converted from a carbon to a propane basis, the formaldehyde emission factor is added (where available), then the available emission factors for non-VOC compounds, including acetone, methane, and methylene chloride, are subtracted. This procedure is expressed simply by the following equation:

$$\text{VOC as propane} = (1.22 \times \text{THC as carbon}) + \text{formaldehyde} - (\text{acetone} + \text{methane} + \text{methylene chloride})$$

In cases where no emission factor is available (or the emission factor is reported only as below the test method detection limit, or "BDL") for one or more of the compounds used to estimate the VOC-as-propane value, adjustments to the converted THC value are made only for those compounds for which emission factors are available. That is, a value of zero is inserted in the above equation for the specified compounds where no emission factor is available, or where the emission factor is reported only as BDL. For example, if no methane emission factor is available, the THC-as-carbon emission factor is converted to THC-as-propane, formaldehyde is added, and only acetone and methylene chloride are subtracted.

Table 10.5-1 presents emission factors for veneer dryer emissions of PM, including filterable PM and condensible PM. Table 10.5-2 presents emission factors for veneer dryer emissions of NO_x, CO, and CO_2. Table 10.5-3 presents emission factors for veneer dryer emissions of organic compounds, some of which are listed as HAPs under section 112(b) of the Clean Air Act. The emission factors for dryer emissions are presented in units of pounds of pollutant per thousand square feet of 3/8-inch thick panel produced (lb/MSF 3/8). Separate emission factors are presented for hardwood plywood and softwood plywood veneer dryers. In Tables 10.5-2 and -3, separate emission factors also are presented for the heated zones and cooling section of a veneer dryer. When estimating total emissions from the drying process, emissions from heated zones and cooling section should be combined.

Table 10.5-4 presents emission factors for plywood press emissions of PM, including filterable PM and condensible PM. Table 10.5-5 presents emission factors for plywood press emissions of NO_x, CO, and CO_2. Table 10.5-6 presents emission factors for plywood press emissions of organic compounds, some of which are HAPs. The units for the press emission factors are pounds of pollutant per thousand square feet of 3/8-inch thick panel produced (lb/MSF 3/8). Table 10.5-7 presents emission factors for organic compounds from miscellaneous plywood manufacturing sources. Some of these compounds are listed HAPs under section 112(b) of the Clean Air Act.

Table 10.5-1. EMISSION FACTORS FOR PLYWOOD VENEER 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		
Indirect heated, heated zones, softwood (SCC 3-07-007-62)	Uncontrolled	0.35	D	ND		1.0	D
Direct natural gas-fired, heated zones, softwood (SCC 3-07-007-52)	Uncontrolled	0.079	D	ND		0.42	D
Direct wood-fired, heated zones, softwood (SCC 3-07-007-36)	WESP	0.24	D	ND		ND	
Radio frequency-heated redryer, softwood (SCC 3-07-007-71)	Uncontrolled	0.0050	E	ND		0.0060	E

[a] Emission factor units are pounds of pollutant per thousand square feet of 3/8-inch thick veneer (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. Reference 16. See Table 10.5-8 for the hardwood and softwood species commonly used in the production of plywood and other composite wood products. **Note: emission factors in table represent averages of data sets. The data spreadsheets, which may be more useful for specific applications, are available on EPA's Technology Transfer Network (TTN) website at: http://www.epa.gov/ttn/chief/.**

[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: WESP = wet electrostatic precipitator.

[d] Condensible PM is that PM collected in the impinger portion of a PM sampling train (EPA Method 202).

Table 10.5-2. EMISSION FACTORS FOR PLYWOOD VENEER DRYERS--NO_x, CO, AND CO_2 [a]

Source	Emission Control Device[b]	NO_x	EMISSION FACTOR RATING	CO	EMISSION FACTOR RATING	CO_2	EMISSION FACTOR RATING
Indirect heated, heated zones, softwood (SCC 3-07-007-62)	Uncontrolled	ND		0.028[c]	E	ND	
	RTO	ND		0.062[c]	E	ND	
Indirect heated, cooling section, softwood (SCC 3-07-007-63)	Uncontrolled	ND		0.043[c]	E	ND	
Indirect heated, heated zones, hardwood (SCC 3-07-007-56)	Uncontrolled	ND		0.0088[c]	E	ND	
Indirect heated, cooling section, hardwood (SCC 3-07-007-57)	Uncontrolled	ND		0.099[c]	E	ND	
Direct natural gas-fired, heated zones, softwood (SCC 3-07-007-52)	Uncontrolled	0.012[d]	D	0.64[e]	D	28[f]	D
	RCO	ND		0.0076[c]	E	ND	
Direct natural gas-fired, cooling section, softwood (SCC 3-07-007-53)	Uncontrolled	ND		0.010[c]	E	ND	
Direct wood-fired, heated zones, softwood (SCC 3-07-007-36)	Uncontrolled	0.17[g]	D	3.2[g]	D	100[h]	D
Direct wood-fired, heated zones, hardwood (SCC 3-07-007-34)	Uncontrolled	ND		0.23[c]	E	ND	

[a] Emission factor units are pounds of pollutant per thousand square feet of 3/8-inch thick veneer (lb/MSF 3/8). One lb/MSF 3/8 = 0.5 kg/m^3. Factors represent uncontrolled emissions unless otherwise noted. Factors for heating zones and cooling section should be summed when estimating total dryer emissions. SCC = Source Classification Code. ND = no data available. See Table 10.5-8 for the hardwood and softwood species commonly used in the production of plywood and other composite wood products. **Note: emission factors in table represent averages of data sets. The data spreadsheets, which may be more useful for specific applications, are available on EPA's TTN website at: http://www.epa.gov/ttn/chief/.**

[b] Emission control device: RTO = regenerative thermal oxidizer; RCO = regenerative catalytic oxidizer.

[c] Reference 17.

[d] Reference 16.

[e] References 16 and 17.

Table 10.5-2 (cont.).

[f] Reference 18.
[g] References 16 and 19.
[h] Reference 19.

Table 10.5-3. EMISSION FACTORS FOR PLYWOOD VENEER DRYERS--ORGANICS[a]

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Indirect heated, heated zones, softwood (SCC 3-07-007-62)	Uncontrolled		THC as carbon[d]	1.5[f]	B
			VOC as propane[e]	1.8	C
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
		13466-78-9	3-Carene	0.040	C
		75-07-0	Acetaldehyde *	0.017	C
		67-64-1	Acetone	0.013	C
		107-02-8	Acrolein *	0.0013	C
		80-56-8	Alpha-pinene	0.96	C
		71-43-2	Benzene *	0.00059	C
		127-91-3	Beta-pinene	0.27	C
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.014	C
		138-86-3	Limonene	0.080	C
		67-56-1	Methanol *	0.039	C
			Methyl ethyl ketone *	BDL	
		108-10-1	Methyl isobutyl ketone *	0.0015	C
			Methylene chloride *	BDL	
		1330-20-7	m,p-Xylene *	0.00075	C
			o-Xylene *	BDL	
			p-Cymene	BDL	
		99-83-2	p-Mentha-1,5-diene	0.017	C
		108-95-2	Phenol *	0.0034	C
		123-38-6	Propionaldehyde *	0.0024	C
			Styrene *	BDL	
		108-88-3	Toluene *	0.0011	C

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Indirect heated, cooling section, softwood (SCC 3-07-007-63)	Uncontrolled		THC as carbon[d]	0.050	D
			VOC as propane[e]	0.054	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0046	D
		67-64-1	Acetone	0.0085	D
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.049	D
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0013	D
			Limonene	BDL	
		67-56-1	Methanol *	0.010	D
			Methyl ethyl ketone *	BDL	
		108-10-1	Methyl isobutyl ketone *	0.0054	D
			Methylene chloride *	BDL	
		1330-20-7	m,p-Xylene *	0.0019	D
		95-47-6	o-Xylene *	0.0014	D
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.0062	D
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Indirect heated, heated zones, softwood (SCC 3-07-007-62)	RTO		THC as carbon[d]	0.14	D
			VOC as propane[e]	0.17	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0019	D
		67-64-1	Acetone	0.0017	D
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.026	D
		71-43-2	Benzene *	0.00040	E
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0023	D
			Limonene	BDL	
		67-56-1	Methanol *	0.0023	D
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.0050	D
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Indirect heated, heated zones, hardwood (SCC 3-07-007-56)	Uncontrolled		THC as carbon[d]	0.23[g]	D
			VOC as propane[e]	0.28	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0043	D
		67-64-1	Acetone	0.0040	D
			Acrolein *	BDL	
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0011	D
			Limonene	BDL	
		67-56-1	Methanol *	0.041	D
			Methyl ethyl ketone *	BDL	
		108-10-1	Methyl isobutyl ketone *	0.0022	D
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.0030	D
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Indirect heated, cooling section, hardwood (SCC 3-07-007-57)	Uncontrolled		THC as carbon[d]	0.62	D
			VOC as propane[e]	0.72	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.032	D
		67-64-1	Acetone	0.047	D
			Acrolein *	BDL	
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0065	D
			Limonene	BDL	
		67-56-1	Methanol *	0.021	D
			Methyl ethyl ketone *	BDL	
		108-10-1	Methyl isobutyl ketone *	0.029	D
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Direct natural gas-fired, heated zones, softwood (SCC 3-07-007-52)	Uncontrolled		THC as carbon[d]	2.1[h]	D
			VOC as propane[e]	2.5	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.062	D
		67-64-1	Acetone	0.059	D
		107-02-8	Acrolein *	0.0090	D
		80-56-8	Alpha-pinene	1.0	D
		71-43-2	Benzene *	0.0057	D
		127-91-3	Beta-pinene	0.41	D
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.064[j]	D
		138-86-3	Limonene	0.081	D
		74-82-8	Methane	0.067[k]	D
		67-56-1	Methanol *	0.036	D
		78-93-3	Methyl ethyl ketone *	0.0019	D
		108-10-1	Methyl isobutyl ketone *	0.0026	D
			Methylene chloride *	BDL	
		1330-20-7	m,p-Xylene *	0.0039	D
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.0060	D
		123-38-6	Propionaldehyde *	0.0016	D
		100-42-5	Styrene *	0.0015	D
		108-88-3	Toluene *	0.0074	D

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Direct natural gas-fired, cooling section, softwood (SCC 3-07-007-53)	Uncontrolled		THC as carbon[d]	0.038	E
			VOC as propane[e]	0.044	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0034	E
		67-64-1	Acetone	0.0041	E
			Acrolein *	BDL	
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0015	E
			Limonene	BDL	
		67-56-1	Methanol *	0.0057	E
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.010	E
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Direct natural gas-fired, heated zones, softwood (SCC 3-07-007-52)	RCO		THC as carbon[d]	0.30	E
			VOC as propane[e]	0.36	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.061	E
		67-64-1	Acetone	0.048	E
			Acrolein *	BDL	
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.038	E
			Limonene	BDL	
		67-56-1	Methanol *	0.0049	E
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.0055	E
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	
Direct wood-fired, heated zones, softwood (SCC 3-07-007-36)	Uncontrolled		THC as carbon[d]	0.83[m]	D
			VOC as propane[e]	1.1	E
		50-00-0	Formaldehyde *	0.045[n]	D

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Direct wood-fired, heated zones, hardwood (SCC 3-07-007-34)	Uncontrolled		THC as carbon[d]	0.053	E
			VOC as propane[e]	0.063	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0052	E
		67-64-1	Acetone	0.0045	E
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0025	E
			Limonene	BDL	
		67-56-1	Methanol *	0.0095	E
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Direct wood-fired, cooling section, hardwood (SCC 3-07-007-35)	Uncontrolled		THC as carbon[d]	0.0037	E
			VOC as propane[e]	0.0045	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
			Acetaldehyde *	BDL	
			Acetone	BDL	
			Acrolein *	BDL	
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
			Formaldehyde *	BDL	
			Limonene	BDL	
			Methanol *	BDL	
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-3 (cont.).

Source	Emission Control Device[b]	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Radio frequency-heated redryer, softwood (SCC 3-07-007-71)	Uncontrolled		THC as carbon[d]	0.23[f]	D
			VOC as propane[e]	0.28	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0015	D
		67-64-1	Acetone	0.00089	D
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.17	D
			Benzene *	BDL	
		127-91-3	Beta-pinene	0.056	D
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.00035	D
		138-86-3	Limonene	0.0040	D
		67-56-1	Methanol *	0.0027	D
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

[a] Emission factor units are pounds of pollutant per thousand square feet of 3/8-inch thick veneer (lb/MSF 3/8). One lb/MSF 3/8 = 0.5 kg/m^3. Factors represent uncontrolled emissions unless otherwise noted. Factors for heating zones and cooling section should be summed when estimating total dryer emissions. SCC = Source Classification Code. * = hazardous air pollutant. BDL = below test method detection limit; indicates that this pollutant has not been detected in any test runs on this source. Reference 17 unless otherwise noted. See Table 10.5-8 for the hardwood and softwood species commonly used in the production of plywood and other composite wood products. **Note: emission factors in table represent averages of data sets. The data spreadsheets, which may be more useful for specific applications, are available on EPA's TTN website at: http://www.epa.gov/ttn/chief/.**

[b] Emission control device: RTO = regenerative thermal oxidizer; RCO = regenerative catalytic oxidizer.

[c] CASRN = Chemical Abstracts Service Registry Number.

[d] THC as carbon = total hydrocarbon measurements using EPA Method 25A.

Table 10.5-3 (cont.).

[e] VOC as propane = (1.22 × THC) + formaldehyde - (acetone + methane + methylene chloride); a value of zero is inserted in the equation for the specified compounds where no emission factor is available, or where the emission factor is reported only as "BDL".

[f] References 16 and 17.

[g] References 17 and 20.

[h] References 16, 17, and 18.

[j] References 17 and 18.

[k] Reference 18.

[m] References 16 and 19.

[n] Reference 19.

Table 10.5-4. EMISSION FACTORS FOR PLYWOOD PRESSES--PARTICULATE MATTER[a]

Source[c]	Emission Control Device	Filterable[b]				Condensible[d]	EMISSION FACTOR RATING
		PM	EMISSION FACTOR RATING	PM-10	EMISSION FACTOR RATING		
Hot press, PF resin, softwood plywood (SCC 3-07-007-83)	Uncontrolled	0.12	D	ND		0.083	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. Reference 16. See Table 10.5-8 for the hardwood and softwood species commonly used in the production of plywood and other composite wood products. **Note: emission factors in table represent averages of data sets. The data spreadsheets, which may be more useful for specific applications, are available on EPA's TTN website at: http://www.epa.gov/ttn/chief/.**

[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.

[d] Condensible PM is that PM collected in the impinger portion of a PM sampling train (EPA Method 202).

Table 10.5-5. EMISSION FACTORS FOR PLYWOOD PRESSES--NO_x, CO, AND CO_2[a]

Source[b]	Emission Control Device	NO_x	EMISSION FACTOR RATING	CO	EMISSION FACTOR RATING	CO_2	EMISSION FACTOR RATING
Hot press, PF resin, softwood plywood (SCC 3-07-007-83)	Uncontrolled	ND		ND		ND	

[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. See Table 10.5-8 for the hardwood and softwood species commonly used in the production of plywood and other composite wood products. **Note: emission factors in table represent averages of data sets. The data spreadsheets, which may be more useful for specific applications, are available on EPA's TTN website at: http://www.epa.gov/ttn/chief/.**

[b] PF = phenol formaldehyde.

Table 10.5-6. EMISSION FACTORS FOR PLYWOOD PRESSES--ORGANICS[a]

Source[b]	Emission Control Device	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Hot press, PF resin, softwood plywood (SCC 3-07-007-83)	Uncontrolled		THC as carbon[d]	0.21[f]	D
			VOC as propane[e]	0.25	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0042	D
		67-64-1	Acetone	0.0065	D
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.098	D
			Benzene *	BDL	
		127-91-3	Beta-pinene	0.038	D
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0019[g]	D
		138-86-3	Limonene	0.011	D
		67-56-1	Methanol *	0.14	D
		78-93-3	Methyl ethyl ketone *	0.00087	D
		108-10-1	Methyl isobutyl ketone *	0.00071	D
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.0014	D
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-6 (cont.).

Source[b]	Emission Control Device	CASRN[c]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Hot press, UF resin, hardwood plywood (SCC 3-07-007-85)	Uncontrolled		THC as carbon[d]	0.055[h]	D
			VOC as propane[e]	0.047	E
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
			Acetaldehyde *	BDL	
		67-64-1	Acetone	0.025	D
			Acrolein *	BDL	
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0047	D
			Limonene	BDL	
		67-56-1	Methanol *	0.032	D
			Methyl ethyl ketone *	BDL	
		108-10-1	Methyl isobutyl ketone *	0.0057	D
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.011	D
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

[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. BDL = below test method detection limit; indicates that this pollutant has not been detected in any test runs on this source. Reference 17 unless otherwise noted. See Table 10.5-8 for the hardwood and softwood species commonly used in the production of plywood and other composite wood products. **Note: emission factors in table represent averages of data sets. The data spreadsheets, which may be more useful for specific applications, are available on EPA's TTN website at: http://www.epa.gov/ttn/chief/.**

[b] PF = phenol formaldehyde; UF = urea formaldehyde.

[c] CASRN = Chemical Abstracts Service Registry Number.

[d] THC as carbon = total hydrocarbon measurements using EPA Method 25A.

[e] VOC as propane = (1.22 × THC) + formaldehyde - (acetone + methane + methylene chloride); a value of zero is inserted in the equation for the specified compounds where no emission factor is available, or where the emission factor is reported only as "BDL".

Table 10.5-6 (cont.).

[f] References 16, 17, and 21.
[g] References 17 and 21.
[h] References 17 and 20.

Table 10.5-7. EMISSION FACTORS FOR PLYWOOD MISCELLANEOUS SOURCES [a]

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Log storage (SCC 3-07-008-95)	Uncontrolled	ND	PM, THC, VOC	ND	
Debarking (SCC 3-07-008-01)	Uncontrolled	ND	PM, THC, VOC	ND	
Log bucking (cutting) (SCC 3-07-008-02)	Uncontrolled	ND	PM, THC, VOC	ND	
Veneer cutting (SCC 3-07-007-25)	Uncontrolled	ND	PM, THC, VOC	ND	
Veneer layup and glue spreading (SCC 3-07-007-27)	Uncontrolled	ND	PM, THC, VOC	ND	
Plywood cutting (SCC 3-07-007-10)	Uncontrolled	ND	PM, THC, VOC	ND	
Plywood finishing (SCC 3-07-007-02)	Uncontrolled	ND	PM, THC, VOC	ND	

Table 10.5-7 (cont.).

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Hardwood plywood combined dust baghouse (includes trim saw, composer, core saw, dry hog, hammermill, and sander)[e] (SCC 3-07-007-88) Use with caution!	Uncontrolled		PM	ND	
			THC as carbon[f]	0.019	U
			VOC as propane[g]	0.014	U
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
			Acetaldehyde *	BDL	
		67-64-1	Acetone	0.0089	U
			Acrolein *	BDL	
			Alpha-pinene	BDL	
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
			Formaldehyde *	BDL	
			Limonene	BDL	
		67-56-1	Methanol *	0.0029	U
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-7 (cont.).

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Softwood plywood, log steaming vat (SCC 3-07-007-89)	Uncontrolled		PM	ND	
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
Use with caution!		75-07-0	Acetaldehyde *	0.0047	U
		67-64-1	Acetone	0.0030	U
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.056	U
			Benzene *	BDL	
		127-91-3	Beta-pinene	0.0064	U
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
			Formaldehyde *	BDL	
			Limonene	BDL	
		67-56-1	Methanol *	0.0073	U
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-7 (cont.).

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Softwood plywood, dry veneer trim chipper (trimmed veneer from layup line) (SCC 3-07-007-90)	Uncontrolled		PM	ND	
			THC as carbon[f]	0.059	U
			VOC as propane[g]	0.072	U
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
Use with caution!		75-07-0	Acetaldehyde *	0.00081	U
		67-64-1	Acetone	0.00082	U
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.032	U
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.00034	U
			Limonene	BDL	
		67-56-1	Methanol *	0.0087	U
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
		108-95-2	Phenol *	0.0019	U
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-7 (cont.).

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Softwood plywood, dry plywood trim chipper (trim from panel saws) (SCC 3-07-007-91) Use with caution!	Uncontrolled		PM	ND	
			THC as carbon[f]	0.056	U
			VOC as propane[g]	0.068	U
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
			Acetaldehyde *	BDL	
			Acetone	BDL	
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.036	U
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
			Formaldehyde *	BDL	
			Limonene	BDL	
		67-56-1	Methanol *	0.0078	U
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-7 (cont.).

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Softwood plywood sander (includes sanders and specialty saw)[h] (SCC 3-07-007-92) Use with caution!	Uncontrolled		PM	ND	
			THC as carbon[f]	0.15	U
			VOC as propane[g]	0.18	U
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.0028	U
		67-64-1	Acetone	0.0047	U
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.023	U
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.0018	U
			Limonene	BDL	
		67-56-1	Methanol *	0.012	U
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

Table 10.5-7 (cont.).

Source[b]	Emission Control Device[c]	CASRN[d]	Pollutant	Emission Factor	EMISSION FACTOR RATING
Softwood plywood saws (includes 3 saws, hog, and sander)[j] (SCC 3-07-007-93) Use with caution!	Uncontrolled		PM	ND	
			THC as carbon[f]	0.072	U
			VOC as propane[g]	0.086	U
			1,2-Dichloroethane *	BDL	
			1,2,4-Trichlorobenzene *	BDL	
			3-Carene	BDL	
		75-07-0	Acetaldehyde *	0.00092	U
		67-64-1	Acetone	0.0019	U
			Acrolein *	BDL	
		80-56-8	Alpha-pinene	0.027	U
			Benzene *	BDL	
			Beta-pinene	BDL	
			Bromomethane *	BDL	
			Camphene	BDL	
			Chloroethane *	BDL	
			Chloroethene *	BDL	
			Cis-1,2-dichloroethylene	BDL	
			Cumene *	BDL	
		50-00-0	Formaldehyde *	0.00034	U
			Limonene	BDL	
		67-56-1	Methanol *	0.012	U
			Methyl ethyl ketone *	BDL	
			Methyl isobutyl ketone *	BDL	
			Methylene chloride *	BDL	
			m,p-Xylene *	BDL	
			o-Xylene *	BDL	
			p-Cymene	BDL	
			p-Mentha-1,5-diene	BDL	
			Phenol *	BDL	
			Propionaldehyde *	BDL	
			Styrene *	BDL	
			Toluene *	BDL	

[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. BDL = below test method detection limit; indicates that this pollutant has not been detected in any test runs on this source. ND = no data available. U = emission factor unrated. These emission factors should be used with caution; the ducting arrangements of these miscellaneous sources varies from mill to mill, therefore, these emission factors may not provide accurate estimates of emissions from other mills. Reference 17. See Table 10.5-8 for the hardwood and softwood species commonly used in the production of plywood and other composite wood products. **Note: emission factors in table represent averages of data sets. The data spreadsheets, which may be more useful for specific applications, are available on EPA's TTN website at: http://www.epa.gov/ttn/chief/.**

[b] SPW = softwood plywood; HPW = hardwood plywood.

[c] Emission control devices (baghouses) are considered no control for organic pollutants.

[d] CASRN = Chemical Abstracts Service Registry Number.

Table 10.5-7 (cont.).

[e] A composer is a device used for gluing veneers along the edge to form larger sheets of veneer; a core saw is used to cut core plies of veneer separately from decorative face veneers; a dry hog is used to reduce the size of wood residue by slicing or chopping; a hammermill is used to pulverize wood residue into small particles.

[f] THC as carbon = total hydrocarbon measurements using EPA Method 25A.

[g] VOC as propane = (1.22 × THC) + formaldehyde - (acetone + methane + methylene chloride); a value of zero is inserted in the equation for the specified compounds where no emission factor is available, or where the emission factor is reported only as "BDL".

[h] A specialty saw is used for cutting and grooving the edges of plywood panels for tongue and groove joints.

[j] A hog is used to reduce the size of wood residue by slicing or chopping.

Table 10.5-8. WOOD SPECIES COMMONLY USED IN COMPOSITE WOOD PRODUCTS MANUFACTURING [a]

Wood product	AP-42 section	Hardwood species	Softwood species
Plywood	10.5	Oak, cherry, poplar, maple, larch	Firs, pines
Oriented strandboard	10.6-1	Aspen	Pines, firs, spruce
Particleboard	10.6-2	Aspen, oak	Pines, firs
Medium density fiberboard	10.6-3	Gum, alder, hickory	Pines, firs
Hardboard/fiberboard	10.6-4	Aspen, birch, beech, oak, maple	Pines
Engineered wood products	10.9	Aspen, birch, poplar	Pines, firs, hemlock

[a] Reference 15.

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