

Note: This material is related to a section in AP42, *Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources*. AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

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AP42 Section:	10.5
Title:	Comments and letters from industry and contractor. Miscellaneous notes.

FROM OLD SECTION



OLD VOC EF (MONROE)

lb/MSF $\frac{7}{8}$

Douglas Fir

Sapwood

STEAM FIED 0.045

GAS FIED 0.753

heartwood 0.13

Larch 0.019

Southern Pine 0.294

Hemlock -

Ponderosa Pine -

White Pine -

FROM NEW SECTION



NEW (TBNMO)

lb/MSF $\frac{3}{8}$

0.40 (MONROE)

-

0.83 (MONROE)

0.19 (MONROE)

2.4 (MONROE)

0.31 (MONROE)

2.4 (MONROE)

0.87 (MONROE)

↑
CORRECTED NO.
FROM TB 13405
TABLE 3
USED ~~REF~~ MONROE TO
DETERMINE DRYER TYPE

LARCH (CODE 13)

DR/BL 15 1 STACK

$$\text{PRODUCTION RATE} = \frac{[(8130 \times 4) + (2500 \times 3) + (9130 \times 4)]}{11} = 8867$$

DATE 10/6/70

$$\text{FLOW} = 6595$$

$$\text{PROC RATE} = 8867$$

$$\text{HC} = 0.30 \text{ lb/ft} = 0.338 \text{ lb/10000 ft}^2$$

$$\text{HEMLOCK} = 22 \text{ ppm}$$

$$\text{LARCH} = 39.6 \text{ ppm}$$

Press

Control	Pollutant	Dryer	Wood species	Rating	Emission Factor
Woodtech					
None	THC	Steam	N/K	B	0.22 lb/h
None	THC	Steam	N/K	B	0.07 lb/h
None	THC	Steam	N/K	B	0.12 lb/h
None	THC	Steam	N/K	B	0.22 lb/h
None	THC	Steam	N/K	B	0.07 lb/h
None	THC	Steam	N/K	B	0.10 lb/h
None	Formaldehyde	Steam	N/K	B	0.032 lb/h
None	Formaldehyde	Steam	N/K	B	0.035 lb/h
None	Formaldehyde	Steam	N/K	B	0.033 lb/h
None	Formaldehyde	Steam	N/K	B	0.016 lb/h
None	Formaldehyde	Steam	N/K	B	0.026 lb/h
None	Formaldehyde	Steam	N/K	B	0.017 lb/h

0.03 lb/MSF
0.01 lb/MSF
0.02 lb/MSF
0.03 lb/MSF
0.01 lb/MSF
0.01 lb/MSF
0.004 lb/MSF
0.005 lb/MSF
0.004 lb/MSF
0.002 lb/MSF
0.003 lb/MSF
0.002 lb/MSF

$$6.98 \text{ m}^3/\text{h}$$

$$= 233 \text{ ft}^3/\text{h}$$

$$\frac{3}{8}'' = .031 \text{ ft} \therefore 7516 \text{ ft}^2/\text{hr} \frac{3}{8}$$

$$7.5 \text{ MSF/hr}$$

TABLE 10.3-2. UNCONTROLLED ORGANIC COMPOUND PROCESS EMISSION FACTORS FOR PLYWOOD VENEER DRYERS^a

EMISSION FACTOR RATING: B

Species	Volatile organic compounds		Condensible organic compounds	
	lb/10 ⁴ ft ²	kg/10 ⁴ m ²	lb/10 ⁴ ft ²	kg/10 ⁴ m ²
Douglas fir				
sapwood				
steam fired	0.45	2.3	4.64	23.8
gas fired	7.53 ✓	38.6	2.37 ✓	12.1
heartwood	1.30	6.7	3.18	16.3
Larch	0.19	1.0	4.14	21.2
Southern pine	2.94 ✓	15.1	3.70 ✓	18.9
Other ^b	0.30-3.00	0.15-15.4	0.5-8.00	2.56-41.0

^aReference 2. Emission factors are expressed in pounds of pollutant per 10,000 square feet of 3/8 inch thick veneer dried, and kilograms of pollutant per 10,000 square meters of 1 centimeter thick veneer dried. All dryers are steam fired unless otherwise specified.

^bThese ranges of factors represent results from one source test for each of the following species (in order from least to greatest emissions): Western Fir, Hemlock, Spruce, Western Pine and Ponderosa Pine.

CONVERSION factor of ≈ 5.1

SHOULD BE 4.8%

Not
consistent
with new
guidance

Summary

Org method 7 = "Particulate measurements"
Part. matter = Half
+ Condensable
EPA 5 -
But may yield "organic condensable particulate matter"
But $\neq$ VOCs

VOCs - Rem memo Regulation

TVOC, methane, NMTVOC, EPA 821 + any other species available

= M25
TG NMO

? Cond. particulate organic
↓

? New AM should be doing

?? 1972 Report ??

Instr. Filter
Condenser

GC/FID

= ? = TVOC ??

Summary -- ① In what units are M25
data to be reported to
NMTVOL ?

? ② Does 1972 Report yield

④ TVOC (cond + noncond fraction)
Add'n

③ Condens organic P.M. (condensable fraction?)

Condensed HC - glass frit filling; in-stack

- condense in ice water bath

- THA GC/FID as C₆ for gases
passing Condenser.

- GC/TLC, IR used on Condensate Fraction
- GC/FID used on Vol. Fraction

Guidance Notes:

N, MT VOC -- how reported -- mass of Carbon?

Level of QA Requirements?

1. 1972 Report -- Appends useless
2. Pgs C-26 -- (F.)-meth E useless

3. Pgs C-2a (G.) M. 11 G -- Meth 25 (okay)
4. Pgs C-18 (D.) Meth D -- Meth 25 (okay)

↓
N, MT VOC

check all calculations?

Basis for
weights?

Guidance on clean air

(1) Total PM -- include B.H. or Not?

(2) -NMVOC -- units of mass?
As carbon?

(1) Tpm - Methods

(2) Pm - 10

[F.H. Fraction

^
Cordruebe



Plywood: metric conversion

$$\frac{1 \text{ lb}}{10^4 \text{ ft}^2 \times \frac{3}{8}''} = \frac{x \text{ Kg}}{10^3 \text{ m}^2 \times 1 \text{ cm}}$$

$$\frac{1 \text{ lb}}{10^4 \text{ ft}^2 \times \frac{3}{8}''} \times \frac{1 \text{ Kg}}{2.2 \text{ lb}} \times \frac{10.76 \text{ ft}^2}{\text{m}^2} \times \left(\frac{.394 \text{ inch}}{1 \text{ cm}} \right)$$

$$= \frac{(10.76)(.394)}{(2.2)(.375)10^4} = \frac{5.1431'' \text{ Kg}}{10^3 \text{ m}^2 \text{ cm}}$$

$$\frac{1 \text{ lb}}{10^4 \text{ ft}^2 \times \frac{3}{8}''} = \frac{5.14 \text{ Kg}}{10^3 \text{ m}^2 \times \text{cm}}$$

$$\div 1.95 \text{ to get } \frac{\text{Kg}}{10^3 \text{ m}^2 \times \text{cm}} \text{ from } \frac{\text{lb}}{10^4 \text{ ft}^2 \times \frac{3}{8}''}$$

also, see next page
for check

$$\frac{\text{lb}}{10^4 \text{ ft}^2 \times \frac{3}{8}''} = \frac{1 \text{ lb}}{10^4 \text{ ft}^2 \times .375'' \times \frac{1 \text{ ft}}{12''}} = \frac{1 \text{ lb}}{312.5 \text{ ft}^3}$$

but $\frac{1 \text{ lb}}{312.5 \text{ ft}^3} \times \frac{35.32 \text{ ft}^3}{\text{m}^3} \times \frac{0.454 \text{ Kg}}{\text{lb}} = \frac{0.0513 \text{ Kg}}{\text{m}^3}$

but $1 \text{ m}^3 = 100 \text{ m}^2$ on a 1 cm basis

$\rightarrow \frac{0.513 \text{ Kg}}{100 \text{ m}^2 \text{ on a 1 cm basis}}$

$\frac{3.28 \text{ feet}}{\text{m}} \rightarrow \frac{35.32 \text{ ft}^3}{\text{m}^3}$

conversion sheet

$$\frac{\text{Kg}}{10^3 \text{ m}^2 \times 1 \text{ cm}} = \frac{1 \text{ lb}}{10,000 \text{ ft}^2 \times \frac{3}{8}''} \times \frac{.454 \text{ Kg}}{\text{lb}} \times \frac{10.76 \text{ ft}^2}{\text{m}^2} \times 1.05 \left(\frac{3/8''}{\text{cm}} \right)$$

$$\frac{(1.65)(.454)(10.76)}{10}$$

$$\frac{\text{Kg}}{10^3 \text{ m}^2} = \frac{.512}{\cancel{488}} \frac{\text{Kg}}{10^3 \text{ m}^2} / \frac{3''}{8''} \text{ basis}$$

$$.375'' \times \frac{1 \text{ cm}}{.394''} = \frac{.952 \text{ cm}}{3/8''}$$

$$10^4 \text{ ft}^2 \times \frac{3}{8}'' = 10^4 \text{ ft}^2 \times .375 \text{ m} \times \frac{1 \text{ ft}}{12 \text{ in}} = 312.5 \text{ ft}^3$$

$$312.5 \text{ ft}^3 = \cancel{1000} \text{ m}^2 \times (1) \cdot 1 \text{ cm} = x \text{ m}^2 \times 10^{-2} \text{ m}$$

$$\text{when } 312.5 \text{ ft}^3 \times \frac{1 \text{ m}^3}{35.31 \text{ ft}^3} = 8.85 \text{ m}^3$$

$$8.85 \text{ m}^3 = 10^{-2} \times x \text{ m}^3$$

$$x = 885$$

$$\therefore 10^4 \text{ ft}^2 \text{ on } \frac{3}{8}'' \text{ basis} \equiv 885 \text{ m}^2 \text{ on } 1 \text{ cm basis}$$

$$\text{also } 1 \text{ lb} = 0.454 \text{ Kg}$$

$$\therefore \frac{1 \text{ lb}}{10^4 \text{ ft}^2 / \frac{3}{8}''} \equiv \frac{0.454 \text{ Kg}}{885 \text{ m}^2 \text{ on } 1 \text{ cm}} \times \frac{1000}{855} = \frac{0.53 \text{ Kg}}{10^3 \text{ m}^2 \text{ on } 1 \text{ cm basis}}$$

INTEROFFICE MEMORANDUM

MIDWEST RESEARCH INSTITUTE

August 3, 1994

To: Project File
From: Richard Marinshaw 
Subject: Response to Comments on Section 10.5, Plywood Manufacturing

The following is a summary of the responses to comments provided by the National Council of the Paper Industry for Air and Stream Improvement (NCASI) on draft AP-42 Section 10.5, Plywood Manufacturing, and the corresponding background report. The comments are provided in the letter from David Word of NCASI to Dallas Safriet, dated April 28, 1994.

COMMENT: (General) We continue to believe that emission factors should be provided as a range, rather than a single average value. Additionally, if the range were supported with information about the number of sources tested and the number of sampling runs, the reader could make judgments about the quality of the factor and its usefulness.

RESPONSE: For each emission factor that is based on more than one test, the emission factor table is footnoted to indicate the range and number of tests on which the factor is based.

COMMENT: (Pages 7 and 10.5-1) The temperatures provided for blended gases from direct-heated wood fired dryers (750° to 1200°F) are above the range normally encountered. These blended gas streams would normally be below 800°F with a range of about 600° to 800°F where the gases enter the dryer.

RESPONSE: Sentence changed as suggested.

COMMENT: (Page 14) The Method 5 filter is maintained at 250° ± 25°F.

RESPONSE: Sentence changed as suggested.

COMMENT: (Page 16) The statement that Method 25A does not include aldehydes and ketones in the VOC estimate is incorrect. Flame ionization detectors (FID's) yield no response from fully oxidized carbon atoms such as the

carbon atom in a carbonyl or carboxyl group. The response of a carbon atom is diminished by substitution for hydrogen of halogens, amines, and hydroxyl groups. Thus, formaldehyde yields no response, and the response of methanol is less than the response of methane. But, for molecules with multiple carbon atoms and a single carboxyl or carbonyl group, the response can be relatively good, since the carbon atoms not directly associated with the carbonyl or carboxyl group can provide full response. For example, for butyraldehyde, $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CHO}$, three of the four carbon atoms should provide a full response.

Consequently, aldehydes and ketones with multiple carbon atoms are included in the VOC estimate of Method 25A. They simply are not included to the extent that they would be if they were all alkanes.

RESPONSE: At the meeting with Dallas Safriet on August 1, 1994, Dallas decided to make no change to the VOC emission factor; the VOC emission factors are reported as TOC and are the sum of the Method 25A results and the emission factor for formaldehyde.

COMMENT: (Page 19) Although multiple simultaneous measurement methods may be a means to arrive at decisions about how pollutants should be measured in the wood products industry, such means are not appropriate for routine sampling purposes. The EPA typically specifies a single compliance test method in its emission standards. It would be best for us to arrive at single test methods that work well for our industry.

Also, the use of Method 0011 to supplement Method 25A is clearly inappropriate. Method 0011 has not been validated for use in the wood products industry. Preliminary lab data indicate that the DNPH solution breaks the bonds between urea and formaldehyde thus overestimating formaldehyde from sources in which fibers containing "bound and stable" urea-formaldehyde resin enter the sampling train. Additionally, in light of the discussion above concerning FID's, you could not simply add the aldehyde and ketone results from a M0011 sample to the Method 25A results, as the response factors for each individual compound would be different.

RESPONSE: At the meeting with Dallas Safriet on August 1, 1994, Dallas decided to retain the formaldehyde emission factors based on the Method 0011 results.

COMMENT: (Tables 10.5-1 and 10.5-2) The carbon monoxide emission factor is an average for a wide range of

values (9 to 57 lb/MSF). If this range cannot be provided in the table, it should be provided in the footnotes to the table.

RESPONSE: Emission factor range is provided in footnote.

COMMENT: (Tables 10.5-3 and 10.5-4) The emission factors for plywood cutting and sanding are given as 450 kg/1,000 m³ and 99 lb/MSF, respectively. These factors represent greater than 10 percent of the weight of the plywood. They are unrealistic and should be removed from the tables.

RESPONSE: The emission factor for plywood cutting and sanding was labeled as unrated in the background report and was deleted from the AP-42 section.

COMMENT: (Table 10.5-5) A footnote should be added to this table explaining how the emission factors for TGNMO and VOC are expressed, i.e., as carbon, propane equivalents, etc. If the formaldehyde emissions are based on something other than the full molecular weight of the compound, that basis should also be footnoted.

RESPONSE: The basis for the emission factors for TOC (referred to as THC in the draft report) and TNMOC (referred to as TGNMO in the draft report) is provided in the footnotes.

MEMORANDUM

Date: March 14, 1994

To: 4601-10 Project File
Section 10.5, Plywood Manufacturing

From: D. Bullock ^{KDB}

Subject: Responses to industry comments

This memorandum documents the responses to comments received from the National Council of the Paper Industry for Air and Stream Improvement (NCASI) dated June 8, 1993.

Documentation Report

COMMENT: 10.5-2. It would be desirable to cite more recent industry statistics on production, number of plants, product value, etc. The 1987 figures will be about seven years old by the time the report is finalized.

RESPONSE: No action taken. No newer industry statistics are available.

COMMENT: 10.5-8. We are not aware of any plywood press vent emission data which would support the claim that type of resin used affects organic emissions. Unless a reference can be cited, this claim should be removed from both the documentation report and AP-42 section.

RESPONSE: The sentence was revised in both the background report and the section to read: "The quantity and composition of emissions from this operation are expected to vary with wood species and resin components. However, few test data are available for hot presses to characterize this variability."

COMMENT: 10.5-14. With respect to Method 18 formaldehyde measurements, it should be made clear that the Method 301 validation has not been performed on veneer dryers and press vents (or similar sources), Such a method validation is a requirement for Method 18 results to be acceptable to EPA.

RESPONSE: Only Reference 2 (Reference 12 in the section) includes Method 18 data. The discussion of this reference was revised to include a sentence reading: "Formaldehyde measurements made with Method 18 are highly questionable, especially when the method has not been subject to a Method 301 validation." In addition, the formaldehyde data from this reference were downrated to D due to the questionable test method. Emission factors based on these data were still included, as they are valid for order of magnitude estimates. However, these emission factors were assigned ratings of E.

COMMENT: 10.5-18. The VOC test results for Mill A when redrying veneer require some discussion of the ten-fold difference between the before and after scrubber results. As noted on page C-4 of TB 405, it was likely that stripping of VOCs from the scrubber water was occurring when the redry was processed.

RESPONSE: A paragraph was added to the discussion of these data as follows: "The organic emissions following the scrubber were substantially greater than the organic emissions entering the scrubber when redry was being processed. This increase suggests that some dissolved organics were stripped from the scrubber solution and entrained in the exhaust stream when the scrubber inlet stream was lightly loaded."

COMMENT: 10.5-24. In discussing the VOC sampling results reported in TB 405, it should be emphasized that many different filter temperatures were used. The filter temperatures were sometimes considerably higher or lower than the vent or stack gas being sampled, and sometimes were at stack temperatures, which ranged from 150 to 750°F. The effect of different filter temperatures on VOC results should be stressed.

RESPONSE: Section 3 of the background report was revised to include lengthy discussions of the test methods used (section 3.4), and emission testing issues (section 3.5). The issue of filter temperature effects on VOC results is discussed in detail. In addition, this issue is again raised in section 4.2.4, results of data analysis. This issue is also presented in the AP-42 section itself, in section 10.5.3, emissions. Emission factor tables were also footnoted and data tables were revised to indicate filter temperatures for VOC and PM data.

COMMENT: 10.5-24. Reporting Method 25 results as methane is said to provide a "conservatively high estimate" because methane has the highest possible hydrogen to carbon ratio. This is a somewhat misleading statement for gas streams containing hydrocarbons with oxygen or other elements. To avoid confusion, we suggest deleting the last sentence of the second paragraph in Section 4.2.4.

RESPONSE: The background report and section have been revised such that this sentence no longer appears.

COMMENT: 10.5-25. To minimize potential confusion, we would again suggest that English units be given preference over metric units in Table 4-3 and all subsequent tables since metric units are seldom used in the U.S. plywood industry.

RESPONSE: No action taken based on EPA guidance.

COMMENT: 10.5-25, 26. The CO sampling results for mill 4K should not be shown as a range since only one sampling run with duplicate simultaneous samples was conducted.

RESPONSE: The data table has been revised to present the data as one run, rather than as a range.

COMMENT: 10.5-29. All data from Table 11 of NCASI Technical Bulletin No. 405 (TB 405) have been deleted from this table.

Most of the ODEQ-7 test results cited in Table 11 for gas-fired veneer dryers were provided by BWR Associates as cited in Reference 20. It would seem that EPA could obtain the information provided to Research Triangle Institute (an EPA contractor) by BWR Associates in 1980 to determine if the data on gas-fired veneer dryer emissions would be usable for AP-42.

RESPONSE: The uncontrolled particulate and condensible organic data for direct heated gas-fired veneer dryers from Table 11 of NCASI Technical Bulletin No. 405 were reinstated. Both the background report and section were revised to include emission factors developed from these data. Emission factors developed from these data were rated E.

COMMENT: 10.5-29. The VOC value of 0.75 lb/MSF taken from Reference 8 should be checked to ensure the calculation errors have been properly corrected.

RESPONSE: Corrected values for the Monroe data (Reference 8) are found in Table 3 of NCASI TB 405. These corrected values were used to replace the incorrect values from the Monroe report.

Draft AP-42 Section

COMMENT: General. We continue to firmly believe it would be of great value to include ranges, number of sources tested, and number of sampling runs for all emission factors presented in the tables. A single average number with a subjective quality rating simply does not provide sufficient information about the emission factor.

RESPONSE: No action taken based on EPA guidance.

COMMENT: 10.5-3. We believe the issues of measurement methods and filter temperatures are important enough to merit at least a one paragraph discussion about their effects on measured VOC and condensible particulate emissions in Section 10.5.3. Also, the effect of recirculation of a portion of the dryer exhausts to a blend box on direct wood-fired dryer VOC and condensible emissions should be mentioned in this section.

RESPONSE: Section 10.5.3 has been revised to include a brief discussion of measurement methods, filter temperatures, and recirculation. It also refers the reader to the background report for the section, which includes a detailed analysis of these issues.

COMMENT: 10.5-4, 5. CO emissions from a wood-fired veneer dryer would be expected to be a function of fuel cell combustion efficiency, amount of heat required for veneer drying, and air leakage into the dryer. By showing different CO emission factors for different wood species and after a wet scrubber, it is implied that CO emissions are only affected by these variables. We suggest revising Tables 10.5-1 and 10.5-2 to show a single CO emission factor for wood-fired dryers of 9 to 57 lb/MSF and to delete references to wood species and control devices. A footnote citing the significance of fuel cell combustion

efficiency, heat required for drying, and amount of inleakage to CO emissions should be added to the tables.

RESPONSE: The emission factor table has been revised to present a single emission factor for CO emissions from wood-fired veneer dryers. In addition, a footnote has been added which reads: "It is important to note that fuel cell combustion efficiency, the amount of heat required for veneer drying, and air leakage into the dryer can all have a significant impact on CO emissions from wood-fired veneer dryers."

COMMENT: 10.5-6,7. Since the uncontrolled lodgepole pine filterable and condensible emissions were measured on the same dryer, the emission factors could be added to show an uncontrolled PM emission factor of 0.8 lb/MSF.

RESPONSE: The filterable and condensible fractions were added as requested and an uncontrolled PM emission factor of 0.8 lb/MSF was included.

COMMENT: 10.5-8,9. A footnote should be added to this table indicating that the VOC emission factors for many of the sources with wet control devices were obtained from Method 25 data with a filter held at stack temperature (e.g. 154°F for Mill A data). This could result in total VOC emission factors lower than those which might be developed from measurement data with the higher filter temperatures now called for in Method 25. A second footnote should be added for the "redry, with wet scrubber" VOC entry stating this factor may have been affected by stripping of compounds present in the scrubber water. It might also be worthwhile to note the value of 0.03 lb/MSF for redry is from a single sampling run and may be an anomalously low value.

RESPONSE: All of the requested footnotes have been added. A footnote has been added regarding VOC emission factors and wet control devices. A note has been added addressing the redry stripping. And a note has been added regarding the anomalously low redry value.

Other

In addition to the above changes, the final section refers to all Method 25 data as TGNMO. In NCASI Technical Bulletin 405, Method 25 data measured at 88°C (190°F) were referred to as "noncondensable organics." In order to be consistent with other AP-42 sections, MRI has referred to all Method 25 data, regardless of filter temperature, as TGNMO.

FAX TRANSMISSION

TO: Dallas Safriet, EIB
FROM: Rick Marinshaw, MRI
DATE: September 8, 1994

RECEIVING FAX NUMBER: 541-0684

SENDING FAX NUMBER: 919-677-0065

THIS FAX CONSISTS OF 2 PAGES (INCLUDING THIS PAGE)

As I tried to explain in the phone message I left you a little while ago, here is a copy of page 11 of NCASI Technical Bulletin 405, which presents revised emission factors from the data used in the Monroe report (Reference 2 of the old plywood AP-42 section). I am not sure what the calculational error was that NCASI refers to. I will take a look at the Monroe report to see if I can figure it out, but it seems to me that I tried once before and could not. I'll let you know.

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FAX TRANSMISSION

TO: DALLAS SAPIET
FROM: R. MARINSHAW
TIME: 9:00 AM
DATE: 2/23/94
CHARGE NO: 4601-10

(Task AND Subtask Nos.)

THIS FAX CONSISTS OF 3 PAGES (INCLUDING THIS PAGE)

RECEIVING FAX NUMBER: _____

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COMMENTS:

HERE ARE THE COVER SHEET & THE PAGE FROM
THE NCASI BULLETIN THAT HAS THE CORRECTED EMISSION
FACTORS FROM THE 1972 WASH. STATE UNIV. REPORT ON
PLYWOOD EMISSIONS. THE REVISED AP-42 SECTION USES
THE EMISSION FACTORS FROM TABLE 3 OF THE NCASI BULLETIN

ncasi

technical bulletin

NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC., 260 MADISON AVENUE, NEW YORK, N. Y. 10016



A STUDY OF ORGANIC COMPOUND EMISSIONS
FROM VENEER DRYERS AND MEANS FOR THEIR CONTROL

TECHNICAL BULLETIN NO. 405

AUGUST 1983

TABLE 2 (Con't.)

<u>Species</u>	<u>Turpentine gal/ton dry wood</u>	<u>Turpentine as CH₄ lb/MSF</u>
White fir	ND	ND
Western larch	0.66	2.8
Western red cedar	ND	ND
Western white pine	0.24	0.9
White spruce	0.16	0.6

ND Quantities found were below the detection level of the procedure.

Measurement of veneer dryer volatile hydrocarbon emissions by a gas chromatograph procedure gave the values listed in Table 3 (7). These volatile organics were determined to be mostly turpentines. The values reported in Table 3 have been corrected for calculation errors in the referenced data and converted to methane equivalent. The values reported are somewhat lower than the quantity of turpentine found in chipped wood. These lower emission values may be due to loss of turpentine during storage of peeled veneer. A 50 percent loss in turpentine yield in 1 week was reported during storage of chips in an open pile (10).

TABLE 3 VOLATILE HYDROCARBON EMISSIONS
FROM VENEER DRYERS (7)

<u>Wood Species</u>	<u>Turpentine Emissions lb as Methane/MSF, 3/8 in basis</u>	
	<u>Average</u>	<u>Range</u>
Douglas fir, heartwood	0.83	0.21 - 2.50
Douglas fir, sapwood	0.40	0.23 - 0.59
Southern pines	2.35	1.28 - 3.86
Larch	0.19	0.09 - 0.27
Hemlock	0.31	--
Ponderosa pine	2.36	--
White pine	0.87	--

B. Aerosol Formation in Veneer Dryer Plumes

A portion of the organic material in veneer dryer emissions form aerosols upon cooling. Aerosol particle sizes measured a few feet above uncontrolled veneer dryer stacks were between 0.1 and 0.3 um (8,11). Little or no aerosol has been found inside

Table 10.3-1. UNCONTROLLED FUGITIVE PARTICULATE EMISSION
FACTORS FOR PLYWOOD VENEER AND LAYOUT OPERATIONS

EMISSION FACTOR RATING: 8

Source	Particulates	
Log debarking ^a	0.024 lb/ton	0.012 kg/MT
Log sawing ^a	0.350 lb/ton	0.175 kg/MT
Sawdust handling ^b	1.0 lb/ton	0.5 kg/MT
Veneer lathing ^c	NA	NA
Plywood cutting and sanding ^d	0.1 lb/ft ²	0.05 kg/m ²

^aReference 7. Emission factors are expressed as units per unit weight of logs processed.

^bReference 7. Emission factors are expressed as units per unit weight of sawdust handled, including sawdust pile loading, unloading and storage.

^cEstimates not available.

^dReference 5. Emission factors are expressed as units per surface area of plywood produced. These factors are expressed as representative values for estimated values ranging from 0.066 to 0.132 lb/ft² (0.322 to 0.644 kg/m²).

The major pollutants emitted from veneer dryers are organic compounds. The quantity and type of organics emitted vary, depending on the wood species and on the dryer type and its method of operation. There are two discernable fractions which are released, condensibles and volatiles. The condensible organic compounds consist largely of wood resins, resin acids and wood sugars, which cool outside the stack to temperatures below 70°F (21°C) and combine with water vapor to form a blue haze, a water plume or both. This blue haze may be eliminated by condensing the organic vapors in a finned tube matrix heat exchanger condenser. The other fraction, volatile organic compounds, is comprised of terpenes and natural gas components (such as unburned methane), the latter occurring only when gas fired dryers are used. The amounts of organic compounds released because of adhesive use during the plywood pressing operation are negligible. Uncontrolled organic process emission factors are given in Table 10.3-2.

OPTIONAL FORM 99 (7-90)

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of pages 2

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Table 10.3-2. UNCONTROLLED ORGANIC COMPOUND PROCESS EMISSION FACTORS FOR PLYWOOD VENEER DRYERS^a

EMISSION FACTOR RATING: B

Species	Volatile Organic Compounds		Condensible Organic Compounds	
	lb/10 ⁴ ft ²	kg/10 ⁴ m ²	lb/10 ⁴ ft ²	kg/10 ⁴ m ²
Douglas Fir sapwood				
steam fired	0.45	2.3	4.64	23.8
gas fired	7.53	38.6	2.37	12.1
heartwood	1.30	6.7	3.18	16.3
Larch	0.19	1.0	4.14	21.2
Southern pine	2.94	15.1	3.70	18.9
Other ^b	0.03-3.00	0.15-15.4	0.5-8.00	2.56-41.0

^aReference 2. Emission factors are expressed in pounds of pollutant per 10,000 square feet of 3/8 inch thick veneer dried, and kilograms of pollutant per 10,000 square meters of 1 centimeter thick veneer dried. All dryers are steam fired unless otherwise specified.

^bThese ranges of factors represent results from one source test for each of the following species (in order from least to greatest emissions): Western Fir, Hemlock, Spruce, Western Pine and Ponderosa Pine.

References for Section 10.3

1. C.B. Hemming, "Plywood", Kirk-Othmer Encyclopedia of Chemical Technology, Second Edition, Volume 15, John Wiley & Sons, Inc., New York, NY, 1968, pp. 896-907.
2. F. L. Monroe, et al., Investigation of Emissions from Plywood Veneer Dryers, Washington State University, Pullman, WA, February 1972.
3. Theodore Baumeister, ed., "Plywood", Standard Handbook for Mechanical Engineers, Seventh Edition, McGraw-Hill, New York, NY, 1967, pp. 6-162 - 6-169.
4. Allen Mick and Dean McCargar, Air Pollution Problems in Plywood, Particleboard, and Hardboard Mills in the Mid-Willamette Valley, Mid-Willamette Valley Air Pollution Authority, Salem, OR, March 24, 1969.

Date: July 29, 1993

Subject: Sampling and Analysis Issues Related to PM-10 and VOC
Emission Factors in the Wood Products Industries (AP-42
Section 10.6)
EPA Contract 68-D2-0159, Work Assignment 006
MRI Project 3606

From: Dennis Wallace

To: Dallas Safriet
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711

As we discussed in earlier meetings with EMB, there are substantial problems in interpreting the PM-10 and VOC emission data from the wood products industry. Attached is a white paper that outlines the problems and presents recommendations for handling the data. Please review the paper and give me a call if you have comments or questions. My telephone number is (919) 677-0249 ext. 5286.

WOOD PRODUCTS INDUSTRY VOC AND PM-10 EMISSION FACTOR COMPLICATIONS

I. Introduction

As a part of a program to improve AP-42 emission factors, the Emission Inventory Branch (EIB) is compiling and evaluating emission test data for the wood products industry. In particular, a substantial amount of information has been collected on VOC and PM-10 emissions from dryers and presses associated with plywood and reconstituted wood products manufacturing. The data were generated from test programs conducted by the U. S. Environmental Protection Agency (EPA), individual wood products facilities, and the National Council of the Paper Industry for Air and Stream Improvement (NCASI) over the past several years. Because these programs were conducted by different groups at different times, a variety of test methods and test protocols were used, making comparison of data from the programs difficult. Also, interpreting emission data from these wood products operations is complicated by the characteristics of the emission streams. The dryer exhausts include solid wood particles and condensible and noncondensable organic compounds, along with high moisture content, while the press exhausts contain both condensible and noncondensable organic compounds with a substantial aldehydic component.

Because of these complications, procedures for interpreting and combining the emission data to develop AP-42 emission factors are not straightforward. This paper provides background information on the factors that complicate these calculations and presents recommendations for evaluating the data to develop emission factors. The remainder of the paper is divided into four sections. Section II provides a brief description of the wood products industry and processes and describes the emission sources of concern. Section III describes the test methods that have been used to collect the available test data. Section IV discusses the major issues associated with interpreting the test data. Section V presents recommendations for developing emission factors for wood products dryers and hot presses.

II. Industry Description

The lumber and wood products industry includes those facilities engaged in cutting timber and pulpwood and in processing that timber into basic wood materials and finished materials constructed from wood and wood-based products. Figure 1 depicts the hierarchy of the Standard Industrial Classification code for the wood products industry graphically. This discussion is concerned with two major components of the industry--plywood manufacturing and reconstituted wood products manufacturing.

Plywood is a building material consisting of veneers (thin wood layers or plies) bonded with an adhesive. The outer layers (face and back) surround a core, which is usually lumber, veneer, or particleboard. Most plywood is made from Douglas Fir, southern pines, or other softwoods. Hardwood veneers make up

only a very small portion of total production. Plywood manufacture consists of seven primary processes (debarking, heating the logs, peeling the logs into veneers, drying the veneers, gluing the veneers together, pressing the veneers together in a hot press and finishing processes such as sanding and trimming) as depicted in Figure 2. The two elements of the process that are important relative to the sampling, analysis and data interpretation problems addressed in this memo are the veneer drying and gluing and pressing operations.

The veneers produced by the initial processing operations are introduced to the veneer dryer to reduce the moisture contents to levels in the range of 1 to 15 percent, with the target moisture content based on the resins and glues used in later steps. The two primary types of dryers used by the industry are longitudinal dryers and jet dryers. In the longitudinal dryer, air circulates in a path parallel to the veneer along the axis of the dryer. The jet dryers direct hot, high velocity air at the surface of the veneers creating a more turbulent air flow with consequent reduced drying times. Typical drying temperatures range from 150° to 200°C (300° to 400 °F).

After the veneers are dried to a specified moisture content, they are glued together with a thermosetting resin. Typically phenol-formaldehyde resins are used for softwood and exterior grades of hardwood, and urea-formaldehyde resins are used for interior grades of hardwood. The glued and assembled panels are sent to hot press where they are consolidated under heat and pressure. The two objectives of hot pressing are to press the glue into a thin layer over each sheet of veneer and to activate the thermosetting resin. Typical press temperatures range from 130° to 165°C (270° to 330°F) for softwood plywood and 110° to 135°C (225° to 275°F) for hardwood plywood with press times in the range of 2 to 7 minutes.

Reconstituted wood products are a group of building materials made from wood particles or wood fibers that have been reformed into panels or molded articles. Various names are applied to these products depending on the manufacturing process. Panels may be classified into two broad types: particleboard (including waferboard and oriented strandboard) manufactured from chips, wafers, or wood particles; and fiberboard (including insulation board, medium density fiberboard and hardboard) manufactured from wood fibers. Most reconstituted wood products are made from softwoods, and most of the plants are in the Pacific Northwest or in the Southeast.

Although the processing steps involved in producing the different reconstituted wood products vary among different plants and product lines, the overall process is similar to the particleboard process depicted in Figure 3. Raw materials for most of the processes are generally either green or dry wood chips, planer shavings, or sawdust. Particles may be further reduced in size by hammermills and refiners and then dried in triple-pass rotary drum dryers or tube dryers. The materials are

then blended with resins, formed, treated in a hot press, and then subjected to finishing operations. Again the primary operations of interest for this memo are the drying operations and the hot presses.

A variety of dryers types are used in the reconstituted wood products industry, including both multiple pass rotary drum and tube dryers. The dryers may be fired either directly or indirectly, and different fuels including wood waste, propane, natural gas, and fuel oil are used. Depending on the type of material being processed, the dryers reduce the moisture content of the particles, wafers, or fibers to 2 to 10 percent. Operating temperatures are typically about 260°C (500°F), but for extremely wet furnish, the inlet temperatures can reach 870°C (1600°F). After drying, the dried wafers or particles are conveyed pneumatically from the dryer, separated from the gas stream, and screened and/or air classified to remove fines and to separate the wafers or particles by surface area and weight.

Typically, the dried materials are then conveyed to the blender, where they are blended with resin, wax, and any other additives. (Note that for some processes such as medium density fiberboard, the blending step precedes the dryer.) From the blender (or from the dryer if the dryer follows the blender) the resinated material is formed. Then press applies heat and pressure to activate the resin and bond the wafers or particles into a solid reconstituted product.

For both plywood and reconstituted wood products production, emissions from dryers include wood dust and other solid PM, VOC's, and condensible hydrocarbons. The condensible hydrocarbons and portion of the VOC's leave the dryer stack as vapor but condense at normal atmospheric temperatures to form liquid particulates that create a visible blue haze. Both the volatile organic compounds and liquid particulates appear to comprise combustion products and compounds evaporated from the wood. Consequently, the quantity of emissions is dependent on wood species, dryer temperature, and fuel used.

Emissions from board presses are dependent on the type of resin used to bind the wood particles together. When the press opens, vapors that may include resin ingredients such as formaldehyde, phenol, methylene-diphenyl-diisocyanate (MDI), and other VOC's are released to the atmosphere through vents in the roof above the press. Formaldehyde is emitted through press vents during pressing and board cooling operations in quantities that are dependent upon the amount of excess formaldehyde in the resin.

III. Emission Test Methods

The primary pollutants of concern from plywood and reconstituted wood products manufacturing are PM (or more specifically PM-10 and condensible PM) from drying operations, VOC from drying operations and hot presses, and formaldehyde from hot presses and some drying operations. Emission data for these pollutants have been obtained via a number of different methods,

and these methods generate data that are not directly comparable. To facilitate interpretation of the data generated by different methods, the paragraphs below identify and briefly describe the procedures that have been used for PM and related pollutants, VOC, and formaldehyde.

Test methods for PM (both filterable and condensible) include the standard reference method (EPA Methods 1 through 5 with Method 5 being the primary PM procedure) and derivatives of Method 5. Other methods that have been used in the wood products industry are EPA Method 17 for total PM, EPA Methods 201 and 201A for PM-10, EPA Method 202 for condensible PM, and the Oregon Department of Environmental Quality Method 7 (ODEQ7) for both PM and condensible PM. The paragraphs below first describe the essential features of Method 5 and then describe how the other procedures differ from Method 5.

A schematic of the Method 5 test train is shown schematically in Figure 4. The primary components of the train are the nozzle, the probe, a filter (which is maintained at 120°C [250°F] in a heated filter box), an impinger train that is kept in an ice bath to cool the gas stream to ambient temperature, a meter box and a pump. The impinger train contains four impingers; the first two contain water, the third is dry, and the fourth contains silica gel to dry the gas stream before it enters the dry gas meter. The Method 5 train collects an integrated sample over one to several hours at sample points that span a cross-section of the exhaust duct or stack, typically on perpendicular traverses across the diameter of the stack. At each sampling point, a sample of the gas stream is collected isokinetically through the nozzle. The captured gas stream moves through the probe to the filter. Some particles are collected on the walls of the probe, and the remaining material that is in particle phase at 120°C (250°F) is collected on the filter. The gases that pass through the filter then go through the impinger train where any organic or inorganic materials that condenses between 16° and 120°C (60° and 250°F) are collected. Typically, the material collected in the probe and filter (front half catch) is considered for regulatory purposes to be PM, and the material captured in the impingers (back half catch) is considered to be condensible PM.

The two other methods that have been used to collect total PM emissions from wood products operations, EPA Method 17 and ODEQ7 encompass the same principles as EPA Method 5 but have specific modifications. The primary difference between EPA Methods 5 and 17 is in the collection temperature for the front half catch. In order to maintain a collection temperature of 120°C (250°F), the Method 5 train employs a heated probe and filter. In contrast, the Method 17 train employs an in-stack filter, so the collection temperature is equal to the actual temperature of the stack. If the stack temperature is less than 120°C (250°F), then any material that condenses at temperatures between 120°C (250°F) and the stack temperature will be measured as condensible PM with Method 5 and filterable PM with Method 17.

The measures are reversed if the stack temperature is greater than 120°C (250°F). The ODEQ7 method modifies EPA METHOD 5 by adding a filter between the third and fourth impingers to collect any condensed material that escapes the impingers. This filter is maintained at approximately ambient temperature, and the material collected in the first three impingers and on the second filter are added to the front-half catch to obtain total PM. This procedure is intended to measure those constituents in the emissions responsible for the formation of PM once the emissions have cooled to ambient temperature.

In 40 CFR Part 51, EPA has published two procedures for determining PM-10 emission rates (EPA Methods 201 and 201A) and a method for measuring condensible PM emission rates (EPA Method 202). Methods 201 and 201A are derivatives of Method 5 that both include in-stack cyclone to remove particles with aerodynamic diameter greater than 10 micrometers (μm) from the gas stream followed by an in-stack cyclone to collect the remaining particles. The back half of the train is identical to the back half of the Method 5 train. Both methods require a traverse of the stack, but Method 201 uses isokinetic sampling with a recirculating system to maintain constant flow through the cyclone, while Method 201A uses a constant sampling rate. The PM-10 is determined gravimetrically from the material captured in the sample line between the cyclone and filter and on the filter. Neither of the two methods specify procedures for determining condensible PM, but both methods indicate that for applications such as inventories of sources contributing to ambient PM-10 levels, PM-10 should be sum of condensible PM emissions and PM-10 emissions measured by the Method 201 or 201A procedures. Condensible emissions can be determined by EPA Method 202. Method 202, which applies to determination of condensible particulate matter (CPM) from stationary sources, measures CPM as material that passes through the filter and is collected in the impingers of a PM train. The primary method specifies that CPM be based on the back-half catch of a Method 17 train (which uses an in-stack filter), but Method 5, 201, or 201A procedures are also acceptable. The method specifies that the impinger solution be extracted with methylene chloride, the inorganic and organic fractions be dried separately, the residues weighed, and the CPM be determined from the combination of both residues. Note that because the method allows the use of either a heated filter system or an in-stack filter system, some ambiguity in results can occur from test to test.

Total hydrocarbon or VOC emission estimates from wood products dryers and hot presses have been obtained primarily via one of two EPA methods--Method 25 and Method 25A. Method 25 measures VOC emissions as total gaseous nonmethane organics (TGNMO), and emission levels are typically reported as carbon concentrations or mass rates. Figure 5 shows a schematic of the Method 25 sampling apparatus. Because organic PM interferes with the organic analysis, the sample is drawn through a heated filter for PM removal. The method currently requires that the

filter be maintained at $121^{\circ} \pm 3^{\circ}\text{C}$ ($250^{\circ} \pm 5^{\circ}\text{F}$), but these filter requirements have evolved. Initially, the filter was optional, and temperature requirements have changed over the years. The sample is drawn from the filter through a condensate trap into an evacuated sample tank. The material in the trap and sample tank are recovered and analyzed separately, and the results are combined to determine total VOC. The organic material in the condensate trap is oxidized to CO_2 and collected in an evacuated vessel; then a portion of the CO_2 is reduced to CH_4 and measured by FID. A portion of the gas collected in the sample tank is first passed through a gas chromatograph to separate CO , CO_2 , and CH_4 from the remaining nonmethane organic material (NOM). The NOM is then oxidized to CO_2 , reduced to CH_4 , and measured by FID. This procedure essentially determines the number of carbon atoms present in the nonmethane volatile organic material and eliminates inconsistencies associated with the variable response of the FID to different organic compounds.

Method 25A is used to provide a continuous measure the concentration of organic vapors consisting primarily of alkanes, alkenes, and aromatic hydrocarbons. The stack gas sample is collected through a heated sample line with either an in-stack or heated filter to remove PM. From the filter, the sample is directed to a flame ionization analyzer (FIA), and the concentration of organic material in the gas stream is measured as calibration gas equivalents or as carbon equivalents. The results depend strongly on the particular constituents that make up the organic content of the gas stream because the FIA has different response factors for different organic bond structures.

Because the resins used to bond plywood and reconstituted wood products are formaldehyde based, the exhaust gasses from the presses and from drying operations where resin is applied prior to drying are known to contain substantial quantities of formaldehyde and may contain some amount of other aldehydes and ketones. The available data on aldehyde and ketone emissions from these operations have obtained with EPA Method 0011. Method 0011 was developed specifically for formaldehyde emissions, but it has been applied to other aldehyde and ketone compounds. The procedure collects an integrated sample isokinetically at points along perpendicular traverses of the stack. The gaseous and particulate pollutants in the sample gas are collected in an impinger train that contains an aqueous acidic solution of dinitrophenyl-hydrazine. Formaldehyde reacts with the dinitrophenyl-hydrazine to form a formaldehyde dinitrophenylhydrazone derivative. This derivative is extracted, solvent exchanged, concentrated, and analyzed by high performance liquid chromatography.

IV. Issues

Many of the difficulties encountered in developing VOC and PM-10 emission factors for wood products industry driers and hot presses arise because of the chemical composition of the organic materials found in the emission streams from these processes and

the inconsistencies in the way the different test methods described above collect and analyze these organic compounds. Also, the chemical and physical characteristics of these emission streams, particularly the moisture content and temperature variations, complicate sampling and analysis and data reduction. Particular issues of concern are complications associated with high moisture in exhaust streams, inconsistent VOC and PM-10 results from different procedures and associated concerns related to inconsistency in condensible PM from Method 202, and the interrelationship in the estimates of VOC and PM-10 emissions and the potential for double counting those emissions. The paragraphs below first discuss the characteristics of the organic material in wood products exhaust streams and then address the general issues outlined above.

A. Organic Emissions from Dryers and Presses

As green wood is subjected to heat in plywood veneer dryers and reconstituted wood products dryers, some of the organic material in the wood is volatilized and carried off with the exhaust stream. These organic materials that emanate from the wood are the primary VOC's and condensible organic PM in the dryer exhaust. Consequently, the organic compounds found in wood products dryer emissions typically include terpenes, terpene-like materials, resins, and fatty acids comparable to those found in wood. The boiling points of many of these materials are in the range of 155° to 370°C (310° to 700°F). These temperatures are greater than typical dryer temperatures, but the compounds exhibit significant vapor pressures at dryer temperatures. Consequently, some of these organic compounds are at saturation levels in the gas streams and will condense as the gas stream cools.

Some wood products operations, particularly medium density fiberboard manufacturing, apply resin to the wood prior to drying. For those systems, the organic material in the dryer exhaust also contains compounds that volatilize from the resin, particularly formaldehyde. These resin-based compounds are also generated from the hot press operations. The primary organic compounds found in this exhaust stream other than formaldehyde include other aldehydic compounds and phenolic resins.

B. Moisture Content of Dryer Exhaust

The inherent moisture content of wood products dryer exhaust streams complicates measurement of PM-10 emissions in these streams. This problem is most prevalent for facilities that have wet control devices such as wet ESP's or ionizing wet scrubbers. Because the exhaust from these systems is saturated, moisture condensation downstream from the control device is common. The PM-10 procedures described above prescribe an in-stack filter that operates at stack temperatures. If the gas stream does contain water droplets, sample train filter blinding is likely to preclude PM-10 sampling. This problem has been encountered during EPA tests on conducted on wet ESP-controlled dryers as a part of the program to develop emission factors for the wood products industry.

One solution to this problem is to use a heated filter rather than an in-stack filter in the Method 201 or 201A train. As a part of the testing, Method 202 could be used to determine condensible PM emissions from the back half of the Method 201 or 201A train. The total PM-10 emissions could be estimated as the sum of the PM-10 emissions obtained from Method 201 or 201A and the condensible PM emissions obtained from Method 202. This solution will eliminate the moisture problem, but it does have two drawbacks. First, since this procedure is different from the procedure used for dry control systems, the results will not be directly comparable. Second, this procedure exacerbates the problems related to double counting of VOC and PM-10 discussed below.

C. Inconsistent VOC and PM-10 Measurements

As suggested by the characteristics of the organic emissions from wood products dryers describe in Section IV.A, the dryer exhaust gas contains a substantial amount of organic material that is condensible in the range of 50° to 120° C (120° to 250°F). Because all of the test methods describe earlier contain a filter to collect particulate material, the amount of this material that remains on that filter and the amount that will be measured downstream from the filter depend on the operating temperature of the filter. Consequently, the material classified as PM-10, condensible PM, and VOC will differ, depending of filter temperature. The situation related to VOC emissions is further complicated by the presence of aldehydes and ketones in the exhaust streams from dryers and presses. Because these compounds are treated differently by Methods 25 and 25A, results obtained by these two methods are not directly comparable. The paragraphs below first address the PM-10 issues and then the VOC issues.

The applicability sections for EPA Methods 201 and 201A indicate that if PM-10 results are to be used for purposes such as inventories then the PM-10 results from those methods should be added to condensible PM results from Method 202 to obtain total PM-10 emissions. Because the primary purpose of AP-42 is to aid in preparing emission inventories, such a combination appears to be appropriate for developing AP-42 emission factors. However, condensible PM emissions can be determined via Method 202 in conjunction with a variety of trains. The available data base on condensible PM emissions from the wood products industry has been obtained using EPA Method 5 and Method 201A trains and ODEQ7 trains. Because these trains operate at different filter temperatures, they will generated different measures of condensible PM emissions for the same facility. Furthermore, because Method 201A and ODEQ7 operate with in-stack filters, their distribution of filterable and condensible fractions will vary from site to site depending on stack temperatures. Such differences generate inconsistencies in the data base and complicate averaging results across facilities.

The two principal issues concerning VOC emission estimates from the wood products industry that need to be addressed are the

inconsistencies in the historical EPA Method 25 data and the inconsistencies between the results obtained via Method 25 and Method 25A. As noted in the discussion of Method 25 above, the protocol concerning the Method 25 particulate prefilter has changed over time. Data collected during the last several years are based on the organic material that passes through a 120°C (250°F) filter. However, some of the historical VOC data for the wood products industry were based on Method 25 trains with in-stack filters or with heated filters operating at 88°C (190°F). Because available data from NCASI testing indicate that substantial quantities of the organic material in wood products dryers may condense at temperatures between 120°C (250°F) and 77°C (170°F), the results from the historical tests with different filter temperatures cannot be combined consistently.

Development of VOC emission factors is further complicated by the inconsistencies between Method 25 and Method 25A results. First, Method 25A allows the use of an in-stack particulate filter in lieu of a heated filter, so the organic material that is subjected to analysis via the two methods is not equivalent. More importantly, the analytical methods are quite different. Method 25 collects an integrated sample over time and essentially counts the number of carbon atoms in the volatile fraction of the organic material collected. Consequently, irrespective of the structure of the organic compounds in the emission stream, the method measures the moles of carbon contained in those compounds. In contrast, Method 25A provides a continuous measure of the organic material present by measuring the response of an FID to that material relative to the response of the FID to a calibration gas. If the organic compounds in the exhaust gas are primarily aliphatic and aromatic hydrocarbons, the two methods provide reasonably comparable measures, but if the exhaust contains substantial quantities of oxygenated compounds such as aldehydes and ketones, the results will differ substantially. This difference is a consequence of the poor response of the FID to aldehydes and ketones. Because the hot press exhaust and some dryer exhaust streams are known to contain substantial quantities of aldehydes and ketones, the two methods are not expected to produce comparable results for those operations.

D. Double Counting of PM-10 and VOC Emissions

The sampling problems described in Section IV.C that lead to inconsistencies in estimating PM-10 and VOC emissions can also lead to measuring some fraction of the organic constituents in the exhaust stream as both PM-10 emissions and VOC emissions. Available test data for wood products dryer emissions indicate that irrespective of filter temperature, essentially all of the condensible PM that passes through the filter and is collected in the back half of a PM or PM-10 train is organic material. Also, any organic material that passes through an in-stack filter used with Method 25A or that passes through a heated filter at 120°C (250°F) as used with Method 25 will be measured as VOC. At the same time, organic material that condenses between the stack temperature and 120°C (250°F) will be measured as PM-10 by

Methods 201 and 201A. Furthermore, material that condenses in the back half of an EPA Method 5 train will be classified as condensible PM by EPA Method 202.

Because of these anomalies in the sampling and analysis procedures, two forms of double counting occur. First, if the recommendations of Methods 201 and 201A related to including condensible PM in estimating total PM-10 emissions are followed, condensible PM will be measured as both VOC and PM-10. Also, some fraction of the organic material retained on the Method 201 or 201A filter and measured as PM-10 may also be counted as VOC via Method 25 because of the filter temperatures in the Method 25 train will be higher than that of the PM-10 train for these emission sources.

V. Recommendations.

The information presented in the previous sections indicates that the procedures used to measure PM-10 and VOC emissions from wood products manufacturing lead to ambiguous results. For historical test data, all of these ambiguities cannot be resolved, and some judgement will be needed to combine data from different tests to obtain average emission factors. However, for future testing in the industry, a standard protocol is needed so that tests at different facilities will be comparable. Recommendations for evaluating existing data and for prescribing a standard protocol for future tests are tabulated below.

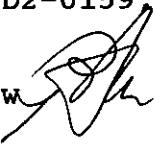
1. For all existing test data, the stack conditions during testing and the sampling and analysis procedures used, including filter temperatures should be fully documented in the AP-42 background report. If filter temperatures are not presented in the test report, the data from that report should be not be rated. The unrated data should not be used to develop emission factors unless no other data are available for a specific source.
2. For existing test data, VOC emissions from dryers upstream from the resin blending operation can be obtained from either Method 25 or Method 25A data. Because the organic compounds from such sources are primarily turpenes, the two procedures should give comparable results. However, in developing average emission factors, preference should be given to tests conducted with an in-stack filter because such measures are comparable with PM-10 procedures, and stack temperatures should be noted. To the degree possible the effects of process characteristics (type of dryer, type of wood dried, air pollution control device, stack temperature, and fuel source) on VOC emission factors should be quantified. Also, to the degree possible, the amount of material captured as condensate and as volatile material via Method 25 should be specified even though the combined quantity is used as a VOC measure. By presenting the two fractions separately, the amount of double counting of VOC

and PM-10 emissions can be quantified because the condensate fraction will also be counted as PM-10.

3. For existing data, PM-10 emission factors for either driers or hot presses should be based only on Method 201 or 201A data and Method 202 data that are obtained with a test procedure that uses an in-stack filter. Method 202 data obtained from a Method 5 train should not be used unless no other data are available because a fraction of the condensibles obtained with this method will have been captured on the in-stack filter used with Methods 201 and 201A. The disadvantage of this protocol is that it may include some estimation of condensible PM as both PM-10 and VOC emissions. However, it does provide a better estimate of the actual ambient PM-10 contributions from these sources in that any materials that condense in the atmosphere but that are volatile at stack temperatures will be included as PM-10.
4. For existing data, VOC emission factors for hot presses and for dryers that are downstream from blending operation should be obtained by combining the results from Method 25A and the aldehyde and ketone results from Method 0011. The FIA with Method 25A has essentially zero response to formaldehyde and a limited response to the other aldehydes and ketones that are there in substantially smaller quantities than formaldehyde. However, the Method 25A results do provide a good measure of the pure hydrocarbon fraction of the volatile organic emissions, and the Method 0011 results measure the aldehydes and ketones. Hence, a protocol that combines both appears to give a reasonable estimate of total VOC emissions.
5. A working group should be established between NCASI and EPA to develop a sampling and analysis procedure that clearly defines PM-10 emissions and VOC emissions from wood products dryer and hot press operations. The recommendations presented above for evaluating existing test data provide a working protocol, but they do have substantial limitations. They do not necessarily provide a scientifically sound mechanism for establishing which fraction of the organic emissions from wood products operations will actually condense in the atmosphere and contribute to ambient PM-10 problems and which fraction will remain as VOC in the atmosphere and contribute to atmospheric reactions that generate ozone. Because the primary function of AP-42 is as an inventory tool, the emission factors should be related to ambient air quality problems. Consequently, a method that better classifies the emissions as a function of their contribution to ambient air quality problems is desirable.

Date: January 5, 1993

Subject: Review and Update of Wood Products Industry Sections of
Chapter 10, AP-42
EPA Contract 68-D2-0159, Work Assignment 006
MRI Project 3606

From: Richard Marinshaw 

To: Dallas Safriet
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

Enclosed are four copies of the revised AP-42 Section 10.5 and background report for plywood manufacturing. These documents have been revised to incorporate the changes that you discussed with Dennis Wallace last November. In addition to those changes, we have revised the emission factor tables to present all emission factors in two significant figures. We also have made a number of minor changes to the text and tables in the background report, such as including metric units for annual production rates, to clarify the material being presented.

I apologize for the delay in getting these over to you.

Please let me know if you have any further comments or additional changes to this section.



Date: October 2, 1992

Subject: Submittal of Draft AP-42 Section 10.5, Plywood Manufacturing

From: Dennis Wallace *DW*
Work Area Coordinator

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TSD/EIB (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711

Attached are four copies of the Draft Background Report for AP-42, Section 10.5, Plywood Manufacturing. With this report we have submitted drafts for each of the sections in Chapter 10. I understand from a conversation with John Kinsey that you still have concerns about the quality of the reports that we are submitting for Chapter 10. I've reviewed this last document carefully and am confident that the types of editorial and mechanical problems that were found in some of the documents that were submitted earlier have been addressed. If possible, please review this document before you spend any time on the Chapter 10 sections that we submitted earlier. If it is not what you want in a Background Document, I would like to meet with you to discuss what we need to do to improve document quality and to prepare a document that does meet your expectations.

While preparing the document, we encountered several technical issues that you may want consider in your review. We addressed those issues to be consistent with the general AP-42 guidance that we've received on other sections, but we would like your input. The key technical/mechanical issues that you may want to consider are:

1. The available test data were frequently generated from experimental programs that were designed to evaluate test methods for volatile and condensible organic emissions. Consequently, the data could not always be converted to standard AP-42 formats. In particular, a substantial amount of data for which front and back half catch could not be separated were generated by NCASI. We have chosen to include those data in a separate category [PM (filterable and condensible)] rather than to exclude them from consideration. We would appreciate any input that you have as to how to handle such data.

2. Both the NCASI data and the EPA data contained Method 25 VOC concentrations. Per our earlier discussion, we have

converted those results to mass emission rates of VOC using methane for the conversion. Because we believe that the compounds are primarily hydrocarbons, this method probably produces estimates that are biased slightly upward. We do not discuss this issue in the Background Document. Should we?

3. The data base on emissions from plywood manufacturing dryers contained a substantial amount of information about the wood types that were being processed during testing. In the data summaries in Chapter 4 of the Background Document, we presented all data by wood type. However, in developing the final emission factors, we averaged across wood types when they had the same general character and emission factors were similar. You might want to look at the data and evaluate whether you would like us to generate wood-specific emission factors to the degree possible. Also, the averaging process is described in footnotes to tables but not in the text. Should we expand the text to discuss how we averaged across wood types?

4. Limited data were also available on different types of wet scrubbing systems. The data indicated that performance of the different systems was comparable. Consequently, we averaged across scrubber types. Should we keep those averages or should we report the different types separately? Also, is it sufficient to explain the averaging in table footnotes (as is presently done), or should we discuss the decision to average in the text?

I hope that you find in your review that the quality of our Background Documents is moving toward your expectations. I look forward to working with you to continue to improve their quality. If during your review you have questions or comments, please call me at 677-0249 Ext. 5286. After you have completed your review, I would like to schedule a meeting to go over your comments and to discuss how to revise the other Wood Products sections.

Attachment

wp51 file AP42rate.tst 7/11/91

TEST DATA QUALITY RATING

REFERENCE CODE: ^{EPA-78} EPA (1978)

EVALUATOR: BLC

DATE: 7/15/91

EXCLUSION FACTOR FOR AP-42 (p. 32):

1. Units not convertible to an emission factor (p. 20):
2. Incompatible test methods:
3. Control device not specified:
4. Source process unclear:
5. Unclear whether controlled or uncontrolled:
6. Not a primary reference (p. 19):

*Yet this is ref. 5 for AP-42 1980.
Plywood sanding & cutting EF (cite a 1972 MTR
Report)*

METHODOLOGY SCORE

POOR AVG. GOOD SUPERIOR

Manner in which source operated well documented

X

Source operated within typical parameters during test

X

Std. sampling methods

X

Sampling method deviated, but deviations well documented. Evaln. made of how alternative procedure could affect results

No wide variations in sampling and process data that cannot be explained by info. in report

Test reports contain original raw data

X

QUALITY RATING OF TEST DATA (Circle appropriate letter)

A Tests performed by a sound methodology and reported in enough detail for adequate validation. These tests are not necessarily EPA reference method tests, although such reference methods are certainly to be used as a guide.

B Tests performed by a generally sound methodology but lack enough detail for adequate validation.

C Tests based on an untested or new methodology or lack a significant amount of background data.

D Tests based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

STANDARD DATA EXTRACTION FORM

PRODUCT: PLYWOOD

SOURCE: PLYWOOD A, B

REFERENCE CODE: EPA78 Ref. 5

RECORD NO. FOR REFERENCE:

EVALUATOR: BJC

DATE: 7/15/91

PLANT IDENTIFICATION

None

1. Name:
2. Company:
3. Location:
4. SAMPLING DATES:
5. PROCESS EQUIPMENT TYPE:
6. PROCESS EQUIPMENT MANUFACTURER:
7. AIR POLLUTION CONTROL DEVICE(S):
8. APCD MANUFACTURER:
9. HEAT SOURCE/BURNER FUEL TYPE:
10. DESIGN HEAT INPUT, MMBTU/hr:
11. WOOD SPECIES:
12. MOISTURE CONTENT OF MATERIAL:
13. PRODUCTION RATE: 3.6 tons/hr estimate
14. INLET TEMPERATURE:
15. OUTLET TEMPERATURE:
16. OPERATING TEMPERATURE RANGE:
17. SAMPLING PERIOD:
18. STACK TEMPERATURE:
19. AIR FLOW RATE:
20. RESIN:

ADDITIVES OR DEGRDN PRODUCTS THAT MIGHT CONTRIBUTE TO EMISSIONS

21. Fire retardant:
22. Oil:
23. Wax and Rosin:
24. Wood hydrolysis products:
25. Asphalt:
26. Solvent:
27. Other:

28. COMMENTS:

EMISSIONS DATA

trans. 10/15/78

REFERENCE CODE: *EPA 78*

RECORD NO.: *A*

EVALUATOR: *BLC 7/15/91*

[ENTER WT. PER UNIT VOLUME (SI UNITS IN PARENTHESES)\WT. PER WT. OF DRY FURNISH OR OTHER "ACTIVITY" (SI UNITS IN PARENTHESES)\OTHER MEASURE]

- 29. Total Particulate: *A 150 to 271 lb/ton*
- 30. Front-half:
- 31. Back-half:
- 32. PM₁₀:
- 33. Other particle fractions:

(75-135 kg/mg) physical error in ref.

from a 1972 Mitre report

- 34. Formaldehyde:
- 35. Phenol:
- 36. Methane:

from a 1974 Environ. Sci. & Eng. Inc. report
B Hydrocarbon 1.0-2.1 lb/ton (0.5-1.0 kg/mg)

- 37. TGNMO (include designation "hydrocarbon"):
- 38. Condensible organics (AP-42 doesn't combine front-half & back-half catches):

- 39. Front-half:
- 40. Back-half:
- 41. SO_x:
- 42. NO_x:
- 43. CO:

44. Other [AP-42 authors are required to report the NMVOC constituent species for entry in a supplement to the VOC Species Data Manual (the KVB report)]:

NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC.
260 MADISON AVE. NEW YORK, N.Y. 10016 (212) 532-9000 FAX: (212) 779-2849

Dr. John E. Pinkerton
Program Director
Air Quality
(212) 532-9047

April 13, 1993

Mr. Dallas W. Safriet (MD-14)
Emission Factor and Methodologies Section
Emission Inventory Branch
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Dear Dallas:

RE: Draft Revision of AP-42 Section 10.5, "Plywood
Manufacturing"

We appreciate the opportunity to review the subject draft section of AP-42 as requested in your February 2 letter, and apologize for the delay in forwarding this response.

In general, we feel the revised material prepared by EPA and its contractor represent a major improvement over the current AP-42 section on plywood manufacturing. The distinction between condensable and non-condensable VOCs and between filterable and condensable particulates is very useful. Discussion of the various measurement methods and the effects of filter temperature in the documentation section is helpful.

However, a careful review of the documentation section has revealed several apparent shortcomings in the interpretation, analysis and use of available emission measurements. The majority of measurement data was obtained from NCASI Technical Bulletin No. 405, "A Study of Organic Compound Emissions from Veneer Dryers and Means for their Control" (later referred to as TB 405). In our opinion, this document provides a comprehensive compilation of emission measurements from softwood veneer dryers and could be used by itself as a primary source for emission factors. We feel the authors of the AP-42 documentation section have inappropriately reinterpreted much the information contained in TB 405.

National Council staff who reviewed the draft AP-42 material included David Rovell-Rixx, David Word, Andre Caron and myself. We have also spoken with Victor Dallons, a former NCASI employee who was the primary investigator and author of TB 405, and some of his review comments are incorporated in this letter. Our comments focus mainly on the documentation section which forms

the basis for the revised draft Section 10.5. We have also provided you with a few comments on the draft AP-42 section. Our comments are provided by page number.

Documentation Section

10.5-2. The correct SIC code for hardwood plywood is 2435.

10.5-2. It would seem production figures for a more recent year than 1987 would be available to include in Section 2.1.

10.5-9. Press temperatures generally range from 270 to 330°F for softwood plywood, and 225 to 275°F for hardwood plywood.

10.5-10. Unless a veneer dryer is directly-fired with wood fuels, particulate emissions from dryers would all be expected to be classified as PM₁₀.

10.5-10. Emissions of hazardous air pollutants from veneer drying are unlikely (see "Study of the Physical and Chemical Properties of Atmospheric Aerosols Attributable to Plywood Dryer Emissions", Final Report to the American Plywood Association by D. Cronn, M. Campbell, L. Bamesburger, and S. Truitt, 1981). However, trace amounts of combustion by-products which are considered to be hazardous air pollutants, e.g. aldehydes, may be present in direct-fired veneer dryer exhausts as a result of fossil fuel or wood combustion gases being passed through the dryer.

10.5-10. Condensible compounds in veneer dryer emissions which are associated with 'blue haze' are primarily resin and fatty acids, which condense at much higher temperatures than 70°F. These compounds do not have to be cooled to below 70°F or combine with water vapor to become visible. We are not aware of any evidence that wood sugars are a component of condensible organics. VOCs resulting from combustion are only found in direct-fired veneer dryer exhausts.

10.5-10. We are not aware of any measurement data which would suggest the type of resin applied would have an effect on the quantity or composition of compounds present in press vent exhaust gases. This inference should be deleted unless a reference can be provided.

10.5-10. Trimming and sanding operations are normally controlled to prevent fugitive particulate emissions and to recover the material for use as a fuel.

10.5-11. An EFB will not control condensible organic emissions unless the dryer exhaust is cooled sufficiently to cause

condensation of certain organics prior to the EFB.

10.5-11. The authors should check to ascertain if any plywood plants are still directing dryer exhaust to boilers. Most plants have discontinued this practice. Furthermore, plants which did combust veneer dryer exhaust had boilers which were larger than required to produce steam and hot water for the plywood operation.

10.5-11. To our knowledge, there have been no recent installations of ionizing wet scrubbers on veneer dryers, and it should not be identified as an "emerging technology".

10.5-11. EFBs used on veneer dryers typically have a fixed, rather than a moving, gravel bed.

10.5-12. Baghouses are also commonly used to control particulate emissions from sanding, trimming, and material handling operations.

10.5-12. A possible addition to the list of references is "Control Techniques for Organic Emissions from Plywood Veneer Dryers" (EPA-450/3-83-012), May 1983.

10.5-14. A more recent Census of Manufacturers should be used since there have been numerous plant closures since 1987.

10.5-14. NCASI is not a trade association; it is the environmental technical studies organization of the forest products industry.

10.5-19. It is our understanding that EPA Method 18 is not appropriate for measurement of formaldehyde. EPA's favored measurement method is currently draft Method 0011, which is being widely used by EPA contractors at the present time. We feel any formaldehyde measurements made with Method 18 or some variant of Method 18 are highly questionable, especially if the method has not been subject to a Method 301 validation for this type of source.

10.5-19. It is not clear if the hood capture efficiency for the press vent area was determined. If the efficiency is less than 100%, VOC and formaldehyde emission rates measured at the hood exit may understate these rates.

10.5-20. Data from references 3 and 5 were cited in TB 405 as mills C and E, respectively. Unfortunately, the same data from these two plants have been counted twice in many of the emission factor calculations. These computations need to be corrected.

10.5-24. As noted earlier, Mill C test results are the same as described in Reference 3.

10.5-25. As noted earlier, Mill E test results are the same as described in Reference 5.

10.5-33. Although the authors have chosen to express VOC emissions in terms of methane, it should be acknowledged that expressing VOC results in terms of carbon is currently the most widely accepted reporting method. We would encourage EPA to review all sampling data cited in the report to ensure that all VOC results expressed as carbon or propane have been properly converted to methane equivalents. Furthermore, the text should provide the appropriate conversion factors.

10.5-35, 36 (Table 4-3). In this table and all other tables with emission factors, we would strongly suggest that only English units be shown. All referenced data are expressed in English units, and metric units are rarely used in the U.S. plywood industry. Eliminating the metric units would make the tables more user-friendly and would avoid the possibility of errors in converting the English units to metric units.

10.5-35, 36 (Table 4-3). All entries in this table are from TB 405. The first four entries were taken from Appendix C for Mill I, the next eight entries were for Mill J, and the next three for Mill K. The remaining entries were taken from Tables 9 and 10. As stated in TB 405, the data contained in Tables 9 and 10 includes sampling results from the various mills described in Appendix C. Thus many of the entries in Table 4-3 are for the same data points. For example, the Appendix C VOC data for Mill K are shown in line 13 of Table 4-3 (two test runs, results of 2.4 and 3.9 lb/MSF). Then the Mill K individual VOC test run results taken from Table 9 are shown again in lines 16 and 17. This table should be reviewed and duplicate sampling results removed.

10.5-35, 36 (Table 4-3). In extracting test information from TB 405, it appears that many factors discussed in the report were either overlooked or ignored. For example, the Mill J and K veneer dryers recirculated a portion of the dryer exhaust to a blend box, with the remainder of the exhaust being ducted to the atmosphere. Exhaust gas recirculation may affect the characteristics of VOCs and particulates in the dryer exhaust, yet there is no discussion of this possibility in the text accompanying Table 4-3. Measurements taken before and after blend boxes have been averaged in many cases; such averaging may not be appropriate. A second example is the omission of the distinction between sampling results for Douglas fir heartwood versus sapwood. The heartwood VOC results were 50% lower than the sapwood results, yet the two have been averaged together in

line 13 of the table. As a third example, CO measurements at Mill J were made both before and after the ionizing wet scrubber. In Table 4-3, the CO data from Mill J have been subdivided according to the species being dried during the test run. In line 11, two outlet test runs and one inlet test run (taken simultaneously with the second outlet test run) have been averaged. In line 12, an inlet and outlet test run taken at the same time have been averaged together. Since CO emissions are primarily from the fuel cell, and would not be expected to change across a wet scrubber, we question the appropriateness of subdividing CO test results by wood species, especially considering that the exhausts gases were from three dryer lines, only one of which dried white fir during the first three test runs. In addition, we were not able to calculate the same lb/MSF values shown in Table 4-3 from the reported Appendix C CO concentration data for Mill J; we suggest that these calculations be checked to verify their accuracy.

10.5-37 to 42 (Table 4-4). Similar to Table 4-3, this table contains many duplicate entries from TB 405. In addition, there are duplicate entries from TB 405 and References 3 and 5 as noted earlier. As for Table 4-3, we suggest that EPA review the organization of data presented in this table to ensure test results have been put in appropriate categories.

10.5-38, 39. The last line in Table 4-4 on page 10.5-38 and the first line on page 10.5-39 are apparent misinterpretations of Mill F sampling results from TB 405. The veneer dryer at this plant had two exhaust stacks, one at the green end and one at the dry end. The stacks were sampled in sequence, and the results should be added together, not counted as separate runs. This error needs to be corrected in subsequent tables as well.

10.5-39. The third and fourth lines of Table 4-4 on this page cite ODEQ-7 results for Mill G, as described in Appendix C of TB 405. These test data were taken on the green end stack of a southern pine veneer dryer. As described in TB 405, this dryer had three additional stacks at the dry end which were not sampled with ODEQ-7. Thus the PM and condensable emission rates cited in Table 4-4 only represent part of the total emissions for this dryer. The results should be removed from the table and all subsequent calculations.

10.5-42. The emission factors presented in Reference 8 have a calculation error, as discussed in TB 405. Corrected values may also be found in Table 7 of TB 405. According to Victor Dallons, the values from Reference 8 should be multiplied by 6 to correct for the 6 carbon atoms used in the calibration gas.

10.5-43, 44 (Table 4-5). All data in this table were taken from Table 11 in TB 405. Unfortunately, emissions for direct wood-

fired dryers appearing in the last portion of Table 11 were inadvertently mislabeled as 'Direct-Fired Gas Fired'. Thus test results beginning at line 15 of Table 4-5 should be deleted from this table and moved into Table 4-3.

10.5-46. As discussed earlier, we have reservations about the averaging procedure used to calculate the CO emission factor. The discussion should include information about the dryer exhaust recycling to a blend box and its potential effect on CO concentrations in the dryer exhaust.

10.5-47, 48 (Tables 4-7 and 4-8). The ND entries under SO₂ should be changed to NA; combustion of natural gas, propane or wood fuels results in negligible SO₂ emissions.

10.5-49 to 52 (Tables 4-9 and 4-10). References to sizer cyclones and EPA Methods 201/201A in Footnote b should be deleted since none of the measurements used for developing these tables were made with these measurement techniques. Reference to EPA Method 202 in Footnote c should be deleted for the same reason. A footnote should be added to the column labeled "PM (filterable and condensible)" to indicate these measurements represent ODEQ-7 results. It would also be helpful to note the effect different filter temperatures have on the filterable and condensible emissions. In fact, some of the PM factors have been computed using ODEQ-7 results with varying front-half filter temperatures. For example, the factor for steam-heated units drying firs and hemlock, after a wet scrubber, was calculated from ODEQ-7 runs which had filter temperatures of 190 and 250°F. The factor for steam-heated units redrying veneer, after a scrubber, is based ODEQ-7 results with a filter temperature of 154°F.

10.5-49 to 52 (Tables 4-9 and 4-10). We would urge EPA to review the data averaging procedures employed in calculating the emission factors shown in this table from the disaggregated data presented in Tables 4-3, 4-4 and 4-5. The emission factors for gas-fired dryers need to be recalculated as indicated earlier. The PM entry under steam-heated veneer dryers for pines should be labeled as after a wet scrubber in the first column since the value represents the average of three ODEQ-7 runs at Mill A after the Burley scrubber, as reported in TB 405. The entries for steam-heated dryers for pines demonstrates the inappropriateness of using different data sources for the filterable, condensible and total PM emission factors. A casual reader would wonder how the total PM after a control device could be almost twice as large as the sum of the filterable plus condensible uncontrolled components of total PM. As noted earlier, there are calculation errors in the filterable and condensible emission factors for steam-heated units drying pines.

10.5-53 (Table 4-11). Again we would urge EPA to review the selection and averaging procedures used to calculate the various emission factors included in this table. For example, the wood-fired dryer VOC factor of 2 lb/MSF is obtained from averaging two emission factors, one for hemlock (0.77) and one for Douglas fir (3.15). Four sampling runs at one dryer were used to obtain the hemlock value. However, the Douglas fir value was the average of one run on heartwood (2.4) and one run on sapwood (3.9). It simply does not seem reasonable to combine these diverse results into a single emission factor for 'fir and hemlock'. The wood-fired dryer NC-VOC emission factor of 1 lb/MSF was obtained by averaging emission factors for five different species or species mixes given in Table 4-3. Another way of calculating this factor would be to average the emission factors for each of the three dryers (Mills I, J and K in TB 405); the resulting factor would be 1.3 lb/MSF. A third alternative would be to assign equal weight to each individual sampling run (total of 11); the resulting factor would be 1.1 lb/MSF. There are still other variations possible with these data points since four of the Mill J test runs represented simultaneous scrubber inlet/outlet values, and it could be argued that these should be considered as two data points, not four. The point to be made is that there are many different ways to calculate emission factors, and we feel EPA has not always chosen the most reasonable method for the calculations. Calculations for all of the factors in Table 4-11 should be reviewed carefully to ensure they make sense. Again, presentation of single number in the table fails to indicate the wide range in observed test results and the number of sources and test runs used to compute the factor. This information should be included to assist the AP-42 user.

10.5-53 (Table 4-11). The calculation of the VOC emission factors for a steam-heated unit drying firs and hemlock (with and without controls) should be redone to eliminate double-counting of Mill C test results. It is questionable as to whether emissions from two quite different scrubbing systems (sprays followed by a packed tower versus the Burley system) should be averaged together, especially considering there was roughly a factor of two difference in the VOC emission rates. An explanatory footnote about the possibility of a VOC contribution from the scrubber water should be added to the redry emission factor.

10.5-53 (Table 4-11). The average for steam-heated dryers for VOC for pines should be 2.9 rather than 2.7 lb/MSF. A footnote should be added to explain that THC refers to an EPA Method 25A measurement. The potential effect of varying Method 25 filter temperatures should be addressed considering that factors for pine of 2.14 lb/MSF, redry of 0.03 lb/MSF and redry with wet scrubber of 0.3 lb/MSF were developed from one, one and two sample runs, respectively, with filter temperatures of 150°F.

10.5-53 (Table 4-11). The wisdom of including formaldehyde measurements made with an unproven, unvalidated sampling method at a single source should be seriously reconsidered.

Draft AP-42 Section 10.5, Pages 10.5-1 to 10.5-12

General

This section should be consistent with the documentation report. It will need to be revised to reflect changes which will be made to the draft documentation report.

As with other AP-42 sections, the National Council staff continue to object to the presentation of single numbers in tables. A single average number does not provide the AP-42 user with an appreciation of the variability which may exist among similar sources. Since ranges are already included in the documentation section, we see no reason why ranges should be excluded from the AP-42 section. We also feel it is a disservice to AP-42 users to not indicate the number of sources or test runs which were used to develop the emission factors. Without this information, users have no idea about the robustness of a given factor and the degree of confidence that should be assigned to it. Assignment of subjective data quality ratings is a poor substitute for showing ranges and number of sources or test runs.

Specific

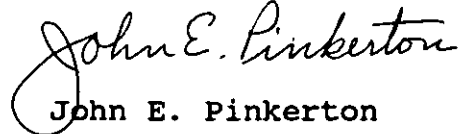
10.5-9 (Table 10.5-5). The terms VOC, NC-VOC and THC should be defined in a footnote, including mention of the sampling method and associated filter temperatures. The filter temperatures should be noted to avoid confusion because EPA Method 25 was revised in 1988 to specify a filter held at 250°F (all data included in the emission factors are pre-1988). It should also be clearly indicated that the emission factors are expressed as methane.

10.5-12. Reference 12 and 14 are the same document.

The NCASI staff appreciates the opportunity to provide comments on this proposed revision to AP-42 and hope that our comments will result in an improved quality document. We would be pleased to further discuss these comments with you or your consultants and answer any questions you may have concerning the above material. We would like to review the revised draft when it becomes available.

Furthermore, the NCASI staff would welcome the chance to review proposed revisions to other AP-42 sections dealing with other forest products industry sources such as combination boilers, wood pulping operations, particleboard plants, OSB plants, MDF plants, hardboard plants, and sawmills, as well as prescribed forestry burning activities.

Very truly yours,


John E. Pinkerton

cc: J. Emery
V. Dallons
D. Mumper
J. Boswell
L. Otwell
D. McVey
G. Andrew
R. Kaufmann
A. Caron
D. Word



NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC.

April 28, 1994

Mr. Dallas Safriet
Emission Inventory Branch (MD-13)
Emission Standards and Engineering Division
Office of Air Quality Planning and Standards
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711

Re: AP-42 Plywood

Dear Dallas:

Thank you for the opportunity to review the revised Plywood AP-42. The majority of our previous comments have been incorporated into this version, thus our comments will be relatively brief. The comments are preceded by page, section or table number(s).

General. We continue to believe that emission factors should be provided as a range, rather than a single average value. Additionally, if the range were supported with information about the number of sources tested and the number of sampling runs, the reader could make judgements about the quality of the factor and its usefulness.

Pages 7 and 10.5-1. The temperatures provided for blended gases from direct-heated wood fired dryers (750 to 1200°F) are above the range normally encountered. These blended gas streams would normally be below 800°F with a range of about 600 to 800°F where the gases enter the dryer.

Page 14. The Method 5 filter is maintained at $250 \pm 25^\circ\text{F}$.

Page 16. The statement that Method 25A does not include aldehydes and ketones in the VOC estimate is incorrect. Flame ionization detectors (FIDs) yield no response from fully oxidized carbon atoms such as the carbon atom in a carbonyl or carboxyl group. The response of a carbon atom is diminished by substitution for hydrogen of halogens, amines, and hydroxyl

groups. Thus, formaldehyde yields no response, and the response of methanol is less than the response of methane. But, for molecules with multiple carbon atoms and a single carboxyl or carbonyl group, the response can be relatively good, since the carbon atoms not directly associated with the carbonyl or carboxyl group can provide full response. For example, for butyraldehyde, $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CHO}$, three of the four carbon atoms should provide a full response.

Consequently, aldehydes and ketones with multiple carbon atoms are included in the VOC estimate of Method 25A. They simply are not included to the extent that they would be if they were all alkanes.

Page 19. Although multiple simultaneous measurement methods may be a means to arrive at decisions about how pollutants should be measured in the wood products industry, such means are not appropriate for routine sampling purposes. EPA typically specifies a single compliance test method in its emission standards. It would be best for us to arrive at single test methods that work well for our industry.

Also, the use of Method 0011 to supplement Method 25A is clearly inappropriate. Method 0011 has not been validated for use in the wood products industry. Preliminary lab data indicate that the DNPH solution breaks the bonds between urea and formaldehyde thus overestimating formaldehyde from sources in which fibers containing "bound and stable" urea-formaldehyde resin enter the sampling train. Additionally, in light of the discussion above concerning FIDs, you could not simply add the aldehyde and ketone results from a M0011 sample to the Method 25A results, as the response factors for each individual compound would be different.

Tables 10.5-1 and 10.5-2. The carbon monoxide emission factor is an average for a wide range of values (9 to 57 lb/MSF). If this range cannot be provided in the table, it should be provided in the footnotes to the table.

Tables 10.5-3 and 10.5-4. The emission factors for plywood cutting and sanding are given as 450 kg/1000 m² and 99 lb/MSF, respectively. These factors represent greater than 10% of the weight of the plywood. They are unrealistic and should be removed from the tables.

Table 10.5-5. A footnote should be added to this table explaining how the emission factors for TGNMO and VOC are expressed, i.e., as carbon, propane equivalents, etc. If the formaldehyde emissions are based on something other than the full molecular weight of the compound, that basis should also be footnoted.

You and your staff have done a good job in expressing some of the problems encountered with emissions measurement in the wood products industry. If I can help you in any way, please do not hesitate to call. I can be reached at (904) 377-4708 ext. 241.

Sincerely,

A handwritten signature in dark ink, appearing to read "David H. Word". The signature is fluid and cursive, with a long horizontal stroke at the end.

David H. Word, Ph.D.
Research Engineer

cc: John Pinkerton



March 31, 1993

Mr. Dallas W. Safriet
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Mr. Safriet:

As you requested, we have reviewed the draft updated version of Section 10.5, "Plywood Manufacturing," that you propose to publish in a supplement to AP-42. We have a number of comments for your consideration.

Most of our comments pertain to the sections which describe the industry and the process. These comments are noted on the enclosed copy of the draft.

We understand that NCASI will be commenting on the emission factors and their derivation, and we endorse those comments. However, I would offer one general comment on the veneer dryer emission factors which are presented, and it relates to the use of single numbers. Because so many variables influence emissions, there is a tremendous amount of variation in the data which have been collected from various sources. This variation is shown clearly in the raw data provided in the draft. The final emission factor tables in Section 10.5 attempt to account for the effects of three important variables, namely wood species, dryer type, and control technology. However, large variations are also caused by factors which are not accounted for, such as temperature, natural variation, and test methodology. Therefore, a single specific emission factor for, say a scrubber-equipped steam-heated dryer drying Douglas-fir, could be very misleading to someone trying to use AP-42 to estimate emissions. We would suggest the use of ranges, rather than single values, to indicate that a great deal of unaccounted-for variation exists. Use of ranges would provide a much-needed perspective on variability for those who would use the document. The need to provide ranges is underscored by the fact that all the emission factors presented are given ratings of D or E, indicating that they are not representative of the industry.

Thank you for the opportunity to review the draft. I hope our comments are helpful.

Sincerely,

A handwritten signature in dark ink, appearing to read "J. Emery".

JOHN A. EMERY, PhD
Manager, Environmental Affairs
Standards and Regulations

/JAE

*APA Comments on
text -*

EMISSION FACTOR DOCUMENTATION FOR AP-42 SECTION 10.5

Plywood Manufacturing

1. INTRODUCTION

The document Compilation of Air Pollutant Emissions Factors (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, State, and local air pollution control programs, and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of activity of the source. The emission factors reported in AP-42 are used by air pollution professionals for widely varied purposes that include:

1. Estimating areawide emissions;
2. Estimating emissions for a specific facility; and
3. Estimating emissions relative to ambient air quality.

The purpose of this report is to provide background information from test reports and other information to support preparation of AP-42 Section 10.5, Plywood Manufacturing.

This background report consists of five sections. Section 1 includes the introduction to the report. Section 2 gives a description of the plywood industry. It includes a characterization of the industry, an overview of the different process types, a description of emissions, and a description of the technology used to control emissions resulting from plywood manufacture. Section 3 is a review of process/emission data collection and laboratory analysis procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Section 4 details revisions to the existing AP-42 section narrative and pollutant emission factor development. It includes the review of specific data sets and the results of data analysis. Section 5 presents the AP-42 Section 10.5, Plywood Manufacturing.

2. INDUSTRY DESCRIPTION

Plywood is a building material consisting of veneers (thin wood layers or plies) bonded with an adhesive. The outer layers (~~faces~~ ^{face and back}) surround a core which is usually lumber, veneer, or particleboard. Plywood has many uses, including wall siding, sheathing, roof decking, concrete formboards, floors, and containers. Most plywood is made from Douglas Fir ^{southern pines, and} or other softwoods. Hardwood veneers make up only a very small portion of total production.

Plywood mills are classified under Standard Industrial Classification (SIC) code 2453, hardwood veneer plywood, and SIC code 2436, softwood veneer plywood. No other industries are classified under these SIC codes. Emission sources in plywood manufacture are included under the Source Classification Code (SCC) 3-07-007.

2.1 CHARACTERIZATION OF THE INDUSTRY¹⁻³

In 1987, plywood and veneer production in the United States amounted to 44.2×10^6 cubic meters (m^3) (1,560 million cubic feet [MMft³]), consisting of $42.2 \times 10^6 m^3$ (1,490 MMft³) of softwood, and $2.0 \times 10^6 m^3$ (70 MMft³) of hardwood. Production and consumption trends are indicated in Figure 2-1. Although imports of softwood plywood are not significant, imports of hardwood plywood have been more than double U.S. production for many years.

The ^{plywood} softwood industry originally developed on the west coast because of the quantities of available high-quality timber. However, the softwood plywood industry has grown rapidly in the South, and production from that region has exceeded production from the West since 1980. The hardwood plywood industry, which is concentrated in the South, is very diverse. It ranges from small firms that produce custom-ordered plywood to large, high capacity plants that produce thin panels in production lines similar to those in the softwood industry.

Additional data on veneer and plywood production are provided by the 1987 Census of Manufactures in Tables 2-1 and 2-2. In 1987, 231 plants produced \$4.395 billion worth of softwood plywood and veneer, while a larger number of hardwood plants, (310) produced \$1.832 billion in plywood and veneer products.

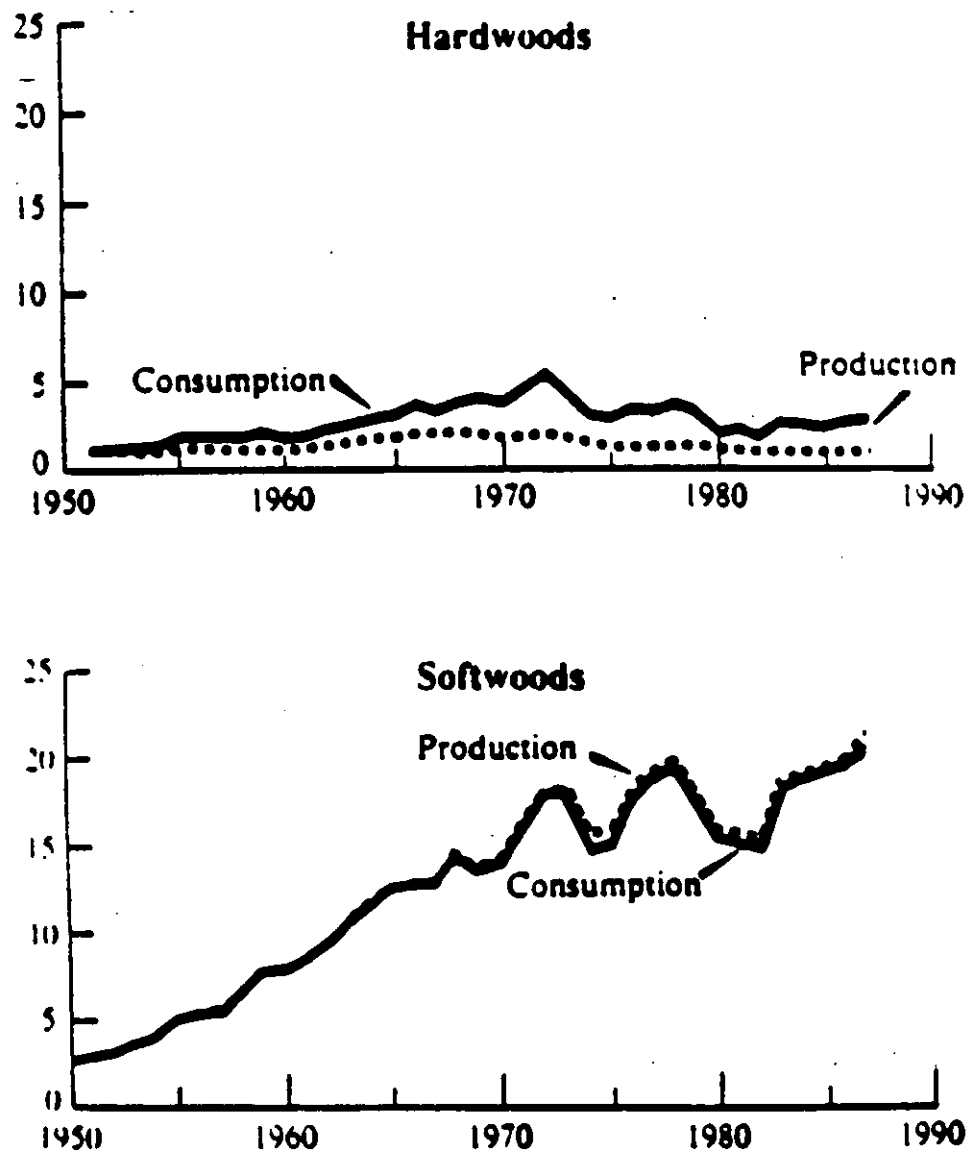


Figure 2-1. Plywood production and consumption trends.³
(Billion square feet, 3/8-in. basis)

TABLE 2-1. SOFTWOOD VENEER AND PLYWOOD 1987 PRODUCTION¹

SIC code	Product	No. of plants	No. of plants with shipments $\geq$ \$100,000	Product shipments ^a	
				10^6 m^3 (MM ft ³)	\$ million
2436	Softwood veneer and plywood (total)	231	NA	NA	4,395
24363	Softwood plywood products		NA	NA	148
24364	Softwood veneer, not reinforced on back		59	643 (6,926)	NA
24365	Softwood plywood, rough		48	1,445 (15,551)	2,292
24366	Softwood plywood, sanded		36	365 (3,929)	756
24367	Softwood, plywood specialties		26	249 (2,684)	583
24360	Softwood veneer and plywood, not specified by kind		NA	NA	86

NA = Data not available.

^aNumbers do not add to totals due to incomplete industry information.

TABLE 2-2. HARDWOOD VENEER AND PLYWOOD 1987 PRODUCTION¹

SIC code	Product	No. of plants	No. of plants with shipments ≥ \$100,000	Product shipments ^a	
				10 ⁶ m ² (MMft ²)	\$ million
2435	Hardwood veneer and plywood (total)	310	NA	NA	1,832
24351	Hardwood plywood products	53	69 [sic]	103 (1,113)	759
24352	Prefinished hardwood plywood made from purchased plywood	17	16	137 (1,471)	313
24354	Hardwood veneer, not reinforced on back	91	> 159 [sic]	382 (4,113)	421
24350	Hardwood veneer and plywood, not specified by kind	NA	NA	NA	104

NA = Data not available.

^aNumbers do not add to totals due to incomplete industry information.

Table 2-3 provides information on plant locations and the number of plants and employees. For softwood plywood and veneer production, the leading States in employment in 1987 were Oregon, Washington, Louisiana, and Texas, which account for 63 percent of the industry's employment. For hardwood plywood and veneer, the leading States in employment were North Carolina, Indiana, Wisconsin, and Virginia, which account for 47 percent of the industry's employment.

2.2 PROCESS DESCRIPTION⁴⁻⁶

The manufacture of plywood consists of seven main processes: debarking, heating the logs, peeling the logs into veneers (thin sheets), drying the veneers, gluing the veneers together, pressing the veneers in a hot press, and finishing processes such as sanding and trimming. Figure 2-2 provides a generic process flow diagram for a plywood mill.

The initial step of debarking is accomplished by feeding the 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. Although the different types of machines function somewhat differently, emissions from the different machines are expected to be comparable.

The logs (now referred to as blocks) are then 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.

After heating, the logs are processed to generate veneer. For most applications a veneer lathe is used, but ^{some} decorative, high quality ^{veneer} plywood is generated with a veneer slicer. The slicer and veneer lathe both work on the same principal; 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. These pieces are then clipped to a useable 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 less than ¹10 to 15 percent. Target moisture contents depend on the type of resin used in subsequent gluing steps. The veneer dryer may be ~~a rotary~~ ^{a longitudinal} dryer, which

(~~the~~ longitudinal
dryers are still
being installed)

? (how many?)

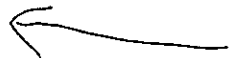


TABLE 2-3. LEADING STATES IN EMPLOYMENT IN 1987 PLYWOOD¹

Industry	State	Total with ≥ employees	Total No. of plants	Total No. of plants by size ^a		
				Small	Medium	Large
SIC 2435	NC	40	64			
Hardwood,	IN	27	33			
veneer	WI	12	18			
plywood	VA	12	20			
	Total U.S.	213	310	97	153	60
	Top four as percent of U.S.					47%
SIC 2436,	OR	80	85			
Softwood,	WA	21	27			
veneer	LA	11	12			
plywood	TX	10	11			
	Total U.S.	190	231	41	58	132
	Top four as percent of U.S.					63%

^aSmall: with 1 to 19 employees

Medium: with 20 to 99 employees

Large: with 100 or more employees

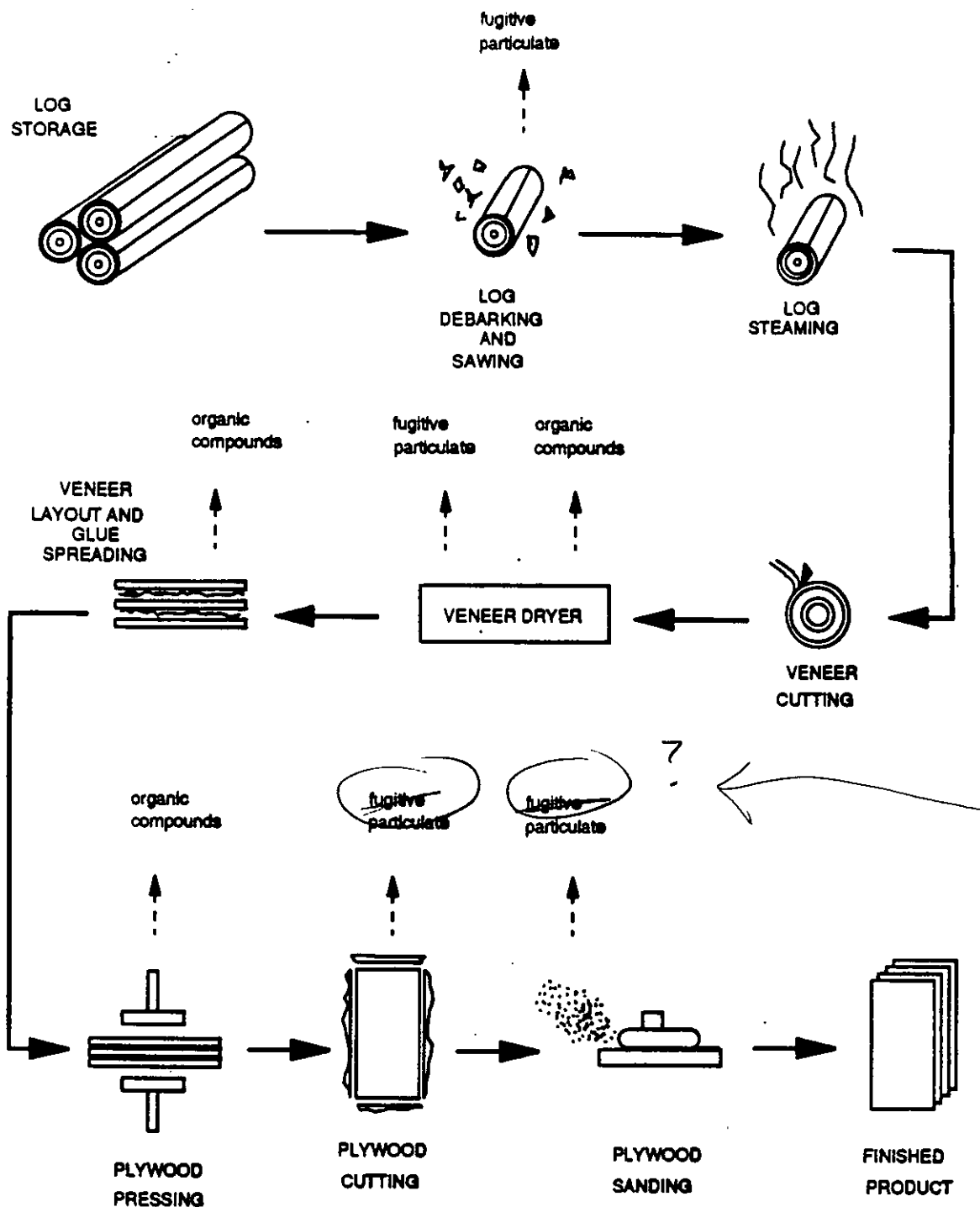


Figure 2-2. Generic process flow diagram for a plywood mill.

circulates air parallel to the veneer, or a newer 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. *The typical drying temperature is 300-400°F. 149° - 204°C*

When the veneers have been dried to their specified moisture content, they are glued together with a thermosetting resin. The two main types of resins are phenol-formaldehyde, used for softwood and exterior grades of hardwood, and urea-formaldehyde, which is used to glue interior grades of hardwood. The resins are applied by glue spreaders, *curtain coaters, or spray systems. Spreaders* 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 unspread veneer.

Assembly of the plywood panels must be symmetrical on either side of a neutral center in order to avoid excessive warpage. ~~Consequently, most plywood is constructed of an odd number of veneer plies, usually five, laid up in the following manner:~~ *For example, a 5-ply panel would be* a back, with the grain direction parallel to the long axis of the panel, is placed on the assembly table. The next veneer will have a grain direction perpendicular to that of the back, and will be spread with resin on both sides. Then comes the center, with no resin, and with the grain perpendicular to the previous veneer (parallel with the back). The fourth veneer will have a grain perpendicular to the previous veneer (parallel with the short axis of the panel) and will be 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.

(A large amount of 4-ply plywood is produced)

The laid-up assembly of veneers is then 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 the entire sheet of ~~plywood~~ *veneer*; and (2) to activate the thermosetting resins. Typical press temperatures are 115°C (240°F), while press times range from 2 to 7 minutes. The time and temperature vary depending on the wood used, the resin used, and the press design.

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

2.3 EMISSIONS⁵⁻¹³

No HAPs in drying, unless the dryer is "direct-fired." (Steam-heated dryers do not emit HAPs)

The primary emissions from the manufacture of plywood include particulate matter (PM and PM-10) from wood cutting and processing, PM emissions from drying, and organic compounds that include volatile organic compounds (VOC's) and hazardous air pollutants (HAP's) from drying operations, and the gluing and hot press processes. Fuel combustion for material drying can also generate carbon monoxide (CO), carbon dioxide (CO₂), and nitrogen oxide (NO_x) emissions. However, only limited CO data and no emission data for CO₂ and NO_x were located as a part of this AP-42 update.

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. The two discernible fractions released from the dryer are condensibles and volatiles. The condensible organic compounds consist largely of *sesquiterpenes, wood resins, resin acids, and wood sugars*. As these condensible compounds cool after being emitted from the stack to temperatures below 21°C (70°F), they often combine with water vapor to form *aerosols* which can cause blue haze. The other fraction, VOC's, comprises terpenes along with small quantities of volatile combustion by-products (where direct-fired units are used).

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 type of resin used. However, few test data are available for the hot presses.

Sanders and trim saws normally have control devices, but small amounts of fugitives may be released.
~~Plywood cutting and sanding operations are the major sources of uncontrolled fugitive PM from a plywood mill. Significant quantities of sawdust and other small wood particles are generated by these trimming and finishing operations. Log debarking, log sawing, and sawdust handling are additional sources of fugitive PM emissions. Emissions from such woodworking and waste collection operations are not addressed herein but are discussed in Section 10.1. Finally, fugitive PM emissions are generated from open dust sources such as sawdust storage and vehicular traffic. Emissions from these operations are discussed in more detail in AP-42 Chapter 11.~~

2.4 CONTROL TECHNOLOGY⁵⁻¹⁴

Methods of controlling emissions from the veneer dryer include multiple spray chambers, a packed tower combined with a cyclonic collector, a sand filter scrubber, an ionizing wet scrubber (IWS), an electrified filter bed (EFB), and a wet electrostatic precipitator (W-ESP). The first three devices are older technologies that are being replaced with newer technologies that combine electrostatic processes with other scrubbing or filtration processes. All of these systems control both PM and condensible organic emissions. No add-on control systems are known to be used for controlling the VOC emissions from veneer dryers. ~~However, some plants direct dryer exhaust through their boilers to combust VOC's and other pollutants.~~ *(One mill still does this) ✓*

In multiple spray chamber systems, the dryer exhaust is routed through a series of chambers in which water is used to capture pollutants. The water is then separated from the exhaust stream in a demisting zone. Use of multiple spray chambers is probably the most common control technology used on veneer dryers today. However, because they provide only limited removal of PM, PM-10, and condensible organic emissions, they are ~~quickly~~ being replaced with newer, more effective techniques. The packed tower/cyclonic collector comprises a spray chamber, a cyclonic collector, and a packed tower in series. Applications of this system are also limited as newer, more efficient controls are applied. The sand filter scrubber incorporates a wet scrubbing section followed by a wet-sand filter and mist eliminator. The larger PM is removed in the scrubber, while a portion of the remaining organic material is collected in the filter bed or the mist eliminator. This scrubbing system is also becoming obsolete as newer, more efficient controls are applied.

Two emerging technologies for controlling veneer dryer emissions are the IWS and the EFB. The IWS combines electrostatic forces with packed bed scrubbing techniques to remove pollutants from the exhaust stream. Because applications of these systems are relatively recent, their performance has not been fully evaluated for veneer dryer emission control. The EFB uses electrostatic forces to attract pollutants to an electrically charged moving gravel bed. The EFB is another newer device that has not been fully evaluated.

The W-ESP 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. The W-ESP is also relatively new to the industry, and performance data are somewhat limited.

Emissions from sawing and sanding operations are generally controlled with cyclonic collectors (cyclones). 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.

Fugitive emissions coming from road dust and uncovered bark and dust storage piles are 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 11.

Little information is available on control devices for plywood pressing operations, as these operations are generally uncontrolled. However, one test report indicates that hot press emissions at one facility are captured by a large hood placed over and around the hot press and cooling station. The captured emissions are ducted to a packed-bed caustic scrubber. The scrubber has a diameter of 1.5m (5 ft) and contains 3.7m (12 ft) of Tellerette packing followed by a chevron blade demister. Formaldehyde collected in the scrubber is converted to sodium formate and discharged to the sewer.

REFERENCES FOR SECTION 2

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14. Source Test Report--Woodtech, Inc., Bluefield, Virginia, prepared for Woodtech, Inc., by Environmental Quality Management, Inc., and Pacific Environmental Services, January 1992.

3. GENERAL DATA REVIEW AND ANALYSIS

3.1 LITERATURE SEARCH AND SCREENING

Data for this investigation were obtained from a number of sources within the Office of Air Quality Planning and Standards (OAQPS) and from outside organizations. The AP-42 Background Files located in the Emission Inventory Branch (EIB) were reviewed for information on the industry, processes, and emissions. The Crosswalk/Air Toxic Emission Factor Data Base Management System (XATEF) and VOC/PM Speciation Data Base Management System (SPECIATE) were searched by SCC code for identification of the potential pollutants emitted and emission factors for those pollutants. A general search of the Air CHIEF CD-ROM also was conducted to supplement the information from these two data bases.

Information on the industry, including number of plants, plant location, and annual production capacities was obtained from the 1987 Census of Manufactures.

Numerous sources of information were investigated specifically for emission test reports and data. A search of the Test Method Storage and Retrieval (TSAR) data base was conducted to identify test reports for sources within the plywood industry. Copies of these test reports were obtained from the files of the Emission Measurement Branch (EMB). The EPA library was searched for additional test reports. Publications lists from the Office of Research and Development (ORD) and Control Technology Center (CTC) were also searched for reports on emissions from the plywood industry. In addition, representative trade associations, including the National Council for Air and Stream Improvement, Inc. (NCASI), were contacted for assistance in obtaining information about the industry and emissions.

To screen out unusable test reports, documents, and information from which emission factors could not be developed, the following general criteria were used:

1. Emission data must be from a primary reference or traceable to facility-specific test data:
 - a. Source testing must be from a referenced study that does not reiterate information from previous studies.

b. The document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document. If the exact source of the data could not be determined, the document was eliminated.

2. The referenced study must contain test results based on more than one test run. In some instances one run of a larger test series is used to characterize emissions from the same operation, using a different wood species. In these cases, the one run will be given the same rating as the other test runs (if appropriate) and averaged with data of a similar species.

3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions (e.g., one-page reports were generally rejected).

A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria.

3.2 EMISSION DATA QUALITY RATING SYSTEM¹

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were excluded from consideration:

1. Test series averages reported in units that cannot be converted to the selected reporting units;
2. Test series representing incompatible test methods (i.e., comparison of EPA Method 5 front half with EPA Method 5 front and back half);
3. Test series of controlled emissions for which the control device is not specified;
4. Test series in which the source process is not clearly identified and described; and
5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Test data sets that were not excluded were assigned a quality rating. The rating system used was that specified by EIB for preparing AP-42 sections. The data were rated as follows:

A--Multiple tests that were performed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B--Tests that were performed by a generally sound methodology but lack enough detail for adequate validation.

C--Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

D--Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When such deviations occurred, the extent to which such alternative procedures could influence the test results was evaluated.

3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operation are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.

4. Laboratory analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM¹

The quality of the emission factors developed from analysis of the test data was rated using the following general criteria:

A--Excellent: Developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

B--Above average: Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. The source category is specific enough so that variability within the source category population may be minimized.

C--Average: Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

D--Below average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E--Poor: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There

also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

The use of these criteria is somewhat subjective and depends to an extent upon the individual reviewer. Details of the rating of each candidate emission factor are provided in Section 4 of this report.

REFERENCES FOR SECTION 3

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