EPA Region 10 HAP and VOC Emission Factors for Veneer Dryer Employing Indirect Steam Heat without Air Pollution Controls, February 2016

This spreadsheet calculates and compiles volatile organic compound (VOC) and hazardous air pollutant (HAP) emission factors in units of pounds of pollutant per thousand square feet 3/8 inch veneer dried (lb/msf 3/8") that are preferred by EPA Region 10 for estimating emissions generated by veneer dryer employing indirect steam heat without air pollution controls. The factors specify separate emission rates for veneer heating, veneer cooling and veneer dryer leaks across three separate categories of wood species; non-resinous softwood, resinous softwood outside the pine family and resinous softwood within the pine family. The emission factors are based on facility-scale emissions testing of white fir (non-resinous softwood), douglas fir (resinous softwood non-pine family) and ponderosa pine (resinous softwood pine family) veneer drying at four Pacific Northwest plywood mills. The testing was conducted by the National Council for Air and Stream Improvement (NCASI), and the test results are published in its Technical Bulletin No. 768. Some of those test results have been amended based upon information NCASI presented to EPA Region 10 on October 14, 2015 and February 3, 2016. Copies of those submittals are provided at the conclusion of this document.

A summary of the emission factors for each category of wood species is included on this sheet. The sheets that follow present the original test data as well as the calculations for creating each emission factor. To assure adequate conservatism for use in applicability determinations and compliance assurance applications, the emission factors represent the 90th percentile of the data when three or more test values are available and the maximum test value of the data when less than three test values are available.

Dryer Activity	WPP1 VOC[1,2] (lb/msf 3/8")	Total HAP (lb/msf 3/8")	Hazardous Air Pollutant Emissions (lb/msf 3/8")							
			Acetaldehyde	Formaldehyde	Methanol	Methyl Isobutyl Ketone	Phenol	Propionaldehyde	m,p-Xylene	o-Xylene
Species: Non-Resinous Softwood (e.g. white fir[3], western hemlock and western red cedar)										
Heating	0.3119	0.1722	0.0392	0.0364	0.0832	0	0.0045	0.0079	0.0010	0
Cooling	0.0295	0.0136	0.0042	0	0.0025	0	0	0	0.0043	0.0026
Leaking	0.0026	0.0026	0	0	0.0026	0	0	0	0	0
TOTAL	0.3440	0.1884	0.0434	0.0364	0.0883	0	0.0045	0.0079	0.0053	0.0026
Species: Resinous Softwood Non-Pine Family (e.g. douglas fir, engelman spruce and larch)										
Heating	0.9208	0.1574	0.0555	0.0273	0.0581	0	0.0105	0.0060	0	0
Cooling	0.0286	0.0171	0.0042	0	0.0039	0	0.0091	0	0	0
Leaking	0.0026	0.0026	0	0	0.0026	0	0	0	0	0
TOTAL	0.9520	0.1771	0.0597	0.0273	0.0646	0	0.0196	0.0060	0	0
Species: Resinous Softwood Pine Family (e.g. lodgepole pine, ponderosa pine and western white pine)										
Heating	1.8318	0.0740	0.0141	0.0074	0.0460	0	0	0.0064	0	0
Cooling	0.0112	0	0	0	0	0	0	0	0	0
Leaking	0.0039	0.0039	0	0	0.0039	0	0	0	0	0
TOTAL	1.8469	0.0779	0.0141	0.0074	0.0499	0.0000	0	0.0064	0	0

[1] VOC emissions have been approximated consistent with EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC). Employing WPP1 VOC underestimates emissions when the mass-to-carbon ratio of unidentified VOC exceeds that of propane. Ethanol and acetic acid are examples of two VOC's that are likely emitted during veneer drying (each is known to be generated during lumber drying), and both have mass-to-carbon ratios exceeding that of propane. In addition, the chemical make-up of both ethanol and acetic acid results in a suppressed RM25A FID response. Because neither of these compounds was among the 20 analyzed in support of NCASI TB No. 768, we are unable to conclude that these VOC are actually emitted during veneer drying.

[2] Because RM25A testing was not conducted to measure THC as carbon emissions generated by leaks in veneer dryers, WPP1 VOC for "Leaking" only reflects

[3] White fir in this context refers to any one of several species of true fir grown in the West. The collection of timber commonly referred to as "white fir" includes the following species: white fir, grand fir, noble fir and subalpine fir.

EPA Region 10 WPP1 VOC Emission Factor for Heating Pacific Northwest Non-Resinous Softwood Veneer via Indirect Steam Heat without Air Pollution Controls

This sheet presents full-scale emissions test data for heating, without air pollution controls, Pacific Northwest non-resinous softwood veneer via indirect steam heat as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data and EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC), EPA Region 10 has calculated a veneer heating VOC emission factor of 0.3119 lb/msf (3/8 inch) for any one of several non-resinous softwood species including the one tested; white fir. White fir refers to any one of several species of true fir grown in the West commonly referred to as "white fir." True fir includes the following species: white fir, grand fir, noble fir and subalpine fir; all classified in the same Abies genus.

To calculate WPP1 VOC emissions, EPA Region 10 employed NCASI test results quantifying both total and speciated VOC. NCASI employed EPA Reference Method 25A (RM25A) to measure VOC emissions not quantified through speciated sampling and analysis. Because RM25A quantifies total hydrocarbon (THC) emissions (and because THC and VOC are not quite the same), some adjustments to the RM25A results were necessary to determine VOC emissions. NCASI reported RM25A results “as carbon” which only accounts for the carbon portion of the compounds measured. EPA Region 10 adjusted the RM25A results to express THC “as propane” to better approximate the VOC compounds generated by veneer drying. RM25A results were further adjusted to deduct that portion attributable to acetone as acetone is not a VOC. The contribution of certain VOC compounds (already quantified through speciated sampling and analysis) to RM25A results have been deducted to avoid double-counting. These adjustments to RM25A results are consistent with EPA’s Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC). Finally, for each test run, the modified RM25A emission rate is added to speciated HAP emission rates to calculate WPP1 VOC. The resultant VOC emission factor is based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

In certain instances, one or two of the runs at a particular dryer would result in an actual measurement of a hydrocarbon while the other run(s) would result in a non-detect. For those runs resulting in a non-detect, a substitute value has been generated to reflect what we think the actual measurement may have been had detection been possible. The substitute values are noted in **bold** and reflect the lesser of (a) the pollutant-specific method detection limit for that run or (b) a calculated value (Compound X_{RUNA}) representing mass emission rate of undetected individual compound "Compound X" during test run "Run A." The value for Compound X_{RUNA} is determined by multiplying known $\Sigma HC_{i\ RUNA}$ by the known ratio of Compound X_{RUNB} to $\Sigma HC_{i\ RUNB}$. Compound X_{RUNA} = ($\Sigma HC_{i\ RUNA}$) X (Compound X_{RUNB} / $\Sigma HC_{i\ RUNB}$) where $\Sigma HC_{i\ RUNA}$ is the summation of measurements of individual hydrocarbons (HC) during Run A except for Compound X and any other hydrocarbons not detected in Run A and/or Run B. Example calculations are provided below for illustration.

Step No. 1: Summarize test results

Emission Test Run ID	Run 115-XDV2N2	Run 115-XDV2N3	Run 155-XDV2N1	Run 155-XDV2N2	Run 155-XDV2N3
Facility No.	115	115	155	155	155
Veneer Dryer No.	1, 2 & 3	1, 2 & 3	1, 2 & 3	1, 2 & 3	1, 2 & 3
Veneer Dryer Type	J	J	No. 1 & 2: J; No. 3: L	No. 1 & 2: J; No. 3: L	No. 1 & 2: J; No. 3: L
Wood Species	WF	WF	WF	WF	WF
Sampling Location Up/Downstream of Water Quench	down	down	up	up	up
Miscellaneous Notes	quench begins in dryer headers	quench begins in dryer headers	veneer from offsite	veneer from offsite	veneer from offsite
NCASI TB768 Page No.	43-54 & B16	43-54 & B16	55-64 & B25	55-64 & B25	55-64 & B25

	Mass Emission Rate as Measured (lb/msf 3/8")				
Pollutant/Compound (as measured)	Run 115-XDV2N2	Run 115-XDV2N3	Run 155-XDV2N1	Run 155-XDV2N2	Run 155-XDV2N3
THC as carbon	0.17	0.15	0.097	0.11	0.10
Acetaldehyde	0.040	0.038	0.0022	**0.0022**	**0.0024**
Acetone (non-VOC)	0.031	0.023	0.0050	0.0083	0.010
Formaldehyde	0.040	0.031	0.0064	0.0023	0.013
Methanol	0.073	0.090	0.044	0.044	0.054
Phenol	0	0	0.0045	**0.0044**	**0.0044**
Propionaldehyde	0.0066	0.0088	0	0	0
m,p-Xylene	0	0	**0.00079**	**0.00078**	0.0011

Example calculation to estimate m,p-xylene emission rate for Run 155-XDV2N1 based upon Run 155-XDV2N3 emission measurements while similarly heating white fir veneer in the same dryer:

m,p-$xylene_{RUN155\text{-}XDV2N1}$ = ($\Sigma HC_{i\ RUN155\text{-}XDV2N1}$) X (m,p-$xylene_{RUN155\text{-}XDV2N3}$ / $\Sigma HC_{i\ RUN155\text{-}XDV2N3}$)

m,p-$xylene_{RUN\ 155\text{-}XDV2N1}$ = (0.0050+0.0064+0.044) X (0.0011) / (0.010+0.013+0.054) = 0.00079 lb/msf 3/8"

Because the estimated value for m,p-$xylene_{RUN155\text{-}XDV2N1}$ of 0.00079 lb/msf 3/8" is less than the test method detection limit of 0.00081 lb/msf 3/8" for that run, the calculated value of 0.00079 lb/msf 3/8" is substituted.

Step No. 2: Convert measurements to a common propane basis

$Compound_X$ expressed as propane = ($Compound_X$) X [($MW_{propane}$) / ($MW_{Compound\ X}$)] X [($\#C_{Compound\ X}$) / ($\#C_{propane}$)]

where: $Compound_X$ represents mass emission rate of $Compound_X$

$MW_{propane}$ equals "44.0962" and represents the molecular weight for propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

$MW_{Compound\ X}$ represents the molecular weight for $Compound_X$

$\#C_{compound\ X}$ equals number of carbon atoms in $Compound_X$

$\#C_{propane}$ equals "3" as three carbon atoms are present within propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

Pollutant/Compound (as propane)	Mass Emission Rate as Propane (lb/msf 3/8") Run 115-XDV2N2	Run 115-XDV2N3	Run 155-XDV2N1	Run 155-XDV2N2	Run 155-XDV2N3
THC	0.2080	0.1836	0.1187	0.1346	0.1224
Acetaldehyde	0.0267	0.0254	0.0015	0.0014	0.0016
Acetone (non-VOC)	0.0235	0.0175	0.0038	0.0063	0.0076
Formaldehyde	0.0196	0.0152	0.0031	0.0011	0.0064
Methanol	0.0335	0.0413	0.0202	0.0202	0.0248
Phenol	0	0	0.0042	0.0041	0.0041
Propionaldehyde	0.0050	0.0067	0	0	0
m,p-Xylene	0	0	0.0009	0.0009	0.0012

Example calculation to convert acetone as measured$_{Run155\text{-}XDV2N1}$ to acetone as propane:
Acetone as propane$_{RUN155\text{-}XDV2N1}$ = (Acetone$_{RUN155\text{-}XDV2N1}$) X [(MW$_{propane}$) / (MW$_{acetone}$)] X [(#C$_{acetone}$) / (#C$_{propane}$)]
Acetone as propane$_{RUN155\text{-}XDV2N1}$ = (0.0050) X (44.0962/58.0798) X (3/3) = 0.0038 lb/msf 3/8"

Step No. 3: Calculate the contribution of individual compounds to THC analyzer measurements as propane

Compound$_X$ expressed as propane by analyzer = (Compound$_X$ expressed as propane) X (RF$_{Compound\ X}$)
where: RF$_{Compound\ X}$ represents the flame ionization detector (FID) response factor (RF) for Compound$_X$

Because THC was measured using a THC analyzer, we already know THC analyzer measurement of THC.

Pollutant/Compound (as propane per THC analyzer)	Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8") Run 115-XDV2N2	Run 115-XDV2N3	Run 155-XDV2N1	Run 155-XDV2N2	Run 155-XDV2N3
Acetaldehyde	0.0133	0.0127	0.0007	0.0007	0.0008
Acetone (non-VOC)	0.0157	0.0116	0.0025	0.0042	0.0051
Formaldehyde	0	0	0	0	0
Methanol	0.0167	0.0206	0.0101	0.0101	0.0124
Phenol	0	0	0.0039	0.0038	0.0038
Propionaldehyde	0.0033	0.0045	0	0	0
m,p-Xylene	0	0	0.0009	0.0009	0.0012

Example calculation to determine amount of formaldehyde measured by the THC analyzer as propane$_{RUN155\text{-}XDV2N3}$:
Formaldehyde as propane$_{RUN155\text{-}XDV2N3}$ per THC analyzer = (Formaldehyde as propane$_{RUN155\text{-}XDV2N3}$) X (RF$_{formaldehyde}$)
Formaldehyde as propane$_{RUN155\text{-}XDV2N3}$ per THC analyzer = (0.0064) X (0) = 0 lb/msf 3/8"

Step No. 4: Subtract the contribution of individual compounds measured by the THC analyzer as propane (Step No. 3) from the THC measurement as propane (Step No. 2)

Pollutant/Compound (as propane per THC analyzer)	Mass Emission Rate (lb/msf 3/8") Run 115-XDV2N2	Run 115-XDV2N3	Run 155-XDV2N1	Run 155-XDV2N2	Run 155-XDV2N3
THC	0.2080	0.1836	0.1187	0.1346	0.1224
Acetaldehyde	-0.0133	-0.0127	-0.0007	-0.0007	-0.0008
Acetone (non-VOC)	-0.0157	-0.0116	-0.0025	-0.0042	-0.0051
Formaldehyde	0	0	0	0	0
Methanol	-0.0167	-0.0206	-0.0101	-0.0101	-0.0124
Phenol	0	0	-0.0039	-0.0038	-0.0038
Propionaldehyde	-0.0033	-0.0045	0	0	0
m,p-Xylene	0	0	-0.0009	-0.0009	-0.0012
THC as propane w/o acetone and w/o double-counting VOC$_i$	0.1589	0.1341	0.1006	0.1150	0.0991

Step No. 5: Calculate WPP1 VOC by adding the contribution of individual VOCs (Step No. 1) to the adjusted THC value (Step No. 4)

Pollutant/Compound	Mass Emission Rate (lb/msf 3/8") Run 115-XDV2N2	Run 115-XDV2N3	Run 155-XDV2N1	Run 155-XDV2N2	Run 155-XDV2N3
THC as propane w/o acetone and w/o double-counting VOC$_i$	0.1589	0.1341	0.1006	0.1150	0.0991
Acetaldehyde as measured	0.0400	0.0380	0.0022	**0.0022**	**0.0024**
Formaldehyde as measured	0.0400	0.0310	0.0064	0.0023	0.0130
Methanol as measured	0.0730	0.0900	0.0440	0.0440	0.0540
Phenol as measured	0	0	0.0045	**0.0044**	**0.0044**
Propionaldehyde as measured	0.0066	0.0088	0	0	0
m,p-Xylene as measured	0	0	**0.00079**	**0.00078**	0.0011
WPP1 VOC	0.3185	0.3019	0.1585	0.1686	0.1740

Step No. 6: Calculate WPP1 VOC emission factor equal to 90th percentile value of 5 runs

WPP1 VOC (5-run 90th percentile value):	0.3119 lb/msf 3/8"
5-run average value (informational purposes only)	0.2243 lb/msf 3/8"

Reference Information

Element and Compound Information

Element / Compound	FID RF	MW (lb/lb-mol)	Formula	Carbon Atoms	Hydrogen Atoms	Oxygen Atoms
Acetaldehyde	0.5	44.0530	C_2H_4O	2	4	1
Acetone (non-VOC)	0.6667	58.0798	C_3H_6O	3	6	1
Acrolein	0.6667	56.0640	C_3H_4O	3	4	1
Benzene	1	78.1134	C_6H_6	6	6	0
3-carene	1	136.2364	$C_{10}H_{16}$	10	16	0
Formaldehyde	0	30.0262	CH_2O	1	2	1
Methanol	0.5	32.0420	CH_4O	1	4	1
Methyl Ethyl Ketone	0.75	72.1066	C_4H_8O	4	8	1
Methyl Isobutyl Ketone	0.8333	100.1602	$C_6H_{12}O$	6	12	1
Phenol	0.9167	94.1128	C_6H_6O	6	6	1
Alpha-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Beta-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Propionaldehyde	0.6667	58.0798	C_3H_6O	3	6	1
Toluene	1	92.1402	C_7H_8	7	8	0
m,p-Xylene	1	106.1670	C_8H_{10}	8	10	0
o-xylene	1	106.1670	C_8H_{10}	8	10	0
Propane	1	44.0962	C_3H_8	3	8	0
Carbon	-	12.0110	C	1	-	-
Hydrogen	-	1.0079	H	-	1	-
Oxygen	-	15.9994	O	-	-	1

FID RF = ECN / No. carbon atoms in compound. See Attachment No. 2 to NCASI's September 2011 Technical Bulletin No. 991 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. In the absence of information related to the FID NCASI employed to conduct RM25A testing, empirical effective carbon number (ECN) values will be employed to estimate FID RF.

ECN = (no. aliphatic carbon) + (no. aromatic carbon) - (no. ether oxygen) - (0.5 x no. primary alcohol oxygen)

Calculations to estimate ECN for several compounds:

Element / Compound	Formula	No. Aliphatic Carbon	No. Aromatic Carbon	No. Carbonyl Carbon	No. Carboxyl Carbon	No. Ether Oxygen	No. Primary Alcohol Oxygen	Empirical ECN
Acetaldehyde	CH_3CHO	1		1				1
Acetone (non-VOC)	$(CH_3)_2CO$	2		1				2
Acrolein	CH_2CHCHO	2		1				2
Benzene	C_6H_6		6					6
3-carene	$C_{10}H_{16}$	10						10
Formaldehyde	CH_2O							0
Methanol	CH_3OH	1					1	0.5
Methyl Ethyl Ketone	$CH_3C(O)CH_2CH_3$	3		1				3
Methyl Isobutyl Ketone	$(CH_3)_2CHCH_2C(O)CH_3$	5		1				5
Phenol	C_6H_5OH		6				1	5.5
Alpha-pinene	$C_{10}H_{16}$	10						10
Beta-pinene	$C_{10}H_{16}$	10						10
Propane	C_3H_8	3						3
Propionaldehyde	CH_3CH_2CHO	2		1				2
Toluene	$C_6H_5CH_3$	1	6					7
m,p-Xylene	$C_6H_4CH_3CH_3$	2	6					8
o-xylene	$C_6H_4CH_3CH_3$	2	6					8

<u>Abbreviations/Acronyms</u>

DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 WPP1 VOC Emission Factor for Heating Pacific Northwest Resinous Softwood Non-Pine Family Veneer via Indirect Steam Heat without Air Pollution Controls

This sheet presents full-scale emissions test data for heating, without air pollution controls, Pacific Northwest resinous softwood non-pine family veneer via indirect steam heat as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data and EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC), EPA Region 10 has calculated a <u>veneer heating VOC emission factor of 0.9208 lb/msf (3/8 inch)</u> for any one of several resinous softwood non-pine family species including the one tested; douglas fir.

To calculate WPP1 VOC emissions, EPA Region 10 employed NCASI test results quantifying both total and speciated VOC. NCASI employed EPA Reference Method 25A (RM25A) to measure VOC emissions not quantified through speciated sampling and analysis. Because RM25A quantifies total hydrocarbon (THC) emissions (and because THC and VOC are not quite the same), some adjustments to the RM25A results were necessary to determine VOC emissions. NCASI reported RM25A results “as carbon” which only accounts for the carbon portion of the compounds measured. EPA Region 10 adjusted the RM25A results to express THC “as propane” to better approximate the VOC compounds generated by veneer drying. RM25A results were further adjusted to deduct that portion attributable to acetone as acetone is not a VOC. The contribution of certain VOC compounds (already quantified through speciated sampling and analysis) to RM25A results have been deducted to avoid double-counting. These adjustments to RM25A results are consistent with EPA’s Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC). Finally, for each test run, the modified RM25A emission rate is added to speciated HAP emission rates to calculate WPP1 VOC. The resultant VOC emission factor is based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

In certain instances, one or two of the runs at a particular dryer would result in an actual measurement of a hydrocarbon while the other run(s) would result in a non-detect. For those runs resulting in a non-detect, a substitute value has been generated to reflect what we think the actual measurement may have been had detection been possible. The substitute values are noted in **bold** and reflect the lesser of (a) the pollutant-specific method detection limit for that run or (b) a calculated value (Compound X_{RUNA}) representing mass emission rate of undetected individual compound "Compound X" during test run "Run A." The value for Compound X_{RUNA} is determined by multiplying known $\Sigma HC_{i\ RUNA}$ by the known ratio of Compound X_{RUNB} to $\Sigma HC_{i\ RUNB}$. Compound $X_{RUNA} = (\Sigma HC_{i\ RUNA})$ X (Compound X_{RUNB} / $\Sigma HC_{i\ RUNB}$) where $\Sigma HC_{i\ RUNA}$ is the summation of measurements of individual hydrocarbons (HC) during Run A except for Compound X and any other hydrocarbons not detected in Run A and/or Run B. Example calculations are provided below for illustration.

<u>Step No. 1: Summarize test results</u>

Emission Test Run ID	Run 112-2DV5&6N3	Run 112-XDV2N1	Run 115-XDV2N1	Run 188-XDV2N1	Run 188-XDV2N2	Run 188-XDV2N3	Run 188-XDV2N4	Run 188-XDV2N5	Run 188-XDV2N6
Facility No.	112	112	115	188	188	0	188	188	188
Veneer Dryer No.	2	2&3	1, 2 & 3	1, 2, 3 & 4	1, 2, 3 & 4	1, 2, 3 & 4	1, 2, 3 & 4	1, 2, 3 & 4	1, 2, 3 & 4
Veneer Dryer Type	J	J	J	No.1,2&3:L; No.4:J	No.1,2&3:L; No.4:J	No.1,2&3:L; No.4:J	No.1,2&3:L; No.4:J	No.1,2&3:L; No.4:J	No.1,2&3:L; No.4:J
Wood Species	DF	DF	DF	DF	DF	DF	DF	DF	DF
Sampling Location Up/Downstream of Water Quench	up	down	down	up	up	up	up	up	up
Notes	results for dry and green sections combined	quench begins in chamber prior to cyclone/WESP	quench begins in dryer headers	fresh douglas fir	fresh douglas fir	fresh douglas fir	7-day old douglas fir	7-day old douglas fir	7-day old douglas fir
NCASI TB768 Page No.	26-42, B2 & B3	26-42 & B12	43-54 & B16	93-99 & B46	93-99 & B46	93-99 & B46	93-99 & B48	93-99 & B48	93-99 & B48

Mass Emission Rate as Measured (lb/msf 3/8")

Pollutant/Compound (as measured)	Run 112-2DV5&6N3	Run 112-XDV2N1	Run 115-XDV2N1	Run 188-XDV2N1	Run 188-XDV2N2	Run 188-XDV2N3	Run 188-XDV2N4	Run 188-XDV2N5	Run 188-XDV2N6
THC as carbon	0.75	0.35	0.19	0.50	0.47	0.51	0.43	0.47	0.68
Acetaldehyde	0.0233	0.012	0.027	0.0099	0.0068	0.0037	0.030	0.055	0.060
Acetone (non-VOC)	0.0063	0.0049	0.042	0.0067	0.0063	**0.0030**	0.0096	0.0086	0.0099
Formaldehyde	0.0086	0.0053	0.048	0.0073	0.011	**0.00019**	0.020	0.0044	0.025
Methanol	0.0254	0.015	0.036	0.017	0.017	**0.0028**	0.058	0.031	0.059
Phenol	0	0	0.015	0.0055	0.0056	0.0056	0.010	0.0084	0.0094
Alpha-pinene	0.223	0.16	0	0.23	0.22	0.22	0.19	0.20	0.29
Beta-pinene	**0.012**	0	0	0	0	0	0	0	0
Propionaldehyde	0	**0.0023**	0.035	0	0	0	0	0	0

Example calculation to estimate methanol emission rate for Run 188-XDV2N3 based upon Run 188-XDV2N1 and N2 emission measurements while similarly heating fresh douglas fir veneer:

$Methanol_{RUN188\text{-}XDV2N3} = 1/2\ [(\Sigma HC_{i\ RUN188\text{-}XDV2N3})\ X\ (Methanol_{RUN188\text{-}XDV2N1} / \Sigma HC_{i\ RUN188\text{-}XDV2N1}) + (\Sigma HC_{i\ RUN188\text{-}XDV2N2})\ X\ (Methanol_{RUN188\text{-}XDV2N2} / \Sigma HC_{i\ RUN188\text{-}XDV2N2})]$

$Methanol_{RUN\ 188\text{-}XDV2N3}$ = (0.5) X [((0.0037+0.0056+0.22) X (0.017) / (0.0099+0.0055+0.23)) + ((0.0037+0.0056+0.22) X (0.017) / (0.0068+0.0056+0.22))] = 0.0163 lb/msf 3/8"

Because the estimated value for $methanol_{RUN188\text{-}XDV2N3}$ of 0.0163 lb/msf 3/8" is greater than the test method detection limit of 0.0028 lb/msf 3/8" for that run, the detection limit value of 0.0028 lb/msf 3/8" is substituted instead of the calculated value.

Beta-pinene was not detected during Run 112-2DV6N3, but an emission rate has been assigned given the detection of this compound during Runs 112-2DV6N1 and N2 while similarly heating douglas fir veneer. Because the estimated value is greater than the test method detection limit of 0.12 lb/msf for Run 112-2DV6N3, the detection limit value of 0.012 lb/msf is substituted instead of the calculated value.

Mass Emission Rate as Measured (lb/msf 3/8")

Pollutant/Compound (as measured)	Run 112-2DV6N1 (green end)	Run 112-2DV6N2 (green end)	Run 112-2DV6N3 (green end)
THC as carbon	NMP	0.21	0.18
Acetaldehyde	0.0049	0.0012	0.0083
Acetone (non-VOC)	0.0040	0.0017	0.0018
Formaldehyde	0.0013	0.00059	0.0013
Methanol	0.011	0.0084	0.0094
Phenol	0	0	0
Alpha-pinene	0.18	0.11	0.093
Beta-pinene	0.020	0.014	**0.012**
Propionaldehyde	0	0	0

Run 112-2DV5N3 (dry end) and Run 112-2DV6N3 (green end) were conducted simultaneously and measured heating emissions (RM25A and speciated HAP) from each of the two exhausts serving the dryer's heating zone. Emissions for the entire heating zone were determined by adding together the test results from the simultaneous 2DV5N3 and 2DV6N3 runs. (Runs 2DV5&6N1 and N2 were not considered as (a) RM25A measurements were not simultaneously performed in each of the two exhausts and (b) measurements recorded were similar to those of 2DV5&6N3. And because XDV2N1 (downstream of 2DV5&6N1 and conducted simultaneously with 2DV5&6N1), is being considered, Run 2DV5&6N1 emissions are measured through XDV2N1 measurements already.

Pollutant/Compound (as measured)	Run 112-2DV5N3 (dry end)	Run 112-2DV6N3 (green end)	Run 112-2DV5&6N3 (combined)
	Mass Emission Rate as Measured (lb/msf 3/8")		
THC as carbon	0.57	0.18	0.75
Acetaldehyde	0.015	0.0083	0.0233
Acetone (non-VOC)	0.0045	0.0018	0.0063
Formaldehyde	0.0073	0.0013	0.0086
Methanol	0.016	0.0094	0.0254
Phenol	0	0	0
Alpha-pinene	0.13	0.093	0.223
Beta-pinene	0	**0.012**	**0.012**
Propionaldehyde	0	0	0

Propionaldehyde was not detected during Run 112-XDV2N1, but an emission rate has been assigned given the detection of this compound during Run 112-XDV2N3 while similarly heating douglas fir veneer. Because the estimated value is greater than the test method detection limit of 0.0023 lb/msf 3/8" for Run 112-XDV2N1, the detection limit value of 0.0023 lb/msf 3/8" is substituted instead of the calculated value.

Pollutant/Compound (as measured)	Run 112-XDV2N1	Run 112-XDV2N3
	Mass Emission Rate as Measured (lb/msf 3/8")	
THC as carbon	0.35	NMP
Acetaldehyde	0.012	0.018
Acetone (non-VOC)	0.0049	0.021
Formaldehyde	0.0053	0.017
Methanol	0.015	0.021
Phenol	0	0
Alpha-pinene	0.16	0.13
Beta-pinene	0	0
Propionaldehyde	**0.0023**	0.0028

Step No. 2: Convert measurements to a common propane basis

Compound_X expressed as propane = $(\text{Compound}_X) \times [(MW_{propane}) / (MW_{Compound\ X})] \times [(\#C_{Compound\ X}) / (\#C_{propane})]$

where: Compound_X represents mass emission rate of Compound_X

$MW_{propane}$ equals "44.0962" and represents the molecular weight for propane; the compound that is the "basis" for expressing mass of VOC per

$MW_{Compound\ X}$ represents the molecular weight for Compound_X

$\#C_{compound\ X}$ equals number of carbon atoms in Compound_X

$\#C_{propane}$ equals "3" as three carbon atoms are present within propane; the compound that is the "basis" for expressing mass of VOC per WPP1

Mass Emission Rate as Propane (lb/msf 3/8")

Pollutant/Compound (as propane)	Run 112-2DV5&6N3	Run 112-XDV2N1	Run 115-XDV2N1	Run 188-XDV2N1	Run 188-XDV2N2	Run 188-XDV2N3	Run 188-XDV2N4	Run 188-XDV2N5	Run 188-XDV2N6
THC	0.9178	0.4283	0.2325	0.6119	0.5752	0.6241	0.5262	0.5752	0.8322
Acetaldehyde	0.0155	0.0080	0.0180	0.0066	0.0045	0.0025	0.0200	0.0367	0.0400
Acetone (non-VOC)	0.0048	0.0037	0.0319	0.0051	0.0048	0.0023	0.0073	0.0065	0.0075
Formaldehyde	0.0042	0.0026	0.0235	0.0036	0.0054	0.0001	0.0098	0.0022	0.0122
Methanol	0.0117	0.0069	0.0165	0.0078	0.0078	0.0013	0.0266	0.0142	0.0271
Phenol	0	0	0.0141	0.0052	0.0052	0.0052	0.0094	0.0079	0.0088
Alpha-pinene	0.2406	0.1726	0	0.2482	0.2374	0.2374	0.2050	0.2158	0.3129
Beta-pinene	0.0129	0	0	0	0	0	0	0	0
Propionaldehyde	0	0.0017	0.0266	0	0	0	0	0	0

Example calculation to convert methanol as $\text{measured}_{RUN112\text{-}XDV2N1}$ to methanol as propane:

Methanol as $\text{propane}_{RUN112\text{-}XDV2N1}$ = $(\text{Methanol}_{RUN112\text{-}XDV2N1}) \times [(MW_{propane}) / (MW_{methanol})] \times [(\#C_{methanol}) / (\#C_{propane})]$

Methanol as $\text{propane}_{RUN112\text{-}XDV2N1}$ = (0.015) X (44.0962/32.0420) X (1/3) = 0.0069 lb/msf 3/8"

Step No. 3: Calculate the contribution of individual compounds to THC analyzer measurements as propane

Compound_X expressed as propane by analyzer = $(\text{Compound}_X$ expressed as propane$) \times (RF_{Compound\ X})$

where: $RF_{Compound\ X}$ represents the flame ionization detector (FID) response factor (RF) for Compound_X

Because THC was measured using a THC analyzer, we already know THC analyzer measurement of THC.

Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8")

Pollutant/Compound (as propane per THC analyzer)	Run 112-2DV5&6N3	Run 112-XDV2N1	Run 115-XDV2N1	Run 188-XDV2N1	Run 188-XDV2N2	Run 188-XDV2N3	Run 188-XDV2N4	Run 188-XDV2N5	Run 188-XDV2N6
Acetaldehyde	0.0078	0.0040	0.0090	0.0033	0.0023	0.0012	0.0100	0.0184	0.0200
Acetone (non-VOC)	0.0032	0.0025	0.0213	0.0034	0.0032	0.0015	0.0049	0.0044	0.0050
Formaldehyde	0	0	0	0	0	0	0	0	0
Methanol	0.0058	0.0034	0.0083	0.0039	0.0039	0.0006	0.0133	0.0071	0.0135
Phenol	0	0	0.0129	0.0047	0.0048	0.0048	0.0086	0.0072	0.0081
Alpha-pinene	0.2406	0.1726	0	0.2482	0.2374	0.2374	0.2050	0.2158	0.3129
Beta-pinene	0.0129	0	0	0	0	0	0	0	0
Propionaldehyde	0	0.0012	0.0177	0	0	0	0	0	0

Example calculation to determine amount of acetone measured by the THC analyzer as propane$_{RUN188\text{-}XDV2N1}$:

Acetone as propane$_{RUN188\text{-}XDV2N1}$ per THC analyzer = (Acetone as propane$_{RUN188\text{-}XDV2N1}$) X (RF$_{acetone}$)

Acetone as propane$_{RUN188\text{-}XDV2N1}$ per THC analyzer = (0.0051) X (0.6667) = 0.0034 lb/msf 3/8"

Step No. 4: Subtract the contribution of individual compounds measured by the THC analyzer as propane (Step No. 3) from the THC measurement as propane (Step No. 2)

	Mass Emission Rate (lb/msf 3/8")								
Pollutant/Compound (as propane per THC analyzer)	Run 112-2DV5&6N3	Run 112-XDV2N1	Run 115-XDV2N1	Run 188-XDV2N1	Run 188-XDV2N2	Run 188-XDV2N3	Run 188-XDV2N4	Run 188-XDV2N5	Run 188-XDV2N6
THC	0.9178	0.4283	0.2325	0.6119	0.5752	0.6241	0.5262	0.5752	0.8322
Acetaldehyde	-0.0078	-0.0040	-0.0090	-0.0033	-0.0023	-0.0012	-0.0100	-0.0184	-0.0200
Acetone (non-VOC)	-0.0032	-0.0025	-0.0213	-0.0034	-0.0032	-0.0015	-0.0049	-0.0044	-0.0050
Formaldehyde	0	0	0	0	0	0	0	0	0
Methanol	-0.0058	-0.0034	-0.0083	-0.0039	-0.0039	-0.0006	-0.0133	-0.0071	-0.0135
Phenol	0	0	-0.0129	-0.0047	-0.0048	-0.0048	-0.0086	-0.0072	-0.0081
Alpha-pinene	-0.2406	-0.1726	0	-0.2482	-0.2374	-0.2374	-0.2050	-0.2158	-0.3129
Beta-pinene	-0.0129	0	0	0	0	0	0	0	0
Propionaldehyde	0	-0.0012	-0.0177	0	0	0	0	0	0
THC as propane w/o acetone and w/o double-counting VOC_i	0.6475	0.2446	0.1634	0.3484	0.3236	0.3786	0.2845	0.3224	0.4726

Step No. 5: Calculate WPP1 VOC by adding the contribution of individual VOCs (Step No. 1) to the adjusted THC value (Step No. 4)

	Mass Emission Rate (lb/msf 3/8")								
Pollutant/Compound	Run 112-2DV5&6N3	Run 112-XDV2N1	Run 115-XDV2N1	Run 188-XDV2N1	Run 188-XDV2N2	Run 188-XDV2N3	Run 188-XDV2N4	Run 188-XDV2N5	Run 188-XDV2N6
THC as propane w/o acetone and w/o double-counting VOC_i	0.6475	0.2446	0.1634	0.3484	0.3236	0.3786	0.2845	0.3224	0.4726
Acetaldehyde as measured	0.0233	0.0120	0.0270	0.0099	0.0068	0.0037	0.0300	0.0550	0.0600
Formaldehyde as measured	0.0086	0.0053	0.0480	0.0073	0.0110	**0.00019**	0.0200	0.0044	0.0250
Methanol as measured	0.0254	0.0150	0.0360	0.0170	0.0170	**0.0028**	0.0580	0.0310	0.0590
Phenol as measured	0	0	0.0150	0.0055	0.0056	0.0056	0.0100	0.0084	0.0094
Alpha-pinene as measured	0.2230	0.1600	0	0.2300	0.2200	0.2200	0.1900	0.2000	0.2900
Beta-pinene as measured	**0.012**	0	0	0	0	0	0	0	0
Propionaldehyde as measured	0	**0.0023**	0.0350	0	0	0	0	0	0
WPP1 VOC	0.9398	0.4392	0.3244	0.6181	0.5840	0.6108	0.5925	0.6212	0.9160

Step No. 6: Calculate WPP1 VOC emission factor equal to 90th percentile value of 9 runs

WPP1 VOC (9-run 90th percentile value)	0.9208 lb/msf 3/8"
9-run average value (informational purposes only)	0.6273 lb/msf 3/8"

Reference Information

Element and Compound Information

Element / Compound	FID RF	MW (lb/lb-mol)	Formula	Carbon Atoms	Hydrogen Atoms	Oxygen Atoms
Acetaldehyde	0.5	44.0530	C_2H_4O	2	4	1
Acetone (non-VOC)	0.6667	58.0798	C_3H_6O	3	6	1
Acrolein	0.6667	56.0640	C_3H_4O	3	4	1
Benzene	1	78.1134	C_6H_6	6	6	0
3-carene	1	136.2364	$C_{10}H_{16}$	10	16	0
Formaldehyde	0	30.0262	CH_2O	1	2	1
Methanol	0.5	32.0420	CH_4O	1	4	1
Methyl Ethyl Ketone	0.75	72.1066	C_4H_8O	4	8	1
Methyl Isobutyl Ketone	0.8333	100.1602	$C_6H_{12}O$	6	12	1
Phenol	0.9167	94.1128	C_6H_6O	6	6	1
Alpha-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Beta-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Propionaldehyde	0.6667	58.0798	C_3H_6O	3	6	1
Toluene	1	92.1402	C_7H_8	7	8	0
m,p-Xylene	1	106.1670	C_8H_{10}	8	10	0
o-xylene	1	106.1670	C_8H_{10}	8	10	0
Propane	1	44.0962	C_3H_8	3	8	0
Carbon	-	12.0110	C	1	-	-
Hydrogen	-	1.0079	H	-	1	-
Oxygen	-	15.9994	O	-	-	1

FID RF = ECN / No. carbon atoms in compound. See Attachment No. 2 to NCASI's September 2011 Technical Bulletin No. 991 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. In the absence of information related to the FID NCASI employed to conduct RM25A testing, empirical effective carbon number (ECN) values will be employed to estimate FID RF.

ECN = (no. aliphatic carbon) + (no. aromatic carbon) - (no. ether oxygen) - (0.5 x no. primary alcohol oxygen)
Calculations to estimate ECN for several compounds:

Element / Compound	Formula	No. Aliphatic Carbon	No. Aromatic Carbon	No. Carbonyl Carbon	No. Carboxyl Carbon	No. Ether Oxygen	No. Primary Alcohol Oxygen	Empirical ECN
Acetaldehyde	CH_3CHO	1		1				1
Acetone (non-VOC)	$(CH_3)_2CO$	2		1				2
Acrolein	CH_2CHCHO	2		1				2
Benzene	C_6H_6		6					6
3-carene	$C_{10}H_{16}$	10						10
Formaldehyde	CH_2O							0
Methanol	CH_3OH	1					1	0.5
Methyl Ethyl Ketone	$CH_3C(O)CH_2CH_3$	3		1				3
Methyl Isobutyl Ketone	$(CH_3)_2CHCH_2C(O)CH_3$	5		1				5
Phenol	C_6H_5OH		6				1	5.5
Alpha-pinene	$C_{10}H_{16}$	10						10
Beta-pinene	$C_{10}H_{16}$	10						10
Propane	C_3H_8	3						3
Propionaldehyde	CH_3CH_2CHO	2		1				2
Toluene	$C_6H_5CH_3$	1	6					7
m,p-Xylene	$C_6H_4CH_3CH_3$	2	6					8
o-xylene	$C_6H_4CH_3CH_3$	2	6					8

Abbreviations/Acronyms
DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 WPP1 VOC Emission Factor for Heating Pacific Northwest Resinous Softwood Pine Family Veneer via Indirect Steam Heat without Air Pollution Controls

This sheet presents full-scale emissions test data for heating, without air pollution controls, Pacific Northwest resinous softwood pine family veneer via indirect steam heat as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data and EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC), EPA Region 10 has calculated a veneer heating VOC emission factor of 1.8318 lb/msf (3/8 inch) for any one of several resinous softwood pine family species including the one tested; ponderosa pine.

To calculate WPP1 VOC emissions, EPA Region 10 employed NCASI test results quantifying both total and speciated VOC. NCASI employed EPA Reference Method 25A (RM25A) to measure VOC emissions not quantified through speciated sampling and analysis. Because RM25A quantifies total hydrocarbon (THC) emissions (and because THC and VOC are not quite the same), some adjustments to the RM25A results were necessary to determine VOC emissions. NCASI reported RM25A results “as carbon” which only accounts for the carbon portion of the compounds measured. EPA Region 10 adjusted the RM25A results to express THC “as propane” to better approximate the VOC compounds generated by veneer drying. RM25A results were further adjusted to deduct that portion attributable to acetone as acetone is not a VOC. The contribution of certain VOC compounds (already quantified through speciated sampling and analysis) to RM25A results have been deducted to avoid double-counting. These adjustments to RM25A results are consistent with EPA’s Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC). Finally, for each test run, the modified RM25A emission rate is added to speciated HAP emission rates to calculate WPP1 VOC. The resultant VOC emission factor is based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

In certain instances, one or two of the runs at a particular dryer would result in an actual measurement of a hydrocarbon while the other run(s) would result in a non-detect. For those runs resulting in a non-detect, a substitute value has been generated to reflect what we think the actual measurement may have been had detection been possible. The substitute values are noted in **bold** and reflect the lesser of (a) the pollutant-specific method detection limit for that run or (b) a calculated value (Compound X_{RUNA}) representing mass emission rate of undetected individual compound "Compound X" during test run "Run A." The value for Compound X_{RUNA} is determined by multiplying known $\Sigma HC_{i\ RUNA}$ by the known ratio of Compound X_{RUNB} to $\Sigma HC_{i\ RUNB}$. Compound $X_{RUNA} = (\Sigma HC_{i\ RUNA})$ X (Compound $X_{RUNB} / \Sigma HC_{i\ RUNB}$) where $\Sigma HC_{i\ RUNA}$ is the summation of measurements of individual hydrocarbons (HC) during Run A except for Compound X and any other hydrocarbons not detected in Run A and/or Run B. Example calculations are provided below for illustration.

TB768's Tables 4.2.1 , B7 and B8 suggest that Run No.'s 4, 5 and 6 for Sources 112-2DV5 and 2DV6 were conducted while both douglas fir and ponderosa pine were being processed through Dryer No. 2. TB768's Table 4.2.4 and text appearing in the last paragraph of Section 4.2.1, however, suggest that only ponderosa pine was being processed through Dryer No. 2 during Run No.'s 4, 5 and 6 for Sources 2DV5 and 2DV6. In NCASI's October 14, 2015 letter to EPA Region 10, NCASI confirms that the later is true; that only ponderosa pine was being processed through Dryer No. 2 during Run No.'s 4, 5 and 6 for Sources 2DV5 and 2DV6. The calculations below performed by EPA Region 10 assume that only ponderosa pine was being processed through Dryer No. 2 during Run No.'s 4, 5 and 6 for Sources 2DV5 and 2DV6.

Although Runs 112-2DV5N4,5&6 (dry end) and Runs 112-2DV6N4,5&6 (green end) were conducted simultaneously and measured speciated HAP heating emissions from each of the two exhausts serving the dryer's heating zone, RM25A VOC measurements were performed for only one of the two heating zone exhausts during any one run. To estimate what may have been WPP1 VOC emissions for a single run had simultaneous RM25A measurements been performed for dry and green ends of the heating zone, EPA Region 10 has derived an emission factor for each of the two zones and added them together. For the green end of the heating zone, RM25A VOC was only measured during Run 112-2DV6N4. For the dry end of the heating zone, RM25A VOC was measured during Runs 112-2DV5N5 and N6, and the greater of the two WPP1 VOC emission factors was added to the contribution from the green end.

Step No. 1: Summarize test results

	Green End of Heating Zone			Dry End of Heating Zone		
Emission Test Run ID	Run 112-2DV6N4	Run 112-2DV6N5	Run 112-2DV6N6	Run 112-2DV5N4	Run 112-2DV5N5	Run 112-2DV5N6
Facility No.	112	112	112	112	112	112
Veneer Dryer No.	2	2	2	2	2	2
Veneer Dryer Type	J	J	J	J	J	J
Wood Species	PP	PP	PP	PP	PP	PP
Sampling Location Up/Downstream of Water Quench	up	up	up	up	up	up
NCASI TB768 Page No.	26-42 & B8	26-42 & B8	26-42 & B8	26-42 & B7	26-42 & B7	26-42 & B7

	Mass Emission Rate as Measured (lb/msf 3/8")			Mass Emission Rate as Measured (lb/msf 3/8")		
Pollutant/Compound (as measured)	Run 112-2DV6N4	Run 112-2DV6N5	Run 112-2DV6N6	Run 112-2DV5N4	Run 112-2DV5N5	Run 112-2DV5N6
THC as carbon	0.78	NMP	NMP	NMP	0.57	0.72
Acetaldehyde	0.0045	**0.0023**	**0.0017**	0.01	0.0046	0.011
Acetone (non-VOC)	0.0059	0.0042	0.0058	0.0086	0.0077	0.0100
3-carene	0.2900	0.2100	0.1700	0.1800	0.1900	0.2000
Formaldehyde	0.002	0.001	0.00099	0.0048	0.0032	0.0066
Limonene	0.033	**0.0264**	0.023	0	0	0
Methanol	0.029	0.018	0.024	0.018	0.011	0.018
Alpha-pinene	0.043	0.043	0.030	0	0	0
Beta-pinene	0.066	0.054	0.043	**0.0442**	**0.0432**	0.049
Propionaldehyde	0	0	0	0.0066	**0.0043**	0.0057

Example calculation to estimate acetaldehyde emission rate for Run 112-2DV6N5 based upon Runs 112-2DV6N4 and N6 emission measurements while similarly heating ponderosa pine veneer in the same dryer:

$Acetaldehyde_{RUN112\text{-}2DV6N5} = 1/2\ [(\Sigma HC_{i\ RUN112\text{-}2DV6N5})\ X\ (Acetaldehyde_{RUN112\text{-}2DV6N4} / \Sigma HC_{i\ RUN112\text{-}2DV6N4}) + (\Sigma HC_{i\ RUN112\text{-}2DV6N5})\ X\ (Acetaldehyde_{RUN112\text{-}2DV6N6} / \Sigma HC_{i\ RUN112\text{-}2DV6N6})]$

$Acetaldehyde_{RUN\ 112\text{-}2DV6N5}$ = (0.5) X [((0.0042+0.21+0.001+0.018+0.043+0.054) X (0.033) / (0.0059+0.29+0.002+0.029+0.043+0.066)) + ((0.0042+0.21+0.001+0.018+0.043+0.054) X (0.023) / (0.0058+0.17+0.00099+0.024+0.03+0.043))] = 0.0264 lb/msf 3/8"

Example calculation to estimate beta-pinene emission rate for Run 112-2DV5N5 based upon Run 112-2DV5N6 emission measurements while similarly heating ponderosa pine veneer in the same dryer:

$Beta\text{-}pinene_{RUN112\text{-}2DV5N5} = (\Sigma HC_{i\ RUN112\text{-}2DV5N5})\ X\ (beta\text{-}pinene_{RUN112\text{-}2DV5N6} / \Sigma HC_{i\ RUN112\text{-}2DV5N6})$

$Beta\text{-}pinene_{RUN\ 112\text{-}2DV5N5}$ = (0.0046+0.0077+0.19+0.0032+0.011) X (0.049) / (0.011+0.01+0.2+0.0066+0.018) = 0.0432 lb/msf 3/8"

Step No. 2: Convert measurements to a common propane basis

$Compound_X$ expressed as propane = $(Compound_X)\ X\ [(MW_{propane}) / (MW_{Compound\ X})]\ X\ [(\#C_{Compound\ X}) / (\#C_{propane})]$

where: $Compound_X$ represents mass emission rate of $Compound_X$

$MW_{propane}$ equals "44.0962" and represents the molecular weight for propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

$MW_{Compound\ X}$ represents the molecular weight for $Compound_X$

$\#C_{compound\ X}$ equals number of carbon atoms in $Compound_X$

$\#C_{propane}$ equals "3" as three carbon atoms are present within propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

Mass Emission Rate as Propane (lb/msf 3/8")

Pollutant/Compound (as propane)	Run 112-2DV6N4	Run 112-2DV6N5	Run 112-2DV6N6	Run 112-2DV5N4	Run 112-2DV5N5	Run 112-2DV5N6
THC	0.9545	#VALUE!	#VALUE!	#VALUE!	0.6976	0.8811
Acetaldehyde	0.0030	0.0015	0.0011	0.0067	0.0031	0.0073
Acetone (non-VOC)	0.0045	0.0032	0.0044	0.0065	0.0058	0.0076
3-carene	0.3129	0.2266	0.1834	0.1942	0.2050	0.2158
Formaldehyde	0.0010	0.0005	0.0005	0.0023	0.0016	0.0032
Limonene	0.0356	0.0284	0.0248	0	0	0
Methanol	0.0133	0.0083	0.0110	0.0083	0.0050	0.0083
Alpha-pinene	0.0464	0.0464	0.0324	0	0	0
Beta-pinene	0.0712	0.0583	0.0464	0.0477	0.0466	0.0529
Propionaldehyde	0	0	0	0.0050	0.0033	0.0043

Example calculation to convert methanol as measured$_{RUN112\text{-}2DV6N4}$ to methanol as propane:

Methanol as propane$_{RUN112\text{-}2DV6N4}$ = (Methanol$_{RUN112\text{-}2DV6N4}$) X [(MW$_{propane}$) / (MW$_{methanol}$)] X [(#C$_{methanol}$) / (#C$_{propane}$)]

Methanol as propane$_{RUN112\text{-}2DV6N4}$ = (0.029) X (44.0962/32.0420) X (1/3) = 0.0133 lb/msf 3/8"

Step No. 3: Calculate the contribution of individual compounds to THC analyzer measurements as propane

Compound$_X$ expressed as propane by analyzer = (Compound$_X$ expressed as propane) X (RF$_{Compound\ X}$)

where: RF$_{Compound\ X}$ represents the flame ionization detector (FID) response factor (RF) for Compound$_X$

Because THC was measured using a THC analyzer, we already know THC analyzer measurement of THC.

Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8")

Pollutant/Compound (as propane per THC analyzer)	Run 112-2DV6N4	Run 112-2DV6N5	Run 112-2DV6N6	Run 112-2DV5N4	Run 112-2DV5N5	Run 112-2DV5N6
Acetaldehyde	0.0015	0.0008	0.0006	0.0033	0.0015	0.0037
Acetone (non-VOC)	0.0030	0.0021	0.0029	0.0044	0.0039	0.0051
3-carene	0.3129	0.2266	0.1834	0.1942	0.2050	0.2158
Formaldehyde	0	0	0	0	0	0
Limonene	0.0356	0.0284	0.0248	0	0	0
Methanol	0.0067	0.0041	0.0055	0.0041	0.0025	0.0041
Alpha-pinene	0.0464	0.0464	0.0324	0	0	0
Beta-pinene	0.0712	0.0583	0.0464	0.0477	0.0466	0.0529
Propionaldehyde	0	0	0	0.0033	0.0022	0.0029

Example calculation to determine amount of acetone measured by the THC analyzer as propane$_{RUN112\text{-}2DV6N4}$:

Acetone as propane$_{RUN112\text{-}2DV6N4}$ per THC analyzer = (Acetone as propane$_{RUN112\text{-}2DV6N4}$) X (RF$_{acetone}$)

Acetone as propane$_{RUN112\text{-}2DV6N4}$ per THC analyzer = (0.0045) X (0.6667) = 0.0030 lb/msf 3/8"

Step No. 4: Subtract the contribution of individual compounds measured by the THC analyzer as propane (Step No. 3) from the THC measurement as propane (Step No. 2)

Mass Emission Rate (lb/msf 3/8")

Pollutant/Compound (as propane per THC analyzer)	Run 112-2DV6N4	Run 112-2DV6N5	Run 112-2DV6N6	Run 112-2DV5N4	Run 112-2DV5N5	Run 112-2DV5N6
THC	0.9545	#VALUE!	#VALUE!	#VALUE!	0.6976	0.8811
Acetaldehyde	-0.0015	-0.0008	-0.0006	-0.0033	-0.0015	-0.0037
Acetone (non-VOC)	-0.0030	-0.0021	-0.0029	-0.0044	-0.0039	-0.0051
3-carene	-0.3129	-0.2266	-0.1834	-0.1942	-0.2050	-0.2158
Formaldehyde	0	0	0	0	0	0
Limonene	-0.0356	-0.0284	-0.0248	0	0	0
Methanol	-0.0067	-0.0041	-0.0055	-0.0041	-0.0025	-0.0041
Alpha-pinene	-0.0464	-0.0464	-0.0324	0	0	0
Beta-pinene	-0.0712	-0.0583	-0.0464	-0.0477	-0.0466	-0.0529
Propionaldehyde	0	0	0	-0.0033	-0.0022	-0.0029
THC as propane w/o acetone and w/o double-counting VOC$_i$	0.4773	#VALUE!	#VALUE!	#VALUE!	0.4358	0.5967

Step No. 5: Calculate WPP1 VOC by adding the contribution of individual VOCs (Step No. 1) to the adjusted THC value (Step No. 4)

Mass Emission Rate (lb/msf 3/8")

Pollutant/Compound	Run 112-2DV6N4	Run 112-2DV6N5	Run 112-2DV6N6	Run 112-2DV5N4	Run 112-2DV5N5	Run 112-2DV5N6
THC as propane w/o acetone and w/o double-counting VOC$_i$	0.4773	#VALUE!	#VALUE!	#VALUE!	0.4358	0.5967
Acetaldehyde as measured	0.0045	0.0023	0.0017	0.0100	0.0046	0.0110
3-carene as measured	0.2900	0.2100	0.1700	0.1800	0.1900	0.2000
Formaldehyde as measured	0.0020	0.0010	0.0010	0.0048	0.0032	0.0066
Limonene as measured	0.0330	0.0264	0.0230	0.0000	0.0000	0.0000
Methanol as measured	0.0290	0.0180	0.0240	0.0180	0.0110	0.0180
Alpha-pinene as measured	0.0430	0.0430	0.0300	0.0000	0.0000	0.0000
Beta-pinene as measured	0.0660	0.0540	0.0430	0.0442	0.0432	0.0490
Propionaldehyde as measured	0	0	0	0.0066	0.0043	0.0057
WPP1 VOC	0.9448	#VALUE!	#VALUE!	#VALUE!	0.6921	0.8870

Step No. 6: Calculate WPP1 VOC for each heating section and resultant aggregate heating emission factor by adding contribution of each

Section of Veneer Dryer Heating Zone	Methodology for Determining Emission Rate	Mass Emission Rate (lb/msf)
Green End	One value: 0.9448	0.9448
Dry End	Higher of two values: 0.6921 & 0.8870	0.8870
	WPP1 VOC	1.8318 lb/msf 3/8"

For informational purposes only

Section of Veneer Dryer Heating Zone	Methodology for Determining Emission Rate	Mass Emission Rate (lb/msf)
Green End	One value: 0.9448	0.9448
Dry End	Average of two values: 0.6921 & 0.8870	0.7896
	Average value (for informational purposes only)	1.7344 lb/msf 3/8"

Reference Information

Element and Compound Information

Element / Compound	FID RF	MW (lb/lb-mol)	Formula	Carbon Atoms	Hydrogen Atoms	Oxygen Atoms
Acetaldehyde	0.5	44.0530	C_2H_4O	2	4	1
Acetone (non-VOC)	0.6667	58.0798	C_3H_6O	3	6	1
Acrolein	0.6667	56.0640	C_3H_4O	3	4	1
Benzene	1	78.1134	C_6H_6	6	6	0
3-carene	1	136.2364	$C_{10}H_{16}$	10	16	0
Formaldehyde	0	30.0262	CH_2O	1	2	1
Limonene	1	136.2364	$C_{10}H_{16}$	10	16	0
Methanol	0.5	32.0420	CH_4O	1	4	1
Methyl Ethyl Ketone	0.75	72.1066	C_4H_8O	4	8	1
Methyl Isobutyl Ketone	0.8333	100.1602	$C_6H_{12}O$	6	12	1
Phenol	0.9167	94.1128	C_6H_6O	6	6	1
Alpha-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Beta-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Propionaldehyde	0.6667	58.0798	C_3H_6O	3	6	1
Toluene	1	92.1402	C_7H_8	7	8	0
m,p-Xylene	1	106.1670	C_8H_{10}	8	10	0
o-xylene	1	106.1670	C_8H_{10}	8	10	0
Propane	1	44.0962	C_3H_8	3	8	0
Carbon	-	12.0110	C	1	-	-
Hydrogen	-	1.0079	H	-	1	-
Oxygen	-	15.9994	O	-	-	1

FID RF = ECN / No. carbon atoms in compound. See Attachment No. 2 to NCASI's September 2011 Technical Bulletin No. 991 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. In the absence of information related to the FID NCASI employed to conduct RM25A testing, empirical effective carbon number (ECN) values will be employed to estimate FID RF.

ECN = (no. aliphatic carbon) + (no. aromatic carbon) - (no. ether oxygen) - (0.5 x no. primary alcohol oxygen)

Calculations to estimate ECN for several compounds:

Element / Compound	Formula	No. Aliphatic Carbon	No. Aromatic Carbon	No. Carbonyl Carbon	No. Carboxyl Carbon	No. Ether Oxygen	No. Primary Alcohol Oxygen	Empirical ECN
Acetaldehyde	CH_3CHO	1		1				1
Acetone (non-VOC)	$(CH_3)_2CO$	2		1				2
Acrolein	CH_2CHCHO	2		1				2
Benzene	C_6H_6		6					6
3-carene	$C_{10}H_{16}$	10						10
Formaldehyde	CH_2O							0
Limonene	$C_{10}H_{16}$	10						10
Methanol	CH_3OH	1					1	0.5
Methyl Ethyl Ketone	$CH_3C(O)CH_2CH_3$	3		1				3
Methyl Isobutyl Ketone	$(CH_3)_2CHCH_2C(O)CH_3$	5		1				5
Phenol	C_6H_5OH		6				1	5.5
Alpha-pinene	$C_{10}H_{16}$	10						10
Beta-pinene	$C_{10}H_{16}$	10						10
Propane	C_3H_8	3						3
Propionaldehyde	CH_3CH_2CHO	2		1				2
Toluene	$C_6H_5CH_3$	1	6					7
m,p-Xylene	$C_6H_4CH_3CH_3$	2	6					8
o-xylene	$C_6H_4CH_3CH_3$	2	6					8

Abbreviations/Acronyms

DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 HAP Emission Factors for Heating Pacific Northwest Resinous and Non-Resinous Softwood Veneer via Indirect Steam Heat without Air Pollution Controls

This sheet presents full-scale emissions test data for heating, without air pollution controls, Pacific Northwest resinous and non-resinous softwood veneer via indirect steam heat as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data, EPA Region 10 has calculated veneer heating total HAP emission factors of 0.1722, 0.1574 and 0.0740 lb/msf (3/8 inch), respectively, for non-resinous, resinous non-pine family and resinous pine family softwood categories of wood species. The species of softwood tested were white fir (non-resinous), douglas fir (resinous non-pine family) and ponderosa pine (resinous pine family). White fir refers to any one of several species of true fir grown in the West commonly referred to as "white fir." True fir includes the following species: white fir, grand fir, noble fir and subalpine fir; all classified in the same Abies genus. The total and accompaniying speciated (nine individual compounds) HAP emission factors are based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

The data presented below reflects NCASI TB768 veneer heating test data for only those pollutants that were detected in at least one of 21 runs across four different Pacific Northwest plywood mills.[1] A total of 20 HAPs were analyzed for, but only nine were detected. In all but one instance (Runs 115-XDV2N1 to N3), at least three test runs were conducted while processing the same wood species. In certain instances, one or two of the runs at a particular dryer would result in an actual measurement of a hydrocarbon while the other run(s) would result in a non-detect. For those runs resulting in a non-detect, a substitute value has been generated to reflect what we think the actual measurement may have been had detection been possible. The substitute values are noted in bold and reflect the lesser of (a) the pollutant-specific method detection limit for that run or (b) a calculated value (Compound X_{RUNA}) representing mass emission rate of undetected individual compound "Compound X" during test run "Run A." The value for Compound X_{RUNA} is determined by multiplying known ΣHC_i RUNA by the known ratio of Compound X_{RUNB} to $\Sigma HC_{i\ RUNB}$. Compound $X_{RUNA} = (\Sigma HC_{i\ RUNA})$ X (Compound X_{RUNB} / $\Sigma HC_{i\ RUNB}$) where $\Sigma HC_{i\ RUNA}$ is the summation of measurements of individual hydrocarbons (HC) during Run A except for Compound X and any other hydrocarbons not detected in Run A and/or Run B. Example calculations are provided below for illustration.

Non-Resinous Softwood

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	Up/Downstream of Water Quench	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")									Non-HAP (lb/msf 3/8")
								Acetaldehyde	Acrolein	Benzene	Formaldehyde	Methanol	Phenol	Propionaldehyde	Toluene	m,p-Xylene	Acetone
Run 115-XDV2N2	115	1, 2 & 3	J	WF	down	quench begins in dryer headers	43-54 & B16	0.040	0	0	0.040	0.073	0	0.0066	0	0	0.031
Run 115-XDV2N3	115	1, 2 & 3	J	WF	down	quench begins in dryer headers	43-54 & B16	0.038	0	0	0.031	0.090	0	0.0088	0	0	0.023
Run 155-XDV2N1	155	1, 2 & 3	1&2:J; 3:L	WF	up	veneer from offsite	55-64 & B25	0.0022	0	0	0.0064	0.044	0.0045	0	0	**0.00079**	0.0050
Run 155-XDV2N2	155	1, 2 & 3	1&2:J; 3:L	WF	up	veneer from offsite	55-64 & B25	**0.0022**	0	0	0.0023	0.044	**0.0044**	0	0	**0.00078**	0.0083
Run 155-XDV2N3	155	1, 2 & 3	1&2:J; 3:L	WF	up	veneer from offsite	55-64 & B25	**0.0024**	0	0	0.013	0.054	**0.0044**	0	0	0.0011	0.010
5-run 90th percentile value								0.0392	0	0	0.0364	0.0832	0.0045	0.0079	0	0.0010	
5-run average value (informational purposes only)								0.0170	0	0	0.0185	0.0610	0.0027	0.0031	0	0.0005	
5-run 90th percentile value for TOTAL HAP												0.1722					
5-run average value (informational purposes only)												0.1028					

Example calculation to estimate acetaldehyde emission rate for Run 155-XDV2N2 based upon Run 155-XDV2N1 emission measurements:

$Acetaldehyde_{RUN155\text{-}XDV2N2} = (\Sigma HC_{i\ RUN155\text{-}XDV2N2})$ X $(Acetaldehyde_{RUN1\ 55\text{-}XDV2N1} / \Sigma HC_{i\ RUN155\text{-}XDV2N1})$

$Acetaldehyde_{RUN155\text{-}XDV2N2}$ = (0.0023+0.044+0.0083) X [(0.0022) / (0.0064+0.044+0.0050)] = 0.0022 lb/msf 3/8"

Acetaldehyde, acrolein, benzene, phenol, propionaldehyde, toluene and m,p-xylene were not considered in calculation of ΣHC_i because each of these compounds was a non-detect in at least one of the two runs.

Emission measurements from Run 155-XDV2N3 were not considered because acetaldehyde was a non-detect for this run.

Resinous Softwood Non-Pine Family

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	Up/Downstream of Water Quench	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")									Non-HAP (lb/msf 3/8")	
								Acetaldehyde	Acrolein	Benzene	Formaldehyde	Methanol	Phenol	Propionaldehyde	Toluene	m,p-Xylene	Acetone	Alpha-pinene
Run 112-XDV2N1	112	2 & 3	J	DF	down	quench begins in chamber prior to cyclone/WESP	26-42 & B12	0.012	0	0	0.0053	0.015	0	**0.0023**	0	0	0.0049	0.16
Run 112-XDV2N2	112	2 & 3	J	DF	down	quench begins in chamber prior to cyclone/WESP	26-42 & B12	0.026	0	0	0.018	0.032	0	**0.0026**	0	0	0.037	0.13
Run 112-XDV2N3	112	2 & 3	J	DF	down	quench begins in chamber prior to cyclone/WESP	26-42 & B12	0.018	0	0	0.017	0.021	0	0.0028	0	0	0.021	0.13
Run 115-XDV2N1	115	1, 2 & 3	J	DF	down	quench begins in dryer headers	43-54 & B16	0.027	0	0	0.048	0.036	0.015	0.035	0	0	0.042	0
Run 188-XDV2N1	188	1,2,3&4	J&L	DF	up	fresh douglas fir	93-99 & B46	0.0099	0	0	0.0073	0.017	0.0055	0	0	0	0.0067	0.23
Run 188-XDV2N2	188	1,2,3&4	J&L	DF	up	fresh douglas fir	93-99 & B46	0.0068	0	0	0.011	0.017	0.0056	0	0	0	0.0063	0.22
Run 188-XDV2N3	188	1,2,3&4	J&L	DF	up	fresh douglas fir	93-99 & B46	0.0037	0	0	**0.00019**	**0.0028**	0.0056	0	0	0	**0.0030**	0.22
Run 188-XDV2N4	188	1,2,3&4	J&L	DF	up	7-day old douglas fir	93-99 & B48	0.030	0	0	0.020	0.058	0.010	0	0	0	0.0096	0.19
Run 188-XDV2N5	188	1,2,3&4	J&L	DF	up	7-day old douglas fir	93-99 & B48	0.055	0	0	0.0044	0.031	0.0084	0	0	0	0.0086	0.20
Run 188-XDV2N6	188	1,2,3&4	J&L	DF	up	7-day old douglas fir	93-99 & B48	0.060	0	0	0.025	0.059	0.0094	0	0	0	0.0099	0.29
10-run 90th percentile value								0.0555	0	0	0.0273	0.0581	0.0105	0.0060	0	0		
10-run average value (informational purposes only)								0.0248	0	0	0.0156	0.0289	0.0060	0.0043	0	0		
10-run 90th percentile value for TOTAL HAP												0.1574						
10-run average value (informational purposes only)												0.0796						

Example calculation to estimate propionaldehyde emission rate for Run 112-XDV2N1 based upon Runs 112-XDV2N3 emission measurements:

$Propionaldehyde_{RUN112\text{-}XDV2N1} = (\Sigma HC_{i\ RUN112\text{-}XDV2N1})$ X $(Propionaldehyde_{RUN112\text{-}XDV2N3} / \Sigma HC_{i\ RUN112\text{-}XDV2N3})$

$Propionaldehyde_{RUN112\text{-}XDV2N1}$ = (0.012+0.0053+0.015+0.0049+0.16) X [(0.0028) / (0.018+0.017+0.021+0.021+0.13)] = 0.0027 lb/msf 3/8"

Because the estimated value for $propionaldehyde_{RUN112\text{-}XDV2N1}$ of 0.0027 lb/msf 3/8" is greater than the test method detection limit of 0.0023 lb/msf 3/8" for that run, the detection limit value of 0.0023 lb/msf 3/8" is substituted instead of the calculated value.

Acrolein, benzene, phenol, propionaldehyde, toluene and m,p-xylene were not considered in calculation of ΣHC_i because each of these compounds was a non-detect in at least one of the two runs.

Emission measurements from Run 155-XDV2N2 was not considered because propionaldehyde was a non-detect for this run.

Resinous Softwood Pine Family

TB768's Tables 4.2.1 , B7 and B8 suggest that Run No.'s 4, 5 and 6 for Sources 112-2DV5 and 2DV6 were conducted while both douglas fir and ponderosa pine were being processed through Dryer No. 2. TB768's Table 4.2.4 and text appearing in the last paragraph of Section 4.2.1, however, suggest that only ponderosa pine was being processed through Dryer No. 2 during Run No.'s 4, 5 and 6 for Sources 2DV5 and 2DV6. In NCASI's October 14, 2015 letter to EPA Region 10, NCASI confirms that the later is true; that only ponderosa pine was being processed through Dryer No. 2 during Run No.'s 4, 5 and 6 for Sources 2DV5 and 2DV6. The calculations below performed by EPA Region 10 assume that only ponderosa pine was being processed through Dryer No. 2 during Run No.'s 4, 5 and 6 for Sources 2DV5 and 2DV6.

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	Up/Downstream of Water Quench	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")									Non-HAP (lb/msf 3/8")	
								Acetaldehyde	Acrolein	Benzene	Formaldehyde	Methanol	Phenol	Propionaldehyde	Toluene	m,p-Xylene	Acetone	Alpha-pinene
Run 112-2DV5&6N4	112	2	J	PP	up	results for dry and green sections combined	26-42,B7&B8	0.0145	0	0	0.0068	0.047	0	0.0066	0	0	0.0145	0.043
Run 112-2DV5&6N5	112	2	J	PP	up	results for dry and green sections combined	26-42,B7&B8	0.0069	0	0	0.0042	0.029	0	0.0038	0	0	0.0119	0.043
Run 112-2DV5&6N6	112	2	J	PP	up	results for dry and green sections combined	26-42,B7&B8	0.0127	0	0	0.00759	0.042	0	0.0057	0	0	0.0158	0.03
							3-run 90th percentile value	0.0141	0	0	0.0074	0.0460	0	0.0064	0	0		
							3-run average value (informational purposes only)	0.0114	0	0	0.0062	0.0393	0	0.0054	0	0		
							3-run 90th percentile value for TOTAL HAP					0.0740						
							3-run average value (informational purposes only)					0.0623						

Run No.'s 112-2DV5N4,5&6 (dry end) and Run 112-2DV6N4,5&6 (green end) were conducted simultaneously and measured heating emissions from each of the two exhausts serving the dryer's heating zone. Emissions for the entire heating zone were determined by adding together the test results from the simultaneous runs.

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	Up/Downstream of Water Quench	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")									Non-HAP (lb/msf 3/8")	
								Acetaldehyde	Acrolein	Benzene	Formaldehyde	Methanol	Phenol	Propionaldehyde	Toluene	m,p-Xylene	Acetone	Alpha-pinene
Run 112-2DV5N4	112	2	J	PP	up	results for dry section	26-42 & B7	0.01	0	0	0.0048	0.018	0	0.0066	0	0	0.0086	0
Run 112-2DV6N4	112	2	J	PP	up	results for green section	26-42 & B8	0.0045	0	0	0.002	0.029	0	0	0	0	0.0059	0.043
Run 112-2DV5&6N4	112	2	J	PP	up	results for dry and green sections combined	26-42,B7&B8	0.0145	0	0	0.0068	0.047	0	0.0066	0	0	0.0145	0.043

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	Up/Downstream of Water Quench	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")									Non-HAP (lb/msf 3/8")	
								Acetaldehyde	Acrolein	Benzene	Formaldehyde	Methanol	Phenol	Propionaldehyde	Toluene	m,p-Xylene	Acetone	Alpha-pinene
Run 112-2DV5N5	112	2	J	PP	up	results for dry section	26-42 & B7	0.0046	0	0	0.0032	0.011	0	**0.0038**	0	0	0.0077	0
Run 112-2DV6N5	112	2	J	PP	up	results for green section	26-42 & B8	**0.0023**	0	0	0.001	0.018	0	0	0	0	0.0042	0.043
Run 112-2DV5&6N5	112	2	J	PP	up	results for dry and green sections combined	26-42,B7&B8	0.0069	0	0	0.0042	0.029	0	0.003768569	0	0	0.0119	0.043

Example calculation to estimate acetaldehyde emission rate for Run 112-2DV6N5 based upon Runs 112-2DV6N4 emission measurements:

Acetaldehyde$_{RUN112-2DV6N5}$ = ($\Sigma HC_{i\ RUN112-2DV6N5}$) X (Acetaldehyde$_{RUN112-2DV6N4}$ / $\Sigma HC_{i\ RUN112-2DV6N4}$)

Acetaldehyde$_{RUN112-2DV6N5}$ = (0.001+0.018+0.0042+0.043) X [(0.0045) / (0.002+0.029+0.0059+0.043)] = 0.0037 lb/msf 3/8"

Because the estimated value for acetaldehyde$_{RUN112-2DV6N5}$ of 0.0037 lb/msf 3/8" is greater than the test method detection limit of 0.0023 lb/msf 3/8" for that run, the detection limit value of 0.0023 lb/msf 3/8" is substituted instead of the calculated value.

Acrolein, benzene, phenol, propionaldehyde, toluene and m,p-xylene were not considered in calculation of ΣHC_i because each of these compounds was a non-detect in at least one of the two runs.

Emission measurements from Run 112-2DV6N6 were not considered because acetaldehyde was a non-detect for this run.

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	Up/Downstream of Water Quench	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")									Non-HAP (lb/msf 3/8")	
								Acetaldehyde	Acrolein	Benzene	Formaldehyde	Methanol	Phenol	Propionaldehyde	Toluene	m,p-Xylene	Acetone	Alpha-pinene
Run 112-2DV5N6	112	2	J	PP	up	results for dry section	26-42 & B7	0.011	0	0	0.0066	0.018	0	0.0057	0	0	0.01	0
Run 112-2DV6N6	112	2	J	PP	up	results for green section	26-42 & B8	**0.0017**	0	0	0.00099	0.024	0	0	0	0	0.0058	0.03
Run 112-2DV5&6N6	112	2	J	PP	up	results for dry and green sections combined	26-42,B7&B8	0.0127	0	0	0.00759	0.042	0	0.0057	0	0	0.0158	0.03

Example calculation to estimate acetaldehyde emission rate for Run 112-2DV6N6 based upon Runs 112-2DV6N4 emission measurements:

Acetaldehyde$_{RUN112-2DV6N6}$ = ($\Sigma HC_{i\ RUN112-2DV6N6}$) X (Acetaldehyde$_{RUN112-2DV6N4}$ / $\Sigma HC_{i\ RUN112-2DV6N4}$)

Acetaldehyde$_{RUN112-2DV6N6}$ = (0.00099+0.024+0.0058+0.03) X [(0.0045) / (0.002+0.029+0.0059+0.043)] = 0.0034 lb/msf 3/8"

Because the estimated value for acetaldehyde$_{RUN112-2DV6N6}$ of 0.0034 lb/msf 3/8" is greater than the test method detection limit of 0.0017 lb/msf 3/8" for that run, the detection limit value of 0.0017 lb/msf 3/8" is substituted instead of the calculated value.

Acrolein, benzene, phenol, propionaldehyde, toluene and m,p-xylene were not considered in calculation of ΣHC_i because each of these compounds was a non-detect in at least one of the two runs.

Emission measurements from Run 112-2DV6N5 were not considered because acetaldehyde was a non-detect for this run.

[1] The results from nine of those 30 runs were not considered here. The nine runs were all from facility No. 112. Six runs (Run No.'s 112-DV5N1,2&3 and 112-DV6N1,2&3) were conducted upstream of concurrent sampling (Run No.'s 112-XDV2N1,2&3) that is being considered, and three runs (Run No.'s 112-XDV2N4,5&6) were conducted while sampling exhaust generated by drying both douglas fir and ponderosa pine simultaneously in two different dryers.

Abbreviations/Acronyms

DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 WPP1 VOC Emission Factor for Cooling Pacific Northwest Non-Resinous Softwood Veneer without Air Pollution Controls

This sheet presents full-scale emissions test data for cooling, without air pollution controls, Pacific Northwest non-resinous softwood veneer as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data and EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC), EPA Region 10 has calculated a veneer cooling VOC emission factor of 0.0295 lb/msf (3/8 inch) for any one of several non-resinous softwood species including the one tested; white fir. White fir refers to any one of several species of true fir grown in the West commonly referred to as "white fir." True fir includes the following species: white fir, grand fir, noble fir and subalpine fir; all classified in the same Abies genus.

To calculate WPP1 VOC emissions, EPA Region 10 employed NCASI test results quantifying both total and speciated VOC. NCASI employed EPA Reference Method 25A (RM25A) to measure VOC emissions not quantified through speciated sampling and analysis. Because RM25A quantifies total hydrocarbon (THC) emissions (and because THC and VOC are not quite the same), some adjustments to the RM25A results were necessary to determine VOC emissions. NCASI reported RM25A results “as carbon” which only accounts for the carbon portion of the compounds measured. EPA Region 10 adjusted the RM25A results to express THC “as propane” to better approximate the VOC compounds generated by veneer drying. RM25A results were further adjusted to deduct that portion attributable to acetone as acetone is not a VOC. The contribution of certain VOC compounds (already quantified through speciated sampling and analysis) to RM25A results have been deducted to avoid double-counting. These adjustments to RM25A results are consistent with EPA’s Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC). Finally, for each test run, the modified RM25A emission rate is added to speciated HAP emission rates to calculate WPP1 VOC. The resultant VOC emission factor is based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

The board cooler section of the veneer dryer tested while processing white fir had two exhausts; one nearest the veneer dryer's heating zone and the other nearest the veneer dryer exit. NCASI only measured RM25A THC emissions from the cooling section nearest the heating zone. Assuming emissions from both sections are approximately equal (based upon douglas fir veneer cooling emissions testing results presented in the next section of this document), an aggregate board cooling emission factor is estimated by multiplying the factor derived through emissions testing by a factor of 2.

Step No. 1: Summarize test results

	Cooling Section Nearest to Veneer Dryer Heating Zone
Emission Test Run ID	Run 115-1DV4N1
Facility No.	115
Veneer Dryer No.	1
Veneer Dryer Type	J
Cooling Section Exhaust No.	2
Wood Species	WF
NCASI TB768 Page No.	43-54 & B17

Cooling Section Nearest to Veneer Dryer Exit
NO DATA

Mass Emission Rate as Measured (lb/msf 3/8")

Pollutant/Compound (as measured)	Run 115-1DV4N1
THC as carbon	0.012
Acetone	0.0058
Methanol	0.0039

Step No. 2: Convert measurements to a common propane basis

Compound_X expressed as propane = (Compound_X) X $[(MW_{propane}) / (MW_{Compound\ X})]$ X $[(\#C_{Compound\ X}) / (\#C_{propane})]$

where: Compound_X represents mass emission rate of Compound_X

$MW_{propane}$ equals "44.0962" and represents the molecular weight for propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

$MW_{Compound\ X}$ represents the molecular weight for Compound_X

$\#C_{compound\ X}$ equals number of carbon atoms in Compound_X

$\#C_{propane}$ equals "3" as three carbon atoms are present within propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

Mass Emission Rate as Propane (lb/msf 3/8")

Pollutant/Compound (as propane)	Run 115-1DV4N1
THC	0.0147
Acetone (non-VOC)	0.0044
Methanol	0.0018

Example calculation to convert acetone as $\text{measured}_{Run155\text{-}XDV2N1}$ to acetone as propane:

Acetone as $\text{propane}_{RUN115\text{-}1DV4N1}$ = $(\text{Acetone}_{RUN115\text{-}1DV4N1})$ X $[(MW_{propane}) / (MW_{acetone})]$ X $[(\#C_{acetone}) / (\#C_{propane})]$

Acetone as $\text{propane}_{RUN115\text{-}1DV4N1}$ = (0.0058) X (44.0962/58.0798) X (3/3) = 0.0044 lb/msf 3/8"

Step No. 3: Calculate the contribution of individual compounds to THC analyzer measurements as propane

Compound_X expressed as propane by analyzer = (Compound_X expressed as propane) X $(RF_{Compound\ X})$

where: $RF_{Compound\ X}$ represents the flame ionization detector (FID) response factor (RF) for Compound_X

Because THC was measured using a THC analyzer, we already know THC analyzer measurement of THC.

Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8")

Pollutant/Compound (as propane per THC analyzer)	Run 115-1DV4N1
Acetone (non-VOC)	0.0029

Methanol	0.0009

Example calculation to determine amount of formaldehyde measured by the THC analyzer as propane$_{RUN115\text{-}1DV4N1}$:
Formaldehyde as propane$_{RUN115\text{-}1DV4N1}$ per THC analyzer = (Formaldehyde as propane$_{RUN115\text{-}1DV4N1}$) X (RF$_{formaldehyde}$)
Formaldehyde as propane$_{RUN115\text{-}1DV4N1}$ per THC analyzer = (0) X (0) = 0 lb/msf 3/8"

Step No. 4: Subtract the contribution of individual compounds measured by the THC analyzer as propane (Step No. 3) from the THC measurement as propane (Step No. 2)

Mass Emission Rate (lb/msf 3/8")

Pollutant/Compound (as propane per THC analyzer)	Run 115-1DV4N1
THC	0.0147
Acetone (non-VOC)	-0.0029
Methanol	-0.0009
THC as propane w/o acetone and w/o double-counting VOC$_i$	0.0109

Step No. 5: Calculate WPP1 VOC by adding the contribution of individual VOCs (Step No. 1) to the adjusted THC value (Step No. 4)

Mass Emission Rate (lb/msf 3/8")

Pollutant/Compound	Run 115-1DV4N1
THC as propane w/o acetone and w/o double-counting VOC$_i$	0.0109
Methanol as measured	0.0039
WPP1 VOC	0.0148

Step No. 6: Calculate WPP1 VOC for each board cooler section and resultant aggregate board cooler emission factor by adding contribution of each

Section of Veneer Dryer Board Cooler	Methodology for Determining Emission Rate	Mass Emission Rate (lb/msf 3/8")
Section nearest the veneer dryer heating zone	RM25A THC and HAP emissions measurement	0.0148
Section nearest exit of veneer dryer	Estimate emissions equal to those measured from other section	0.0148
	WPP1 VOC	0.0295 lb/msf 3/8"

Reference Information

Element and Compound Information

Element / Compound	FID RF	MW (lb/lb-mol)	Formula	Carbon Atoms	Hydrogen Atoms	Oxygen Atoms
Acetaldehyde	0.5	44.0530	C_2H_4O	2	4	1
Acetone (non-VOC)	0.6667	58.0798	C_3H_6O	3	6	1
Acrolein	0.6667	56.0640	C_3H_4O	3	4	1
Benzene	1	78.1134	C_6H_6	6	6	0
3-carene	1	136.2364	$C_{10}H_{16}$	10	16	0
Formaldehyde	0	30.0262	CH_2O	1	2	1
Methanol	0.5	32.0420	CH_4O	1	4	1
Methyl Ethyl Ketone	0.75	72.1066	C_4H_8O	4	8	1
Methyl Isobutyl Ketone	0.8333	100.1602	$C_6H_{12}O$	6	12	1
Phenol	0.9167	94.1128	C_6H_6O	6	6	1
Alpha-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Beta-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Propionaldehyde	0.6667	58.0798	C_3H_6O	3	6	1
Toluene	1	92.1402	C_7H_8	7	8	0
m,p-Xylene	1	106.1670	C_8H_{10}	8	10	0
o-xylene	1	106.1670	C_8H_{10}	8	10	0
Propane	1	44.0962	C_3H_8	3	8	0
Carbon	-	12.0110	C	1	-	-
Hydrogen	-	1.0079	H	-	1	-
Oxygen	-	15.9994	O	-	-	1

FID RF = ECN / No. carbon atoms in compound. See Attachment No. 2 to NCASI's September 2011 Technical Bulletin No. 991 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. In the absence of information related to the FID NCASI employed to conduct RM25A testing, empirical effective carbon number (ECN) values will be employed to estimate FID RF.

ECN = (no. aliphatic carbon) + (no. aromatic carbon) - (no. ether oxygen) - (0.5 x no. primary alcohol oxygen)
Calculations to estimate ECN for several compounds:

Element / Compound	Formula	No. Aliphatic Carbon	No. Aromatic Carbon	No. Carbonyl Carbon	No. Carboxyl Carbon	No. Ether Oxygen	No. Primary Alcohol Oxygen	Empirical ECN
Acetaldehyde	CH_3CHO	1		1				1
Acetone (non-VOC)	$(CH_3)_2CO$	2		1				2
Acrolein	CH_2CHCHO	2		1				2
Benzene	C_6H_6		6					6
3-carene	$C_{10}H_{16}$	10						10
Formaldehyde	CH_2O							0
Methanol	CH_3OH	1					1	0.5
Methyl Ethyl Ketone	$CH_3C(O)CH_2CH_3$	3		1				3
Methyl Isobutyl Ketone	$(CH_3)_2CHCH_2C(O)CH_3$	5		1				5
Phenol	C_6H_5OH		6				1	5.5
Alpha-pinene	$C_{10}H_{16}$	10						10
Beta-pinene	$C_{10}H_{16}$	10						10
Propane	C_3H_8	3						3
Propionaldehyde	CH_3CH_2CHO	2		1				2
Toluene	$C_6H_5CH_3$	1	6					7
m,p-Xylene	$C_6H_4CH_3CH_3$	2	6					8
o-xylene	$C_6H_4CH_3CH_3$	2	6					8

Abbreviations/Acronyms
DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 WPP1 VOC Emission Factor for Cooling Pacific Northwest Resinous Softwood Non-Pine Family Veneer without Air Pollution Controls

This sheet presents full-scale emissions test data for cooling, without air pollution controls, Pacific Northwest resinous softwood non-pine family veneer as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data and EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC), EPA Region 10 has calculated a veneer cooling VOC emission factor of 0.0286 lb/msf (3/8 inch) for any one of several resinous softwood non-pine family species including the one tested; douglas fir.

To calculate WPP1 VOC emissions, EPA Region 10 employed NCASI test results quantifying both total and speciated VOC. NCASI employed EPA Reference Method 25A (RM25A) to measure VOC emissions not quantified through speciated sampling and analysis. Because RM25A quantifies total hydrocarbon (THC) emissions (and because THC and VOC are not quite the same), some adjustments to the RM25A results were necessary to determine VOC emissions. NCASI reported RM25A results “as carbon” which only accounts for the carbon portion of the compounds measured. EPA Region 10 adjusted the RM25A results to express THC “as propane” to better approximate the VOC compounds generated by veneer drying. RM25A results were further adjusted to deduct that portion attributable to acetone as acetone is not a VOC. The contribution of certain VOC compounds (already quantified through speciated sampling and analysis) to RM25A results have been deducted to avoid double-counting. These adjustments to RM25A results are consistent with EPA’s Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC). Finally, for each test run, the modified RM25A emission rate is added to speciated HAP emission rates to calculate WPP1 VOC. The resultant VOC emission factor is based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

In certain instances, one or two of the runs at a particular dryer would result in an actual measurement of a hydrocarbon while the other run(s) would result in a non-detect. For those runs resulting in a non-detect, a substitute value has been generated to reflect what we think the actual measurement may have been had detection been possible. The substitute values are noted in **bold** and reflect the lesser of (a) the pollutant-specific method detection limit for that run or (b) a calculated value (Compound X_{RUNA}) representing mass emission rate of undetected individual compound "Compound X" during test run "Run A." The value for Compound X_{RUNA} is determined by multiplying known $\Sigma HC_{i\ RUNA}$ by the known ratio of Compound X_{RUNB} to $\Sigma HC_{i\ RUNB}$. Compound X_{RUNA} = ($\Sigma HC_{i\ RUNA}$) X (Compound X_{RUNB} / $\Sigma HC_{i\ RUNB}$) where $\Sigma HC_{i\ RUNA}$ is the summation of measurements of individual hydrocarbons (HC) during Run A except for Compound X and any other hydrocarbons not detected in Run A and/or Run B. Example calculations are provided below for illustration.

The board cooler section of the veneer dryers tested while processing douglas fir had two exhausts; one nearest the veneer dryer's heating zone and the other nearest the veneer dryer exit. NCASI measured emissions from each separately as no common header existed. Because NCASI did not simultaneously measure emissions from the two exhausts, a unique emission factor has been created for each. The resultant board cooling emission factor is calculated by adding the contribution from each exhaust.

Step No. 1: Summarize test results

	Cooling Section Nearest to Veneer Dryer Heating Zone		Cooling Section Nearest to Veneer Dryer Exit		
Emission Test Run ID	Run 115-1DV4N2	Run 115-1DV4N3	Run 115-2DV3N1	Run 115-2DV3N2	Run 115-2DV3N3
Facility No.	115	115	115	115	115
Veneer Dryer No.	1	1	2	2	2
Veneer Dryer Type	J	J	J	J	J
Cooling Section Exhaust No.	2	2	1	1	1
Wood Species	DF	DF	DF	DF	DF
NCASI TB768 Page No.	43-54 & B17	43-54 & B17	43-54 & B20	43-54 & B20	43-54 & B20

	Mass Emission Rate as Measured (lb/msf 3/8")		Mass Emission Rate as Measured (lb/msf 3/8")		
Pollutant/Compound (as measured)	Run 115-1DV4N2	Run 115-1DV4N3	Run 115-2DV3N1	Run 115-2DV3N2	Run 115-2DV3N3
THC as carbon	0.0084	0.0046	0.019	0.0084	0.0033
Acetaldehyde	0.0044	**0.0038**	0	0	0
Acetone (non-VOC)	0.0051	0.0046	0.012	0.0067	0.0056
Methanol	**0.0037**	0.0040	0	0	0

Example calculation to estimate methanol emission rate for Run 115-1DV4N2 based upon Run 115-1DV4N3 emission measurements:
$Methanol_{RUN115-1DV4N2}$ = ($\Sigma HC_{i\ RUN115-1DV4N2}$) X ($Methanol_{RUN115-1DV4N3}$ / $\Sigma HC_{i\ RUN115-1DV4N3}$)
$Methanol_{RUN115-1DV4N2}$ = (0.0051) X (0.0040 / 0.0046) = 0.0044 lb/msf 3/8"
Because the estimated value for $methanol_{RUN\ 115-1DV4N2}$ of 0.0044 lb/msf 3/8" is greater than the test method detection limit of 0.0037 lb/msf 3/8" for that run, the detection limit value of 0.0037 lb/msf 3/8" is substituted instead of the calculated value.

Step No. 2: Convert measurements to a common propane basis

$Compound_X$ expressed as propane = ($Compound_X$) X [($MW_{propane}$) / ($MW_{Compound\ X}$)] X [($\#C_{Compound\ X}$) / ($\#C_{propane}$)]

where: $Compound_X$ represents mass emission rate of $Compound_X$
$MW_{propane}$ equals "44.0962" and represents the molecular weight for propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC
$MW_{Compound\ X}$ represents the molecular weight for $Compound_X$
$\#C_{compound\ X}$ equals number of carbon atoms in $Compound_X$
$\#C_{propane}$ equals "3" as three carbon atoms are present within propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

	Mass Emission Rate as Propane (lb/msf 3/8")		Mass Emission Rate as Propane (lb/msf 3/8")		
Pollutant/Compound (as propane)	Run 115-1DV4N2	Run 115-1DV4N3	Run 115-2DV3N1	Run 115-2DV3N2	Run 115-2DV3N3
THC	0.0103	0.0056	0.0233	0.0103	0.0040
Acetaldehyde	0.0029	0.0025	0	0	0
Acetone (non-VOC)	0.0039	0.0035	0.0091	0.0051	0.0043
Methanol	0.0017	0.0018	0	0	0

Example calculation to convert methanol as $measured_{RUN115-1DV4N3}$ to methanol as propane:
Methanol as $propane_{RUN115-1DV4N3}$ = ($Methanol_{RUN115-1DV4N3}$) X [($MW_{propane}$) / ($MW_{methanol}$)] X [($\#C_{methanol}$) / ($\#C_{propane}$)]
Methanol as $propane_{RUN115-1DV4N3}$ = (0.0040) X (44.0962/32.042) X (1 / 3) = 0.0018 lb/msf 3/8"

Step No. 3: Calculate the contribution of individual compounds to THC analyzer measurements as propane

$Compound_X$ expressed as propane by analyzer = ($Compound_X$ expressed as propane) X ($RF_{Compound\ X}$)

where: $RF_{Compound\ X}$ represents the flame ionization detector (FID) response factor (RF) for $Compound_X$

Because THC was measured using a THC analyzer, we already know THC analyzer measurement of THC.

	Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8")		Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8")		
Pollutant/Compound (as propane per THC analyzer)	Run 115-1DV4N2	Run 115-1DV4N3	Run 115-2DV3N1	Run 115-2DV3N2	Run 115-2DV3N3
Acetaldehyde	0.0015	0.0013	0	0	0
Acetone (non-VOC)	0.0026	0.0023	0.0061	0.0034	0.0028
Methanol	0.0008	0.0009	0	0	0

Example calculation to determine amount of acetone measured by the THC analyzer as $propane_{RUN115-2DV3N2}$:
Acetone as $propane_{RUN115-2DV3N2}$ per THC analyzer = (Acetone as $propane_{RUN115-2DV3N2}$) X ($RF_{acetone}$)
Acetone as $propane_{RUN115-2DV3N2}$ per THC analyzer = (0.0051) X (0.6667) = 0.0034 lb/msf 3/8"

Step No. 4: Subtract the contribution of individual compounds measured by the THC analyzer as propane (Step No. 3) from the THC measurement as propane (Step No. 2)

Pollutant/Compound (as propane per THC analyzer)	Run 115-1DV4N2	Run 115-1DV4N3	Run 115-2DV3N1	Run 115-2DV3N2	Run 115-2DV3N3
	Mass Emission Rate (lb/msf 3/8")		Mass Emission Rate (lb/msf 3/8")		
THC	0.0103	0.0056	0.0233	0.0103	0.0040
Acetaldehyde	-0.0015	-0.0013	0	0	0
Acetone (non-VOC)	-0.0026	-0.0023	-0.0061	-0.0034	-0.0028
Methanol	-0.0008	-0.0009	0	0	0
THC as propane w/o acetone and w/o double-counting VOC_i	0.0054	0.0011	0.0172	0.0069	0.0012

Step No. 5: Calculate WPP1 VOC by adding the contribution of individual VOCs (Step No. 1) to the adjusted THC value (Step No. 4)

Pollutant/Compound	Run 115-1DV4N2	Run 115-1DV4N3	Run 115-2DV3N1	Run 115-2DV3N2	Run 115-2DV3N3
	Mass Emission Rate (lb/msf 3/8")		Mass Emission Rate (lb/msf 3/8")		
THC as propane w/o acetone and w/o double-counting VOC_i	0.0054	0.0011	0.0172	0.0069	0.0012
Acetaldehyde as measured	0.0044	**0.0038**	0	0	0
Methanol as measured	**0.0037**	0.0040	0	0	0
WPP1 VOC	0.0135	0.0089	0.0172	0.0069	0.0012

Step No. 6: Calculate WPP1 VOC for each board cooler section and resultant aggregate board cooler emission factor by adding contribution of each

Section of Veneer Dryer Board Cooler	Methodology for Determining Emission Rate	Mass Emission Rate (lb/msf 3/8")
Section nearest the veneer dryer heating zone	Higher of two values: 0.0135 or 0.0089	0.0135
Section nearest exit of veneer dryer	90th percentile value: 0.0172, 0.0069 & 0.0012	0.0151
	WPP1 VOC	0.0286 lb/msf 3/8"

For informational purposes only

Section of Veneer Dryer Board Cooler	Methodology for Determining Emission Rate	Mass Emission Rate (lb/msf 3/8")
Section nearest the veneer dryer heating zone	Average of two values: 0.0135 or 0.0089	0.0112
Section nearest exit of veneer dryer	Average of three values: 0.0172, 0.0069 & 0.0012	0.0084
	Average value (for informational purposes only)	0.0196 lb/msf 3/8"

Reference Information

Element and Compound Information

Element / Compound	FID RF	MW (lb/lb-mol)	Formula	Carbon Atoms	Hydrogen Atoms	Oxygen Atoms
Acetaldehyde	0.5	44.0530	C_2H_4O	2	4	1
Acetone (non-VOC)	0.6667	58.0798	C_3H_6O	3	6	1
Acrolein	0.6667	56.0640	C_3H_4O	3	4	1
Benzene	1	78.1134	C_6H_6	6	6	0
3-carene	1	136.2364	$C_{10}H_{16}$	10	16	0
Formaldehyde	0	30.0262	CH_2O	1	2	1
Methanol	0.5	32.0420	CH_4O	1	4	1
Methyl Ethyl Ketone	0.75	72.1066	C_4H_8O	4	8	1
Methyl Isobutyl Ketone	0.8333	100.1602	$C_6H_{12}O$	6	12	1
Phenol	0.9167	94.1128	C_6H_6O	6	6	1
Alpha-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Beta-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Propionaldehyde	0.6667	58.0798	C_3H_6O	3	6	1
Toluene	1	92.1402	C_7H_8	7	8	0
m,p-Xylene	1	106.1670	C_8H_{10}	8	10	0
o-xylene	1	106.1670	C_8H_{10}	8	10	0
Propane	1	44.0962	C_3H_8	3	8	0
Carbon	-	12.0110	C	1	-	-
Hydrogen	-	1.0079	H	-	1	-
Oxygen	-	15.9994	O	-	-	1

FID RF = ECN / No. carbon atoms in compound. See Attachment No. 2 to NCASI's September 2011 Technical Bulletin No. 991 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. In the absence of information related to the FID NCASI employed to conduct RM25A testing, empirical effective carbon number (ECN) values will be employed to estimate FID RF.

ECN = (no. aliphatic carbon) + (no. aromatic carbon) - (no. ether oxygen) - (0.5 x no. primary alcohol oxygen)
Calculations to estimate ECN for several compounds:

Element / Compound	Formula	No. Aliphatic Carbon	No. Aromatic Carbon	No. Carbonyl Carbon	No. Carboxyl Carbon	No. Ether Oxygen	No. Primary Alcohol Oxygen	Empirical ECN
Acetaldehyde	CH_3CHO	1		1				1
Acetone (non-VOC)	$(CH_3)_2CO$	2		1				2
Acrolein	CH_2CHCHO	2		1				2
Benzene	C_6H_6		6					6
3-carene	$C_{10}H_{16}$	10						10
Formaldehyde	CH_2O							0
Methanol	CH_3OH	1					1	0.5
Methyl Ethyl Ketone	$CH_3C(O)CH_2CH_3$	3		1				3
Methyl Isobutyl Ketone	$(CH_3)_2CHCH_2C(O)CH_3$	5		1				5
Phenol	C_6H_5OH		6				1	5.5
Alpha-pinene	$C_{10}H_{16}$	10						10
Beta-pinene	$C_{10}H_{16}$	10						10
Propane	C_3H_8	3						3
Propionaldehyde	CH_3CH_2CHO	2		1				2
Toluene	$C_6H_5CH_3$	1	6					7
m,p-Xylene	$C_6H_4CH_3CH_3$	2	6					8
o-xylene	$C_6H_4CH_3CH_3$	2	6					8

Abbreviations/Acronyms

DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 WPP1 VOC Emission Factor for Cooling Pacific Northwest Resinous Softwood Pine Family Veneer without Air Pollution Controls

This sheet presents full-scale emissions test data for cooling, without air pollution controls, Pacific Northwest resinous softwood pine family veneer as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data and EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC), EPA Region 10 has calculated a <u>veneer cooling VOC emission factor of 0.0112 lb/msf (3/8 inch)</u> for any one of several resinous softwood pine family species including the one tested; ponderosa pine.

To calculate WPP1 VOC emissions, EPA Region 10 employed NCASI test results quantifying both total and speciated VOC. NCASI employed EPA Reference Method 25A (RM25A) to measure VOC emissions not quantified through speciated sampling and analysis. Because RM25A quantifies total hydrocarbon (THC) emissions (and because THC and VOC are not quite the same), some adjustments to the RM25A results were necessary to determine VOC emissions. NCASI reported RM25A results "as carbon" which only accounts for the carbon portion of the compounds measured. EPA Region 10 adjusted the RM25A results to express THC "as propane" to better approximate the VOC compounds generated by veneer drying. RM25A results were further adjusted to deduct that portion attributable to acetone as acetone is not a VOC. The contribution of certain VOC compounds (already quantified through speciated sampling and analysis) to RM25A results have been deducted to avoid double-counting. These adjustments to RM25A results are consistent with EPA's Interim VOC Measurement Protocol for the Wood Products Industry - July 2007 (WPP1 VOC). Finally, for each test run, the modified RM25A emission rate is added to speciated HAP emission rates to calculate WPP1 VOC. The resultant VOC emission factor is based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

In certain instances, one or two of the runs at a particular dryer would result in an actual measurement of a hydrocarbon while the other run(s) would result in a non-detect. For those runs resulting in a non-detect, a substitute value has been generated to reflect what we think the actual measurement may have been had detection been possible. The substitute values are noted in **bold** and reflect the lesser of (a) the pollutant-specific method detection limit for that run or (b) a calculated value (Compound X_{RUNA}) representing mass emission rate of undetected individual compound "Compound X" during test run "Run A." The value for Compound X_{RUNA} is determined by multiplying known $\Sigma HC_{i\ RUNA}$ by the known ratio of Compound X_{RUNB} to $\Sigma HC_{i\ RUNB}$. Compound $X_{RUNA} = (\Sigma HC_{i\ RUNA})$ X (Compound $X_{RUNB} / \Sigma HC_{i\ RUNB}$) where $\Sigma HC_{i\ RUNA}$ is the summation of measurements of individual hydrocarbons (HC) during Run A except for Compound X and any other hydrocarbons not detected in Run A and/or Run B. Example calculations are provided below for illustration.

In its work in support of TB768, NCASI did not measure emissions generated by the cooling of ponderosa pine veneer alone. NCASI did, however, measure emissions generated by the cooling of ponderosa pine and douglas fir veneer together at a single dryer. Given NCASI's work at that same dryer measuring emissions generated by the heating of douglas fir veneer alone and ponderosa pine alone, VOC emissions attributable to cooling ponderosa pine veneer can be estimated as illustrated below in Step No. 2.

TB768's Tables 4.2.4, B4 and B5 suggest that Run No.2 for Sources 112-2DV3 and 2DV4 was conducted while the dryer was processing veneer at a rate of 1.5 msf 3/8" per hour. But in NCASI's October 14, 2015 letter to EPA Region 10, NCASI states that it "has determined that there is sufficient uncertainty to warrant discarding the emissions being reported for Run 2" for Sources 112-2DV3 and 2DV4. EPA Region 10 accepts NCASI's October 14, 2015 determination, and the calculations below performed by EPA Region 10 do not take into consideration Run No. 2 for Sources 112-2DV3 and 2DV4. Although the remaining Runs 112-2DV3N1&3 (nearest dryer exit) and Runs 112-2DV4N1&3 (nearest heating zone) were conducted simultaneously and measured speciated HAP cooling emissions from each of the two exhausts serving the dryer's cooling zone, RM25A VOC measurements were simultaneously performed for only one (N3) of the two runs remaining for consideration. Under these circumstances, EPA Region 10 will rely exclusively upon Runs 112-2DV3N3 and 112-2DV4N3 to determine a board cooling emission factor. The resultant factor is calculated by adding the contribution from each exhaust.

<u>Step No. 1: Summarize test results</u>

	Nearest the Heating Zone		
Emission Test Run ID	Run 112-2DV4N1	Run 112-2DV4N2	Run 112-2DV4N3
Facility No.	112	112	112
Veneer Dryer No.	2	2	2
Veneer Dryer Type	J	J	J
Wood Species	DF/PP	DF/PP	DF/PP
NCASI TB768 Page No.	26-42 & B5	26-42 & B5	26-42 & B5

Nearest the Dryer Exit		
Run 112-2DV3N1	Run 112-2DV3N2	Run 112-2DV3N3
112	112	112
2	2	2
J	J	J
DF/PP	DF/PP	DF/PP
26-42 & B4	26-42 & B4	26-42 & B4

Mass Emission Rate as Measured (lb/msf 3/8")

Pollutant/Compound (as measured)	Run 112-2DV4N1	Run 112-2DV4N2	Run 112-2DV4N3
THC as carbon	NMP	~~NMP~~	0.0027
Acetaldehyde	0	~~0~~	0
Acetone (non-VOC)	0.0014	~~0.0071~~	0.00093
Methanol	0	~~0.0076~~	0
Methyl Isobutyl Ketone	0	~~0.0096~~	0

Mass Emission Rate as Measured (lb/msf 3/8")

Run 112-2DV3N1	Run 112-2DV3N2	Run 112-2DV3N3
NMP	~~0.22~~	0.0090
0	~~0.027~~	0
0.0065	~~0.035~~	0.0053
0	~~0.033~~	0
0	~~0.037~~	0

<u>Step No. 2: Estimate contribution of cooling ponderosa pine veneer to test measurements</u>

NCASI measured veneer dryer heating zone emissions generated by drying douglas fir veneer in Facility 112's No. 2 dryer over three runs. Similarly, NCASI separately measured veneer dryer heating zone emissions generated by drying ponderosa pine veneer in Facility 112's No. 2 dryer over three runs. A ratio of the ponderosa-pine-to-douglas-fir mass emission rate was calculated based upon the heating zone testing. In the absence of emissions test data for cooling ponderosa pine veneer, the ponderosa-pine-to-douglas-fir mass emission rate ratio for the dryer's heating zone was applied to the mixed species cooling zone test results to estimate ponderosa pine cooling zone emissions.

Facility 112's No. 2 dryer heating zone (green end) emissions while drying douglas fir veneer are presented as follows:

Mass Emission Rate as Measured (lb/msf 3/8")

Pollutant/Compound (as measured)	Run 112-2DV6N1 (douglas fir - green end)	Run 112-2DV6N2 (douglas fir - green end)	Run 112-2DV6N3 (douglas fir - green end)	Run 112-2DV6N1,2&3 (douglas fir - green end avg.)
THC as carbon	NMP	0.21	0.18	0.1950
Acetaldehyde	0.0049	0.0012	0.0083	0.0048
Acetone (non-VOC)	0.0040	0.0017	0.0018	0.0025
Formaldehyde	0.0013	0.00059	0.0013	0.0011
Methanol	0.011	0.0084	0.0094	0.0096
Alpha-pinene	0.180	0.110	0.093	0.1277
Beta-pinene	0.020	0.014	**0.012**	0.0153

Facility 112's No. 2 dryer heating zone (dry end) emissions while drying douglas fir veneer are presented as follows:

Mass Emission Rate as Measured (lb/msf 3/8")

Pollutant/Compound (as measured)	Run 112-2DV5N1 (douglas fir - dry end)	Run 112-2DV5N2 (douglas fir - dry end)	Run 112-2DV5N3 (douglas fir - dry end)	Run 112-2DV5N1,2&3 (dougas fir - dry end avg.)
THC as carbon	0.47	NMP	0.57	0.5200
Acetaldehyde	0.01	0.025	0.015	0.0167
Acetone (non-VOC)	0.0043	0.0070	0.0045	0.0053
Formaldehyde	0.0048	0.0041	0.0073	0.0054
Methanol	0.014	0.019	0.016	0.0163
Alpha-pinene	0.21	0.18	0.13	0.1733
Beta-pinene	0	0	0	0

Facility 112's No. 2 dryer heating zone (green and dry ends combined) emissions while drying douglas fir veneer are determined by adding together the average test results for each of the zones as follows:

Pollutant/Compound (as measured)	Mass Emission Rate as Measured (lb/msf 3/8") Run 112-2DV6N1,2&3 (douglas fir - green end)	Run 112-2DV5N1,2&3 (douglas fir - dry end)	Run 112-2DV5&6N1,2&3 combined)
THC as carbon	0.1950	0.5200	0.7150
Acetaldehyde	0.0048	0.0167	0.0215
Acetone (non-VOC)	0.0025	0.0053	0.0078
Formaldehyde	0.0011	0.0054	0.0065
Methanol	0.0096	0.0163	0.0259
Alpha-pinene	0.1277	0.1733	0.3010
Beta-pinene	0.0153	0	0.0153

Facility 112's No. 2 dryer heating zone (green end) emissions while drying ponderosa pine veneer are presented as follows:

Pollutant/Compound (as measured)	Run 112-2DV6N4 (ponderosa pine - green end)	Mass Emission Rate as Measured (lb/msf 3/8") Run 112-2DV6N5 (ponderosa pine - green end)	Run 112-2DV6N6 (ponderosa pine - green end)	Run 112-2DV6N4,5&6 avg.)
THC as carbon	0.78	NMP	NMP	0.7800
Acetaldehyde	0.0045	**0.0023**	**0.0017**	0.0028
Acetone (non-VOC)	0.0059	0.0042	0.0058	0.0053
3-carene	0.2900	0.2100	0.1700	0.2233
Formaldehyde	0.002	0.001	0.00099	0.0013
Limonene	0.033	**0.0264**	0.023	0.0275
Methanol	0.029	0.018	0.024	0.0237
Alpha-pinene	0.043	0.043	0.030	0.0387
Beta-pinene	0.066	0.054	0.043	0.0543
Propionaldehyde	0	0	0	0

Facility 112's No. 2 dryer heating zone (dry end) emissions while drying ponderosa pine veneer are presented as follows:

Pollutant/Compound (as measured)	Run 112-2DV5N4 (ponderosa pine - dry end)	Mass Emission Rate as Measured (lb/msf 3/8") Run 112-2DV5N5 (ponderosa pine - dry end)	Run 112-2DV5N6 (ponderosa pine - dry end)	Run 112-2DV5N4,5&6 (ponderosa pine - dry end avg.)
THC as carbon	NMP	0.57	0.72	0.6450
Acetaldehyde	0.01	0.0046	0.011	0.0085
Acetone (non-VOC)	0.0086	0.0077	0.0100	0.0088
3-carene	0.1800	0.1900	0.2000	0.1900
Formaldehyde	0.0048	0.0032	0.0066	0.0049
Limonene	0	0	0	0
Methanol	0.018	0.011	0.018	0.0157
Alpha-pinene	0	0	0	0
Beta-pinene	**0.0442**	**0.0432**	0.049	0.0455
Propionaldehyde	0.0066	**0.0043**	0.0057	0.0055

Facility 112's No. 2 dryer heating zone (green and dry ends combined) emissions while drying ponderosa pine veneer are determined by adding together the average test results for each of the zones as follows:

Pollutant/Compound (as measured)	Mass Emission Rate as Measured (lb/msf 3/8") Run 112-2DV6N4,5&6 (ponderosa pine - green end)	Run 112-2DV5N4,5&6 (ponderosa pine - dry end)	Run 112-2DV5&6N4,5&6 combined)
THC as carbon	0.7800	0.6450	1.4250
Acetaldehyde	0.0028	0.0085	0.0114
Acetone (non-VOC)	0.0053	0.0088	0.0141
3-carene	0.2233	0.1900	0.4133
Formaldehyde	0.0013	0.0049	0.0062
Limonene	0.0275	0	0.0275
Methanol	0.0237	0.0157	0.0393
Alpha-pinene	0.0387	0	0.0387
Beta-pinene	0.0543	0.0455	0.0998
Propionaldehyde	0.0000	0.0055	0.0055

The resultant ponderosa-pine-to-douglas-fir mass emission rate ratio for various compounds is presented as follows:

Pollutant/Compound (as measured)	Mass Emission Rate as Measured (lb/msf 3/8") Run 112-2DV5&6N4,5&6 (ponderosa pine)	Run 112-2DV5&6N1,2&3 (douglas fir)	Ponderosa-Pine-to-Douglas Fir Mass Emission Rate Ratio
THC as carbon	1.4250	0.7150	1.99
Acetaldehyde	0.0114	0.0215	0.53
Acetone (non-VOC)	0.0141	0.0078	1.81
3-carene	0.4133	0	#DIV/0!
Formaldehyde	0.0062	0.0065	0.96
Limonene	0.0275	0	#DIV/0!
Methanol	0.0393	0.0259	1.52
Alpha-pinene	0.0387	0.3010	0.13
Beta-pinene	0.0998	0.0153	6.51
Propionaldehyde	0.0055	0	#DIV/0!

The ponderosa-pine-to-douglas-fir mass emission rate ratios are applied to mixed species cooling zone results to estimate ponderosa pine cooling zone emissions as follows:

Pollutant/Compound (as measured)	Mass Emission Rate as Measured (lb/msf 3/8") Run 112-2DV4N1	Run 112-2DV4N2	Run 112-2DV4N3
THC as carbon	#VALUE!	~~#VALUE!~~	0.0036
Acetaldehyde	0	~~0~~	0
Acetone (non-VOC)	0.0018	~~0.0091~~	0.0012
Methanol	0	~~0.0092~~	0
Methyl Isobutyl Ketone	0	~~0.0126~~	0

Pollutant/Compound (as measured)	Mass Emission Rate as Measured (lb/msf 3/8") Run 112-2DV3N1	Run 112-2DV3N2	Run 112-2DV3N3
THC as carbon	#VALUE!	~~0.2930~~	0.0120
Acetaldehyde	0	~~0.0187~~	0
Acetone (non-VOC)	0.0084	~~0.0451~~	0.0068
Methanol	0	~~0.0398~~	0
Methyl Isobutyl Ketone	0	~~0.0486~~	0

The methyl isobutyl ketone ratio for the ponderosa pine to douglas fir mass emission rate could not be estimated for Runs 112-2DV5&6N1-6 given that the compound was not detected. In its absence, the ΣHCi ratio for ponderosa pine to douglas fir mass emission rate will be substituted.

Assuming equal amounts of ponderosa pine and douglas fir were processed during Runs 112-2DV3&4N1,2&3, the resultant mixed species mass emission rate (lb/msf) = 1/2 (mass emission rate for cooling ponderosa pine) + 1/2 (mass emission rate for cooling douglas fir)
attributable to cooling ponderosa pine veneer during Runs 112-

THC as carbon$_{PP\ RUNS112\text{-}2DV4N3}$ = [2 X (THC as carbon$_{PP/DF\ RUNS112\text{-}}$

THC as carbon$_{PP\ RUNS112\text{-}2DV4N3}$ + (THC as carbon$_{PP\ RUN112\text{-}2DV4N3}$ /

THC as carbon$_{PP\ RUNS112\text{-}2DV4N3}$ X (1 + 1/1.99) = 2 X 0.0027

THC as carbon$_{PP\ RUNS112\text{-}2DV4N3}$ = (2 X 0.0027) / (1 + 1/1.99)

THC as carbon$_{PP\ RUNS112\text{-}2DV4N3}$ = 0.0036 lb/msf 3/8"

Step No. 3: Convert measurements to a common propane basis

Compound$_X$ expressed as propane = (Compound$_X$) X [(MW$_{propane}$) / (MW$_{Compound\ X}$)] X [(#C$_{Compound\ X}$) / (#C$_{propane}$)]

where: Compound$_X$ represents mass emission rate of Compound$_X$

MW$_{propane}$ equals "44.0962" and represents the molecular weight for propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

MW$_{Compound\ X}$ represents the molecular weight for Compound$_X$

#C$_{compound\ X}$ equals number of carbon atoms in Compound$_X$

#C$_{propane}$ equals "3" as three carbon atoms are present within propane; the compound that is the "basis" for expressing mass of VOC per WPP1 VOC

Pollutant/Compound (as propane)	Mass Emission Rate as Propane (lb/msf 3/8") Run 112-2DV4N1	Run 112-2DV4N2	Run 112-2DV4N3
THC as carbon	#VALUE!	~~#VALUE!~~	0.0033
Acetaldehyde	0	~~0~~	0
Acetone (non-VOC)	0.0011	~~0.0054~~	0.0007
Methanol	0	~~0.0035~~	0
Methyl Isobutyl Ketone	0	~~0.0085~~	0

Pollutant/Compound (as propane)	Mass Emission Rate as Propane (lb/msf 3/8") Run 112-2DV3N1	Run 112-2DV3N2	Run 112-2DV3N3
THC as carbon	#VALUE!	~~0.2692~~	0.0110
Acetaldehyde	0	~~0.0180~~	0
Acetone (non-VOC)	0.0049	~~0.0266~~	0.0040
Methanol	0	~~0.0151~~	0
Methyl Isobutyl Ketone	0	~~0.0326~~	0

Example calculation to convert acetone as measured$_{PP\ RUN112\text{-}2DV3N3}$ to acetone as propane:

Acetone as propane$_{PP\ RUN112\text{-}2DV3N3}$ = (Acetone$_{PP\ RUN112\text{-}2DV3N3}$) X [(MW$_{propane}$) / (MW$_{acetone}$)] X [(#C$_{acetone}$) / (#C$_{propane}$)]

Acetone as propane$_{PP\ RUN112\text{-}2DV4N1}$ = (0.0053) X (44.0962/58.0798) X (3/3) = 0.0040 lb/msf 3/8"

Step No. 4: Calculate the contribution of individual compounds to THC analyzer measurements as propane

Compound$_X$ expressed as propane by analyzer = (Compound$_X$ expressed as propane) X (RF$_{Compound\ X}$)

where: RF$_{Compound\ X}$ represents the flame ionization detector (FID) response factor (RF) for Compound$_X$

Because THC was measured using a THC analyzer, we already know THC analyzer measurement of THC.

Pollutant/Compound (as propane per THC analyzer)	Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8") Run 112-2DV4N1	Run 112-2DV4N2	Run 112-2DV4N3
Acetaldehyde	0	~~0~~	0
Acetone (non-VOC)	0.0007	~~0.0036~~	0.0005
Methanol	0	~~0.0017~~	0
Methyl Isobutyl Ketone	0	~~0.0070~~	0

Pollutant/Compound (as propane per THC analyzer)	Mass Emission Rate as Propane Measured by THC Analyzer (lb/msf 3/8") Run 112-2DV3N1	Run 112-2DV3N2	Run 112-2DV3N3
Acetaldehyde	0	~~0.0090~~	0
Acetone (non-VOC)	0.0033	~~0.0177~~	0.0027
Methanol	0	~~0.0076~~	0
Methyl Isobutyl Ketone	0	~~0.0271~~	0

Example calculation to determine amount of acetone measured by the THC analyzer as propane$_{PP\ RUN112\text{-}2DV3N3}$:

Acetone as propane$_{PP\ RUN112\text{-}2DV3N3}$ per THC analyzer = (Acetone as propane$_{PP\ RUN112\text{-}2DV3N3}$) X (RF$_{methanol}$)

Acetone as propane$_{PP\ RUN112\text{-}2DV3N3}$ per THC analyzer = (0.0040) X (0.6667) = 0.0027 lb/msf 3/8"

Step No. 5: Subtract the contribution of individual compounds measured by the THC analyzer as propane (Step No. 4) from the THC measurement as propane (Step No. 3)

Pollutant/Compound (as propane per THC analyzer)	Mass Emission Rate (lb/msf 3/8") Run 112-2DV4N1	Run 112-2DV4N2	Run 112-2DV4N3
THC	#VALUE!	~~#VALUE!~~	0.0033
Acetaldehyde	0	~~0~~	0
Acetone (non-VOC)	-0.0007	~~-0.0036~~	-0.0005
Methanol	0	~~-0.0017~~	0
Methyl Isobutyl Ketone	0	~~-0.0070~~	0
THC as propane w/o acetone and w/o double-counting VOC$_i$	#VALUE!	~~#VALUE!~~	0.0028

Pollutant/Compound (as propane per THC analyzer)	Mass Emission Rate (lb/msf 3/8") Run 112-2DV3N1	Run 112-2DV3N2	Run 112-2DV3N3
THC	#VALUE!	~~0.2692~~	0.0110
Acetaldehyde	0	~~0~~	0
Acetone (non-VOC)	-0.0033	~~-0.0177~~	-0.0027
Methanol	0	~~-0.0076~~	0
Methyl Isobutyl Ketone	0	~~-0.0271~~	0
THC as propane w/o acetone and w/o double-counting VOC$_i$	#VALUE!	~~0.2078~~	0.0083

Step No. 6: Calculate WPP1 VOC by adding the contribution of individual VOCs (Step No. 2) to the adjusted THC value (Step No. 5)

Pollutant/Compound	Mass Emission Rate (lb/msf 3/8") Run 112-2DV4N1	Run 112-2DV4N2	Run 112-2DV4N3
THC as propane w/o acetone and w/o double-counting VOC$_i$	#VALUE!	~~#VALUE!~~	0.0028
Acetaldehyde as measured	0	~~0~~	0
Methanol as measured	0	~~0.0076~~	0
Methyl Isobutyl Ketone	0	~~0.0096~~	0
WPP1 VOC	#VALUE!	~~0.0172~~	0.0028

Pollutant/Compound	Mass Emission Rate (lb/msf 3/8") Run 112-2DV3N1	Run 112-2DV3N2	Run 112-2DV3N3
THC as propane w/o acetone and w/o double-counting VOC$_i$	#VALUE!	~~0.2078~~	0.0083
Acetaldehyde as measured	0	~~0.0270~~	0
Methanol as measured	0	~~0.0330~~	0
Methyl Isobutyl Ketone	0	~~0.0370~~	0
WPP1 VOC	#VALUE!	~~0.3048~~	0.0083

Step No. 7: Calculate WPP1 VOC for each cooling section and resultant aggregate cooling emission factor by adding contribution of each

Section of Veneer Dryer Cooling Zone	Methodology for Determining Emission Rate	Mass Emission Rate (lb/msf 3/8")
Nearest the Heating Zone	Only RM25A run under consideration	0.0028
Nearest thy Dryer Exit	Only RM25A run under consideration	0.0083
	WPP1 VOC	0.0112 lb/msf 3/8"

Reference Information

Element and Compound Information

Element / Compound	FID RF	MW (lb/lb-mol)	Formula	Carbon Atoms	Hydrogen Atoms	Oxygen Atoms
Acetaldehyde	0.5	44.0530	C_2H_4O	2	4	1
Acetone (non-VOC)	0.6667	58.0798	C_3H_6O	3	6	1
Acrolein	0.6667	56.0640	C_3H_4O	3	4	1
Benzene	1	78.1134	C_6H_6	6	6	0
3-carene	1	136.2364	$C_{10}H_{16}$	10	16	0
Formaldehyde	0	30.0262	CH_2O	1	2	1
Methanol	0.5	32.0420	CH_4O	1	4	1
Methyl Ethyl Ketone	0.75	72.1066	C_4H_8O	4	8	1
Methyl Isobutyl Ketone	0.8333	100.1602	$C_6H_{12}O$	6	12	1
Phenol	0.9167	94.1128	C_6H_6O	6	6	1
Alpha-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Beta-pinene	1	136.2364	$C_{10}H_{16}$	10	16	0
Propionaldehyde	0.6667	58.0798	C_3H_6O	3	6	1
Toluene	1	92.1402	C_7H_8	7	8	0
m,p-Xylene	1	106.1670	C_8H_{10}	8	10	0
o-xylene	1	106.1670	C_8H_{10}	8	10	0
Propane	1	44.0962	C_3H_8	3	8	0
Carbon	-	12.0110	C	1	-	-
Hydrogen	-	1.0079	H	-	1	-
Oxygen	-	15.9994	O	-	-	1

conduct RM25A testing, empirical effective carbon number (ECN) values will be employed to estimate FID RF.

ECN = (no. aliphatic carbon) + (no. aromatic carbon) - (no. ether oxygen) - (0.5 x no. primary alcohol oxygen)

Calculations to estimate ECN for several compounds:

Element / Compound	Formula	No. Aliphatic Carbon	No. Aromatic Carbon	No. Carbonyl Carbon	No. Carboxyl Carbon	No. Ether Oxygen	No. Primary Alcohol Oxygen	Empirical ECN
Acetaldehyde	CH_3CHO	1		1				1
Acetone (non-VOC)	$(CH_3)_2CO$	2		1				2
Acrolein	CH_2CHCHO	2		1				2
Benzene	C_6H_6		6					6
3-carene	$C_{10}H_{16}$	10						10
Formaldehyde	CH_2O							0
Methanol	CH_3OH	1					1	0.5
Methyl Ethyl Ketone	$CH_3C(O)CH_2CH_3$	3		1				3
Methyl Isobutyl Ketone	$(CH_3)_2CHCH_2C(O)CH_3$	5		1				5
Phenol	C_6H_5OH		6				1	5.5
Alpha-pinene	$C_{10}H_{16}$	10						10
Beta-pinene	$C_{10}H_{16}$	10						10
Propane	C_3H_8	3						3
Propionaldehyde	CH_3CH_2CHO	2		1				2
Toluene	$C_6H_5CH_3$	1	6					7
m,p-Xylene	$C_6H_4CH_3CH_3$	2	6					8
o-xylene	$C_6H_4CH_3CH_3$	2	6					8

Abbreviations/Acronyms
DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 HAP Emission Factors for Cooling Pacific Northwest Resinous and Non-Resinous Softwood Veneer without Air Pollution Controls

This sheet presents full-scale emissions test data for cooling, without air pollution controls, Pacific Northwest resinous and non-resinous softwood veneer as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter and subsequent February 3, 2016 email to EPA Region 10. Based upon NCASI's test data, EPA Region 10 has calculated veneer cooling total HAP emission factors of 0.0136, 0.0171 and 0 lb/msf (3/8 inch), respectively, for non-resinous, resinous non-pine family and resinous pine family softwood categories of wood species. The species of softwood tested were white fir (non-resinous), douglas fir (resinous non-pine family) and ponderosa pine (resinous pine family). White fir refers to any one of several species of true fir grown in the West commonly referred to as "white fir." True fir includes the following species: white fir, grand fir, noble fir and subalpine fir; all classified in the same Abies genus. The total and accompaniying speciated (six individual compounds) HAP emission factors are based on the 90th percentile value when three or more test runs are available, and on the maximum value when less than three runs are available. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

The data presented below reflects NCASI TB768 veneer cooling test data for only those pollutants that were detected in at least one of 26 runs across four different Pacific Northwest plywood mills. A total of 20 HAPs were analyzed for, but only six were detected. In certain instances, one or two of the runs at a particular dryer would result in an actual measurement of a hydrocarbon while the other run(s) would result in a non-detect. For those runs resulting in a non-detect, a substitute value has been generated to reflect what we think the actual measurement may have been had detection been possible. The substitute values are noted in bold and reflect the lesser of (a) the pollutant-specific method detection limit for that run or (b) a calculated value (Compound X_{RUNA}) representing mass emission rate of undetected individual compound "Compound X" during test run "Run A." The value for Compound X_{RUNA} is determined by multiplying known $\Sigma HC_{i\ RUNA}$ by the known ratio of Compound X_{RUNB} to $\Sigma HC_{i\ RUNB}$. Compound $X_{RUNA} = (\Sigma HC_{i\ RUNA})$ X (Compound $X_{RUNB} / \Sigma HC_{i\ RUNB}$) where $\Sigma HC_{i\ RUNA}$ is the summation of measurements of individual hydrocarbons (HC) during Run A except for Compound X and any other hydrocarbons not detected in Run A and/or Run B. Example calculations are provided below for illustration.

In its work in support of TB768, NCASI did not measure emissions generated by the cooling of ponderosa pine veneer alone. NCASI did, however, measure emissions generated by the cooling of ponderosa pine and douglas fir veneer together. HAP emissions attributable to cooling ponderosa pine veneer can be estimated as illustrated below in Step 2 of Section entitled, "Resinous Softwood Pine Family."

TB768's Tables 4.2.4, B4 and B5 suggest that Run No.2 for Sources 112-2DV3 and 2DV4 was conducted while the dryer was processing veneer at a rate of 1.5 msf 3/8" per hour. But in NCASI's October 14, 2015 letter to EPA Region 10, NCASI states that it "has determined that there is sufficient uncertainty to warrant discarding the emissions being reported for Run 2" for Sources 112-2DV3 and 2DV4. EPA Region 10 accepts NCASI's October 14, 2015 determination, and the calculations below performed by EPA Region 10 do not take into consideration Run No. 2 for Sources 112-2DV3 and 2DV4.

Non-Resinous Softwood

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Exhaust Nearest the Heating Zone or Dryer Exit?	Wood Species	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")						Non-HAP (lb/msf 3/8")
								Acetaldehyde	Methanol	Methyl Isobutyl Ketone	Phenol	m,p-Xylene	o-Xylene	Acetone
Run 115-1DV4N1	115	1	J	HZ	WF		43-54 & B17	0	0.0039	0	0	0	0	0.0058
Run 115-2DV4N1	115	2	J	HZ	WF		43-54 & B19	0	0	0	0	0	0	0.0060
Run 115-3DV4N2	115	3	J	HZ	WF		43-54 & B21	0	**0.0016**	0	0	0	0	0.0020
Run 115-3DV4N3	115	3	J	HZ	WF		43-54 & B21	0	0.0014	0	0	0	0	0.0017
Run 155-3DV3N1	155	3	L	one exhaust	WF		55-64 & B26	**0.0037**	0	0	0	**0.0019**	**0.0019**	0.0039
Run 155-3DV3N2	155	3	L	one exhaust	WF		55-64 & B26	**0.0039**	0	0	0	0.0039	0.0024	0.0044
Run 155-3DV3N3	155	3	L	one exhaust	WF		55-64 & B26	0.0046	0	0	0	0.0049	0.0029	0.0046
							7-run 90th percentile value	0.0042	0.0025	0	0	0.0043	0.0026	
							7-run average value (informational purposes only)	0.0017	0.0010	0	0	0.0015	0.0010	
							7-run 90th percentile value for TOTAL HAP			0.0136				
							7-run average value (informational purposes only)			0.0053				

Example calculation to estimate acetaldehyde emission rate for Run 155-3DV3N2 based upon Run 155-3DV3N3 emission measurements:

$Acetaldehyde_{RUN155\text{-}3DV3N2} = (\Sigma HC_{i\ RUN155\text{-}3DV3N2})$ X $(Acetaldehyde_{RUN1\ 55\text{-}3DV3N3} / \Sigma HC_{i\ RUN155\text{-}3DV3N3})$

$Acetaldehyde_{RUN155\text{-}3DV3N2} = (0.0039+0.0024+0.0044)$ X $[(0.0046) / (0.0049+0.0029+0.0046)] = 0.0040$ lb/msf 3/8"

Because the estimated value for $acetaldehyde_{RUN155\text{-}3DV3N2}$ of 0.0040 lb/msf 3/8" is greater than the test method detection limit of 0.0039 lb/msf 3/8" for that run, the detection limit value of 0.0039 lb/msf 3/8" is substituted instead of the calculated value.

Acetaldehyde, methanol, methyl isobutyl ketone and phenol were not considered in calculation of ΣHC_i because each of these compounds was a non-detect in at least one of the two runs.

Emission measurements from Run 155-3DV3N1 was not considered because acetaldehyde was a non-detect for this run.

Four of the runs noted above (115-1DV4N1, 115-2DV4N1, 115-3DV4N2 and 115-3DV4N3) only measured a portion of board cooling emissions. In each instance, NCASI only sampled from one of the two exhausts serving the board cooler section of the veneer dryer. On these runs, NCASI sampled emissions in the exhaust nearest the heating zone. Although NCASI also sampled emissions in the exhaust nearest the veneer dryer exit, sampling of the two exhausts was not conducted simultaneously. Pollutants detected in one exhaust during a particular run cannot be assumed present in the other during a different run. As illustrated in the table immediately below, no HAPs were detected in the only testing conducted of the board cooling exhaust nearest the veneer dryer exit. Therefore, it is assumed that no HAP would have been detected in the exhaust nearest the dryer exit for runs 115-1DV4N1, 115-2DV4N1, 115-3DV4N2 and 115-3DV4N3 had simultaneous testing been conducted.

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Exhaust Nearest the Heating Zone or Dryer Exit?	Wood Species	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")						Non-HAP (lb/msf 3/8")
								Acetaldehyde	Methanol	Methyl Isobutyl Ketone	Phenol	m,p-Xylene	o-Xylene	Acetone
Run 115-3DV3N2	115	3	J	DE	WF	Not concurrent with Run 115-3DV4N2	43-54 & B22	0	0	0	0	0	0	0.0027
Run 115-3DV3N3	115	3	J	DE	WF	Not concurrent with Run 115-3DV4N3	43-54 & B22	0	0	0	0	0	0	0.0035

Resinous Softwood Non-Pine Family

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Exhaust Nearest the Heating Zone or Dryer Exit?	Wood Species	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")						Non-HAP (lb/msf 3/8")
								Acetaldehyde	Methanol	Methyl Isobutyl Ketone	Phenol	m,p-Xylene	o-Xylene	Acetone
Run 115-1DV4N2	115	1	J	HZ	DF	Not concurrent with Run 115-1DV3N2	43-54 & B17	0.0044	**0.0037**	0	0	0	0	0.0051
Run 115-1DV4N3	115	1	J	HZ	DF	Not concurrent with Run 115-1DV3N3	43-54 & B17	**0.0038**	0.0040	0	0	0	0	0.0046
Run 115-2DV4N2	115	2	J	HZ	DF	Not concurrent with Run 115-2DV3N2	43-54 & B19	0	0	0	0.0092	0	0	0.0064
Run 115-2DV4N3	115	2	J	HZ	DF	Not concurrent with Run 115-2DV3N3	43-54 & B19	0	0	0	**0.0089**	0	0	0.0079
Run 115-3DV4N1	115	3	J	HZ	DF		43-54 & B21	0	0.0011	0	0	0	0	0.0015
5-run 90th percentile value								0.0042	0.0039	0	0.0091	0	0	
5-run average value (informational purposes only)								0.0016	0.0018	0	0.0036	0	0	

5-run 90th percentile value for TOTAL HAP 0.0171
5-run average value (informational purposes only) 0.0070

Example calculation to estimate acetaldehyde emission rate for Run 115-1DV4N3 based upon Run 115-1DV4N2 emission measurements:

Acetaldehyde$_{RUN115\text{-}1DV4N3}$ = ($\Sigma HC_{i\ RUN115\text{-}1DV4N3}$) X (Acetaldehyde$_{RUN1\ 15\text{-}1DV4N2}$ / $\Sigma HC_{i\ RUN115\text{-}1DV4N2}$)

Acetaldehyde$_{RUN115\text{-}1DV4N3}$ = (0.0046) X [(0.0044) / (0.0051)] = 0.0040 lb/msf 3/8"

Because the estimated value for acetaldehyde$_{RUN115\text{-}1DV4N3}$ of 0.0040 lb/msf 3/8" is greater than the test method detection limit of 0.0038 lb/msf 3/8" for that run, the detection limit value of 0.0038 lb/msf 3/8" is substituted instead of the calculated value.
Acetaldehyde, methanol, methyl isobutyl ketone, phenol, m,p-xylene and o-xylene were not considered in calculation of ΣHC_i because each of these compounds was a non-detect in at least one of the two runs.

All of the runs noted above only measured a portion of board cooling emissions. In each instance, NCASI only sampled from one of the two exhausts serving the board cooler section of the veneer dryer. On these runs, NCASI sampled emissions in the exhaust nearest the heating zone. Although NCASI also sampled emissions in the exhaust nearest the veneer dryer exit, sampling of the two exhausts was not conducted simultaneously. Pollutants detected in one exhaust during a particular run cannot be assumed present in the other during a different run. As illustrated in the table immediately below, no HAPs were detected in the only testing conducted of the board cooling exhaust nearest the veneer dryer exit. Therefore, it is assumed that no HAP would have been detected in the exhaust nearest the dryer exit had simultaneous testing been conducted.

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Exhaust Nearest the Heating Zone or Dryer Exit?	Wood Species	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")						Non-HAP (lb/msf 3/8")
								Acetaldehyde	Methanol	Methyl Isobutyl Ketone	Phenol	m,p-Xylene	o-Xylene	Acetone
Run 115-1DV3N1	115	1	J	DE	DF		43-54 & B18	0	0	0	0	0	0	0.0051
Run 115-1DV3N2	115	1	J	DE	DF	Not concurrent with Run 115-1DV4N2	43-54 & B18	0	0	0	0	0	0	0.0069
Run 115-1DV3N3	115	1	J	DE	DF	Not concurrent with Run 115-1DV4N3	43-54 & B18	0	0	0	0	0	0	0.0053
Run 115-2DV3N1	115	2	J	DE	DF		43-54 & B20	0	0	0	0	0	0	0.012
Run 115-2DV3N2	115	2	J	DE	DF	Not concurrent with Run 115-2DV4N2	43-54 & B20	0	0	0	0	0	0	0.0067
Run 115-2DV3N3	115	2	J	DE	DF	Not concurrent with Run 115-2DV4N3	43-54 & B20	0	0	0	0	0	0	0.0056

Resinous Softwood Pine Family

Step No. 1: Summarize test results

Throughout the course of three test runs at facility No. 112, NCASI simultaneously measured emissions from both exhausts of the board cooler section to veneer dryer No. 2 as presented in the table immediately below:

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Exhaust Nearest the Heating Zone or Dryer Exit?	Wood Species	Notes	NCASI TB768 Page No.	Hazardous Air Pollutant Emissions (lb/msf 3/8")						Non-HAP (lb/msf 3/8")
								Acetaldehyde	Methanol	Methyl Isobutyl Ketone	Phenol	m,p-Xylene	o-Xylene	Acetone
Run 112-2DV4N1	112	2	J	HZ	50/50 PP/DF	PP & DF combined	26-42 & B5	0	0	0	0	0	0	0.0014
Run 112-2DV3N1	112	2	J	DE	50/50 PP/DF	PP & DF combined	26-42 & B4	0	0	0	0	0	0	0.0065
Combined, refer to single run 112-2DV3&4N1								0	0	0	0	0	0	
Run 112-2DV4N2	112	2	J	HZ	50/50 PP/DF	PP & DF combined	26-42 & B5	~~0~~	~~0.00760~~	~~0.0096~~	~~0~~	~~0~~	~~0~~	~~0.0071~~
Run 112-2DV3N2	112	2	J	DE	50/50 PP/DF	PP & DF combined	26-42 & B4	~~0.027~~	~~0.033~~	~~0.037~~	~~0~~	~~0~~	~~0~~	~~0.035~~
Combined, refer to single run 112-2DV3&4N2								~~0.0270~~	~~0.0406~~	~~0.0466~~	~~0~~	~~0~~	~~0~~	
Run 112-2DV4N3	112	2	J	HZ	50/50 PP/DF	PP & DF combined	26-42 & B5	0	0	0	0	0	0	0.00093
Run 112-2DV3N3	112	2	J	DE	50/50 PP/DF	PP & DF combined	26-42 & B4	0	0	0	0	0	0	0.0053
Combined, refer to single run 112-2DV3&4N3								0	0	0	0	0	0	

With no HAP having been detected during the two runs (N1 & N3) remaining for consideration given NCASI's October 14, 2015 letter to EPA Region 10, the resultant emission factor for all HAP: 0 lb/msf 3/8"

Abbreviations/Acronyms

DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
WPP1 VOC: EPA Interim VOC Measurement Protocol for the Wood Products Industry - July 2007

EPA Region 10 HAP and VOC Emission Factors for Veneer Dryer Leaks while Processing Pacific Northwest Resinous and Non-Resinous Softwood Veneer

This sheet presents full-scale emissions test data for veneer dryer leaks associated with processing Pacific Northwest resinous softwood veneer as reported in National Council for Air and Stream Improvement (NCASI) January 1999 Technical Bulletin No. 768 (TB768) - Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities Part I - Plywood. Information presented in TB768 was later clarified by NCASI in an October 14, 2015 letter to EPA Region 10. Based upon NCASI's test data, EPA Region 10 has calculated veneer dryer leaking methanol emission factors of 0.0026 and 0.0039 lb/msf (3/8 inch), respectively, for resinous non-pine family and resinous pine family softwood categories of wood species. In the absence of any test data for the lesser-emitting non-resinous softwood category, EPA Region 10 estimates that the veneer dryer leaking methanol emission factor for non-resinous softwood is approximately 0.0026 lb/msf; the lesser of the two resinous softwood values. Because NCASI did not perform RM25A testing, VOC emissions are estimated to be equal to the sum of the individual HAPs detected. Of the 20 HAPs sampled and analyzed for, only methanol was detected while processing douglas fir (resinous non-pine family) and ponderosa pine (resinous pine family) veneer. The emission factors are based on the 90th percentile value for three test runs. For a listing of the sampling and analysis techniques NCASI employed to measure each of the 29 targetted hydrocarbons (HAP and non-HAP), see Tables 2.1 and 2.2 of TB768.

TB768's Tables 4.2.4, 5.2.1 and B6 suggest that testing results for Source 112-1MF1 reflect emissions generated by leaks from dryer No. 2 alone. But in NCASI's October 14, 2015 letter to EPA Region 10, NCASI states that "it is reasonable to assume that building vent 1MF1 captures fugitive emissions from additional sources other than the no. 2 dryer." NCASI further states, "A reasonable assumption would be to allocate building vent 1MF1 to the two dryers... The production rate for building vent 1MF1, therefore, should reflect the throughput assocated with both dryers, or approximately 25 msf 3/8" per hour, instead of just the no. 2 dryer." EPA Region 10 accepts NCASI's October 14, 2015 explanation, and the calculations below performed by EPA Region 10 assume a veneer dryer production rate of 25 msf 3/8" per hour for all three runs of Source 112-1MF1. For example, the methanol emission rate of 0.0088 lb/msf 3/8" per hour for Run 112-1MF1N1 published in TB768's Table B6 was multiplied by a factor of "8/25" to arrive at an amended emission rate of 0.0028 lb/msf 3/8 per hour. A similar adjustment was made for methanol emission rates generated by Runs 112-1MF1N2 and N3.

In its work in support of TB768, NCASI measured emissions generated by veneer dryer leaking while processing ponderosa pine and douglas fir veneer together. HAP emissions attributable to leaks while processing each species separately can be estimated as illustrated below.

Step No. 1: Summarize test results

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	Notes	NCASI TB768 Page No.	HAP Emissions (lb/msf 3/8")
							Methanol
Run 112-1MF1N1	112	2	J	50/50 PP/DF	PP & DF combined	26-42 & B6	0.0028
Run 112-1MF1N2	112	2	J	50/50 PP/DF	PP & DF combined	26-42 & B6	0.0033
Run 112-1MF1N3	112	2	J	50/50 PP/DF	PP & DF combined	26-42 & B6	0.0031

Step No. 2: Estimate contribution of each species to test measurements

$Compound_{X\text{-}PP\ RUN112\text{-}1MF1N1}$ = [2 X ($Compound_{X\text{-}PP/DF\ RUN112\text{-}1MF1N1}$)] - $Compound_{X\text{-}DF\ RUN112\text{-}1MF1N1}$

where: $Compound_{X\text{-}PP/DF\ RUN112\text{-}1MF1N1}$ = 1/2 X ($Compound_{X\text{-}PP\ RUN112\text{-}1MF1N1}$ + $Compound_{X\text{-}DF\ RUN112\text{-}1MF1N1}$). Because equal amounts of ponderosa pine and douglas fir were processed during Run 112-1MF1N1, the resultant mass emission rate "lb/msf 3/8"" reflects an equally weighted or average value.

$Compound_{X\text{-}PP/DF\ RUN112\text{-}1MF1N1}$ is the measured mass emission rate of $Compound_X$ during Run 112-1MF1N1. Douglas fir and ponderosa pine veneer were processed during Run 112-1MF1N1 in equal amounts.

$Compound_{X\text{-}PP\ RUN112\text{-}1MF1N1}$ represents mass emission rate of $Compound_X$ during Run 112-1MF1N1 due to contribution of ponderosa pine. $Compound_{X\text{-}DF\ RUN112\text{-}1MF1N1}$ represents mass emission rate of $Compound_X$ during Run 112-1MF1N1 due to contribution of douglas fir. These values were not measured; they will be estimated based upon estimated ratio of the two values derived from test measurements of veneer heating emissions at dryer No. 2 at facility No. 112. See spreadsheet entitled, "EPA Region 10 WPP1 VOC Emission Factor for Cooling Pacific Northwest Resinous Softwood Pine Family Veneer via Indirect Steam Heat without Air Pollution Controls."

From spreadsheet entitled, "EPA Region 10 WPP1 VOC Emission Factor for Cooling Pacific Northwest Resinous Softwood Pine Family Veneer via Indirect Steam Heat without Air Pollution Controls":

	Estimate of Ratio of Ponderosa Pine to Douglas Fir Mass Emission Rate
Pollutant/Compound (as measured)	Run 112-2DV5&6N1-6
Methanol	1.52

The calculation to estimate the methanol emission rate attributable to veneer dryer leaks while processing ponderosa pine veneer during Run 112-1MF1N1, $Methanol_{PP\ RUN112\text{-}1MF1N1}$ = [2 X ($Methanol_{PP/DF\ RUN112\text{-}1MF1N1}$)] - $Methanol_{DF\ RUN112\text{-}1MF1N1}$, becomes:

$Methanol_{PP\ RUN112\text{-}1MF1N1}$ = [2 X ($Methanol_{PP/DF\ RUN112\text{-}1MF1N1}$)] - ($Methanol_{PP\ RUN112\text{-}1MF1N1}$ / 1.52), given an assumed ratio of "$Methanol_{PP\ RUN112\text{-}1MF1N1}$ / $Methanol_{DF\ RUN112\text{-}1MF1N1}$" equal to 1.52. Substituting the measured value of 0.0028 for $Methanol_{PP/DF\ RUN1121MF1N1}$ and solving for $Methanol_{PP\ RUN112\text{-}1MF1N1}$:

1.6593 X $Methanol_{PP\ RUN112\text{-}1MF1N1}$ = 2 X 0.0028

$Methanol_{PP\ RUN1121MF1N1}$ = 0.0034 lb/msf 3/8"

To estimate methanol emissions attributable to leaks while processing douglas fir veneer for the same run, the following calculation is carried out:

$Methanol_{DF\ RUN112\text{-}1MF1N1}$ = $Methanol_{PP\ RUN112\text{-}1MF1N1}$ / 1.52

$Methanol_{DF\ RUN112\text{-}1MF1N1}$ = 0.0034 / 1.52

$Methanol_{DF\ RUN112\text{-}1MF1N1}$ = 0.0022 lb/msf 3/8"

The results of the calculations are presented in the table immediately below:

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	HAP Emissions (lb/msf 3/8")
					Methanol
Run 112-1MF1N1	112	2	J	DF	0.0022
				PP	0.0034
Run 112-1MF1N2	112	2	J	DF	0.0026
				PP	0.0040
Run 112-1MF1N3	112	2	J	DF	0.0025
				PP	0.0038

Step No. 3: Calculate emission factors

Resinous Softwood Non-Pine Family

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	HAP Emissions (lb/msf 3/8")
					Methanol
Run 112-1MF1N1	112	2	J	DF	0.0022
Run 112-1MF1N2	112	2	J	DF	0.0026
Run 112-1MF1N3	112	2	J	DF	0.0025
				3-run 90th percentile value	0.0026
				3-run average value (informational purposes only)	0.0024

Resinous Softwood Pine Family

Emission Test Run ID	Facility No.	Veneer Dryer No.	Veneer Dryer Type	Wood Species	HAP Emissions (lb/msf 3/8")
					Methanol
Run 112-1MF1N1	112	2	J	PP	0.0034
Run 112-1MF1N2	112	2	J	PP	0.0040
Run 112-1MF1N3	112	2	J	PP	0.0038
				3-run 90th percentile value	0.0039
				3-run average value (informational purposes only)	0.0037

Abbreviations/Acronyms

DE: dryer exit
DF: douglas fir
ECN: effective carbon number
FID: flame ionization detector (aka THC analyzer)
GC/FID: gas chromatograph with a flame ionization detector
GC/MS: gas chromatograph with a mass spectrometer
HC: hydrocarbon
HZ: heating zone
J: jet
L: longitudinal
MSF: one thousand square feet
MW: molecular weight
NCASI: National Council for Air and Stream Improvement
NMP: no measurement performed
PF: phenol formaldehyde
PP: ponderosa pine
RM25A: EPA Reference Method 25A
RF: THC analyzer response factor
RM25A: EPA Reference Method 25A
THC: total hydrocarbon
WF: white fir
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ncasi

NATIONAL COUNCIL FOR AIR AND STREAM IMPROVEMENT, INC.
402 SW 140th Terrace, Newberry, FL 32669
Phone (352) 331-1745 || Fax (352) 331-1766

Vipin K. Varma, PhD
Vice President, Air Quality and
Director, Southern Region
(352) 331-1745
(904) 891-5021
vvarma@ncasi.org

October 14, 2015

Mr. Dan Meyer
USEPA Region 10
1200 Sixth Avenue
Mail Code: AWT-150
Seattle, WA 98101

Re: Evaluation of the Plywood Mill 122 Dataset in NCASI Technical Bulletin 768

Dear Dan:

This is a follow-up to your email and subsequent telephone conversation requesting the National Council for Air and Stream Improvement (NCASI) to review your analysis and assumptions used in calculating HAP emission factors for use in developing an operating permit for a plywood manufacturing facility in the Pacific Northwest. Mr. Richard Law, Project Engineer at NCASI, reviewed your approach and assumptions and, during this process, also reviewed the underlying data published in NCASI Technical Bulletin No. 768 (TB768), *Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities, Part I – Plywood.* Based on this review, NCASI has concluded that the corrections summarized below should be applied when using the information provided in TB 768 to establish HAP emission factors for the above-mentioned generic Pacific Northwest plywood manufacturing facility.

Correction #1. Invalid production rate for source codes 2DV3N2 and 2DV4N2.

Summary of issue: A production rate of 1.5 MSF 3/8/hr was reported for the second test of the two cooling sections, 2DV3N2 and 2DV4N2, for the Mill 112 no. 2 dryer. After a comparison of this production rate with the production rates reported for the eight additional tests conducted on the no. 2 dryer, which ranged from 7.9 to 9.0 MSF 3/8/hr, it is evident that 1.5 MSF 3/8/hr is not a representative production rate for the no. 2 dryer at Mill 112.

Corrective action: Due to the above-stated reason, the production-based mass emission rates derived for the second test of the two cooling vents for the no. 2 dryer, Source Codes 2DV3N2 and 2DV4N2, should not be considered for emission factor determinations. Since the first and third tests are valid, and have non-detect levels of acetaldehyde, methanol, and methyl isobutyl ketone (MIBK), the default value of zero has been applied to the HAP emission factors for the no. 2 dryer cooling sections. Further details are provided in Attachment 1.

Correction #2. ***Change the production rate for the Mill 112 building vent 1MF1 Ponderosa Pine/Douglas Fir (PP/DF) methanol mass emission factor.***

Summary of Issue: The production-based mass emission rate for the building vent (112-1MF1) provided in TB768 was calculated using the production rate from only the no. 2 dryer. While building vent 1MF1 is described as being located over the no. 2 dryer, it should not be considered as exclusively capturing fugitives from the no. 2 dryer because the no. 2 dryer is located in the same building with the no. 3 dryer and two presses. In short, this building houses 2 dryers and 2 presses – fugitive emissions from these sources are vented through two building roof vents, 1MF1 and 1PB1. Therefore, it is reasonable to assume that building vent 1MF1 captures fugitive emissions from additional sources other than the no. 2 dryer.

Corrective action: If building vent HAP emissions are used to calculate a production-based fugitive HAP emission rate (termed leakage rate in your analysis), the production rates used to calculate the HAP mass emission factors for the three tests of the building vent 112-1MF1 need to be modified. A reasonable assumption would be to allocate building vent 1MF1 to the two dryers and press vent 1PB1 to the two presses. The production rate for building vent 1MF1, therefore, should reflect the throughput associated with both dryers, or approximately 25 MSF 3/8/hr, instead of just the no. 2 dryer.

The result of this correction changes the 3-run 90th percentile value of building vent 1MF1 for the PP/DF methanol mass emission factor from 0.0458 lb/MSF 3/8 to 0.0033 lb/MSF 3/8. Further details are provided in Attachment 1.

Correction #3. ***Estimate of PP:DF mass ratios.***

As noted above, building vent 1MF1 was tested during a period when PP/DF furnish mix was processed. EPA-R10 has used the PP/DF methanol emission factor described above along with a PP:DF mass ratio of 4.1 to estimate the methanol emission factors for the building vent when 100% Ponderosa pine and 100% Douglas-fir are processed.

There are, however, two discrepancies in TB768 which have a significant impact on EPA-R10's estimated PP and DF methanol emission factor determinations. This correction changes the Resinous Softwood Non-Pine family methanol lb/MSF 3/8 value from 0.0181 to 0.0027 and the Resinous Softwood Pine family methanol lb/MSF 3/8 value from 0.0735 to 0.0044 lb/MSF 3/8. Further details are provided in Attachment 1.

It is our technical assessment that the above-mentioned corrections are important if the data are to be used as envisioned in your analysis. Concurrent to your request for our technical assessment, NCASI was also approached by Omak Wood Products' parent company Atlas Holdings, and its consultant ENVIRON, for clarifications on the same issue. Subsequently, we are hereby also forwarding a copy of our technical assessment to Omak and ENVIRON.

General Comments on use of 90th Percentile Value of Emission Factors for Analysis

It is our understanding that the data from Technical Bulletin 768, and the underlying analysis, are being used to estimate the total annual methanol (and HAP) emissions from all sources at the plywood manufacturing facility. In other words, this is a summation of methanol (HAP) emissions from all affected sources over the course of the entire year**. We believe the use of 90th percentile values is overly conservative and inappropriate when the goal is to estimate total potential emissions over the course of the year.** One could use the 90th percentile value (or an alternate measure of worst-case emissions) if one were evaluating compliance at any given point in time (i.e., if the objective is to evaluate whether a series of future 1-hr emission tests, conducted during a random 3-hr window, would meet or exceed an emission limit). For instance, the Upper Prediction Limit (UPL) has been used by EPA in MACT rulemakings for setting emission standards – the intent there being to identify what a future 3-hr emission test would yield on the basis of available data on emissions from best performing units. The use of the 90th percentile is also inappropriate given the potential it creates for one high number to bias the outcome, especially in small datasets where an outlier analysis has not been conducted.

Given you are intending for these data to be used in estimating total potential emissions over the course of the entire year, it is our technical assessment that average values are more appropriate.

Please feel free to contact me or Richard Law at (352) 331-1745 if you have additional questions on our technical assessment.

Sincerely,

Vipin Varma

cc: Kyle Heitkamp, ENVIRON International Corporation
David Critchfield, Atlas Holdings LLC
Rob Crawford, NCASI
David Word, NCASI
Richard Law, NCASI

ATTACHMENT 1

This attachment provides a detailed explanation of the corrections noted in the October 14, 2015 NCASI letter to EPA relative to *Evaluation of the Plywood Mill 122 Dataset in NCASI Technical Bulletin 768.* Accompanying this Attachment are three electronic Excel spreadsheet files and Appendix A.

1.0 Introduction

EPA Region 10 (EPA-R10) recently conducted an assessment of western softwood plywood mill emission factors for HAP emitting activities. Since there were limited HAP data available, EPA-R10 relied exclusively on NCASI Technical Bulletin No. 768, *Volatile Organic Compound Emissions from Wood Products Manufacturing Facilities, Part I – Plywood*. The data compiled for this technical bulletin (TB768) represent one component of a multiphase testing program conducted in the late 1990s to prepare for the implementation of the Wood Products NESHAP. In addition to plywood, the NCASI testing program also collected HAP emission data from OSB, particleboard, MDF, hardboard/fiberboard, and engineering wood products mills. This testing program primarily targeted dryers and presses since those were the major HAP emission points at all of the product mill types. Limited emphasis was placed on collecting emission data from other source types due in part to the complex testing scenarios generally encountered.

While the NCASI wood products MACT testing program was extensive, it was impractical to include all dryers, presses, and other miscellaneous HAP emission sources at each product mill and cover all wood species being processed by this industry. As a consequence, NCASI selected a few mills from each product type that had dryers and presses that were testable in order to collect representative HAP emissions data. Efforts were made to include wood species specific HAP emission data where the opportunity was available.

EPA-R10's desire to model the HAP emission activities for a typical Pacific Northwest plywood mill led them to NCASI's TB768. The HAP emission activities extracted from TB768 by EPA-R10 are listed in Table 1. Note that four of the activities of interest were based on emission data from processing southern pine furnish because western softwood data were not available. EPA-R10 also subcategorized the dryer heated and cooling zones and dryer leakage into three generic western softwood categories: non-resinous softwood, resinous softwood/non-pine family, and resinous softwood/pine family. EPA-R10 used the limited HAP dataset for White fir (WF) and Douglas-fir (DF) to meet the wood species criteria for the first two categories, respectively. EPA-R10 used the Ponderosa pine/Douglas-fir mix (PP/DF) and DF only datasets to back-calculate the Ponderosa pine (PP) emission data to represent the last western softwood category. The emission data compiled by EPA-R10 are provided in the two spreadsheets that accompany this attachment titled: 'veneer dryer voc & hap ef rev1.xlsx' and 'plywood mill voc & hap ef rev2.xlsx'.

The intent of the HAP data provided in the technical bulletins that resulted from the NCASI wood products MACT testing program was to provide screening level data for the NESHAP rulemaking and not specifically for emission factor development. As a consequence, NCASI has taken a closer look at TB768 and how EPA-R10 has utilized the HAP data within to establish HAP emission factors for a generic Pacific Northwest plywood mill. The result of this examination has disclosed some inconsistencies in TB768 that led EPA-R10 to generate non-representative HAP emission factors. The following discussion addresses the issues found with the dryer cooling section data and dryer leakage data (or building vent). These issues have been corrected in the third spreadsheet that accompanies this attachment titled: 'plywood mill voc & hap ef ver5.xlsx'.

Table 1. EPA's List of Plywood Mill Activity HAP Emission Sources

Species	Activity	Wood Species
All Pacific Northwest Softwood Species	Log Steaming	DF/L
	Dryer Heating Section	WF/DF/PP
	Dryer Cooling Section	DF/PP
	Building Vent	DF/PP
	Layup Trim Chipping	SYP
	Plywood Hot Pressing	DF/PP/L
	Plywood Trim Chipping & Plywood Sanding	SYP
	Plywood Residue Recovery	SYP
	Plywood Sanderdust Recovery	SYP

1.1 Mill 112 No. 2 Dryer Cooling Section, 2DV3 and 2DV4

The no. 2 veneer dryer at Mill 112 has a normal production rate of 8.5 MSF 3/8/hr. Table 4.2.4 from the NCASI TB768 has been provided in **Appendix A-1** to show that the no. 2 dryer was tested nine times, six tests for the heated sections and three tests for the cooling sections. Note that:

- The six tests of the heated sections for the no. 2 dryer (2DV5 and 2DV6) had production rates that ranged from 7.9 to 9.0 MSF 3/8/hr.

- Two out of the three tests (Runs 1 and 3) for the cooling section for the no. 2 dryer (2DV3 and 2DV4) had production rates of 8.0 and 8.8 MSF 3/8/hr, respectively.

- Run 2 of the cooling section test for the no. 2 dryer (2DV3 and 2DV4), however, had a production rate of 1.5 MSF 3/8/hr, which is significantly different than the production rates being reported for the eight tests above.

The production rate being reported for Run 2 of the cooling section, therefore, appears to be an anomaly that is either (1) a reporting error of the actual production during this test, (2) a data entry error during the compilation of the test data, or (3) an actual but "not-representative" production rate through the dryer during the test. Regardless, the 1.5 MSF 3/8/hr production rate is not a representative value and significantly impacts the derivation of the Run 2 production based mass emission factor for methanol.

The perspective that Run 2 is an anomaly is also evident in the methanol concentration data being reported. The four tests conducted during normal dryer throughput (Runs 1 and 3), the cooling vent exhaust section 1 (112-2DV4) and section 2 (112-2DV3) had non-detect levels of methanol. The same two exhaust vents tested under non-representative conditions during Run 2 yielded slightly higher results that were between non-detect and the practical quantitation limit. The reason for this discrepancy is unclear. Note that the dryer process data shown in Table 4.2.4 (Appendix A-1), specifically the %redry and dryer temperature data, are not significantly different for Run 2 when compared to the remaining dryer datasets. Therefore, if the dryer throughput during Run 2 was actually significantly lower, as indicated by the reported data, then it is possible that the heat input, which is normally absorbed by the green veneer, was cooking the dryer walls, belts, or other residues – the consequence being emissions that do not represent normal operating scenarios.

After re-evaluating the Mill 112 Dryer 2 cooling section data within TB768, NCASI has determined that there is sufficient uncertainty to warrant discarding the emissions being reported for Run 2 of this test event. Since the remaining methanol data for Runs 1 and 3 are non-detect, the dryer cooling section “Activity” is now zero as per your analysis method.

2.0 Building Vent 112-1MF1 Production Rate

According to the press description provided on page 37 of TB768, the press side of the production building at Mill 112 has three vents, one fan-driven roof vent (1PB1) and two roof cupolas which are not fan-driven. Assuming that these three vents adequately ventilate the press side of the building under normal operating conditions and the dryer side of the building does not have additional roof cupolas, it is not unreasonable to assume that building vent 1MF1 captures fugitives from both dryers.

From the perspective that building vent 1MF1 captures the “fugitive” from both dryers, the production rate associated with this test location will have to be adjusted. Unfortunately, building vent 1MF1 was not tested on the same day as the testing of the combined dryer vent, therefore, the exact production rate of both dryers is not known on the day of the building vent test. However, the heated sections (green and dry end exhaust) of the no. 2 dryer (2DV5 and 2DV6) were tested at the same time as the combined dryer vent (XDV2). Based on the fact that the no. 2 dryer was operating at approximately the same production rate for the three heated section tests and for Runs 1 and 3 of the cooling section tests, it appears that a production rate of 25 MSF 3/8/hr is a reasonable approximation for the combined dryer production rate for building vent 1MF1 (refer to Appendix A-1). The corrected production rate impacts the building vent (1MF1) emission factor in the following two ways:

1. The high methanol emission factor determined for 112-1MF1N2, 0.055 lb/MSF 3/8, is thrown out because this value is a direct result of using the non-representative production rate for the no. 2 dryer, a value of 1.5 MSF 3/8/hr.

2. The 3-run 90th percentile methanol mass emission factor for PP/DF building vent 1MF1 changes from 0.0458 to 0.0033 lb/MSF 3/8.

The determination of the revised methanol emission factor for building vent 1MF1 is summarized in Table 2 with detailed calculations provided in the spreadsheet ‘plywood mill voc & hap ef ver5’.xlsx, worksheet ‘Leaking HAP&VOC’, cell range A10:R13.

Table 2. Revised Calculation of Building Vent 1MF1 PP/DF Methanol Emissions

Emission Test Run ID	Wood Species	TB768 Methanol Emissions (lb/MSF 3/8)	TB768 (MSF 3/8/hr)	Methanol Emissions (lb/hr)	Revised (MSF 3/8/hr)	Revised Methanol Emissions (lb/MSF 3/8)
Run 112-1MF1N1	PP/DF	0.0088	8.0	0.0704	25	0.0028
Run 112-1MF1N2	PP/DF	0.0550	1.5	0.0825	25	0.0033
Run 112-1MF1N3	PP/DF	0.0089	8.8	0.0783	25	0.0032
3-run 90th percentile value =		0.0458				0.0033
Average =		0.0242				0.0031

3.0 Estimate of PP:DF Mass Ratios

EPA-R10 has generated emission factors for both VOC as WPP1 and individual HAP for the WF, DF, and PP wood species being processed by a generic Pacific Northwest plywood mill. In doing so, EPA-R10 has estimated some of the DF and PP emission factors for certain activities due to the lack of perceived available data. The estimation has been based on existing data and resulting emission factors appear to be biased high.

Specifically, EPA-R10 estimates the Heating PP VOC, Heating HAP PP dataset, Cooling PP VOC, Cooling HAP PP dataset, and Leaking HAP&VOC DF and PP datasets. All of these estimated emission factors are based on the assumption that (1) a 50/50 mix of PP/DF was dried, and (2) the relationship of HAP emissions determined from one dryer run (112-XDV2N4) of PP/DF dataset to one dryer run (112-XDV1N1) of 100% DF dataset is valid for all other cases. As a consequence of the assumptions made, EPA-R10 used the following formula to estimate the HAP mass emission rates for the Heating PP VOC dataset.

lb 3 m no lb 3l m anol b 3l m nol

This single relationship established the PP to DF mass ratio that was then used to extrapolate the HAP mass emission rates for the PP and DF wood species datasets for the various other activities. While this detailed explanation is provided for methanol, the line of reasoning would also be applicable to the other HAP mass emission rates that EPA has estimated.

The top portion of Table 3 shows how EPA-R10 estimated a methanol mass emission rate of 0.0610 lb/MSF3/8 for the Heating PP VOC dataset. This value then was used to determine a PP:DF mass ratio of 4.07 for methanol. This PP:DF mass ratio is found in cell D98 of the ‘Heating PP VOC’ worksheet of the ‘veneer dryer voc & hap ef’ file. The estimated PP and DF methanol mass emission factors in the Leaking HAP&VOC worksheet were all derived from this mass ratio.

Table 3. Comparison of EPA-R10's Estimated Values for Ponderosa Pine Methanol lb/MSF3/8

	Combined Dryer WESP Inlet				EPA-R10 Estimated PP Methanol Calculation based on 50%PP/50%DF Mix				
Data Source:	Source	Measured PP/DF Methanol lb/MSF3/8	Source	Measured DF Methanol lb/MSF3/8	2xMeasured PP/DF value	-	Average Measured DF value	=	Estimated PP Methanol lb/MSF3/8
EPA's 'Heating PP VOC' worksheet	112-XDV2N4	0.0380	112-XDV2N1	0.0150	0.0760	-	0.0150	=	0.0610
Calculated PP:DF mass ratio from EPA's 'Heating PP VOC' worksheet =									4.07
EPA's 'Heating HAP' worksheet	112-XDV2N4	0.0380	112-XDV2N1	0.0150	0.0760	-	0.0227	=	0.0533
	112-XDV2N5	0.0210	112-XDV2N2	0.0320	0.0420	-	0.0227	=	0.0193
	112-XDV2N6	0.0240	112-XDV2N3	0.0210	0.0480	-	0.0227	=	0.0253
			average =	0.0227					0.0327
Calculated PP:DF mass ratio from EPA's 'Heating HAP' worksheet =									1.44

EPA-R10, however, determined a much lower PP methanol mass emission factor in the ‘Heating HAP’ worksheet which leads to a much lower PP:DF methanol mass ratio. In this case, a different approach was used where the 3-run average of the DF test 112-XDV2N1-3 and the individual PP/DF mix sample run values for 112-XDV2N4, N5, and N6 were used to calculate an average PP methanol emission factor of 0.0327 lb/MSF3/8 (shown in ‘Heating HAP’!M119). This second set of data is also provided in Table 3 and indicates that the PP:DF mass ratio could have the significantly lower value of 1.44.

The discrepancy in the two EPA PP:DF mass ratios led NCASI to conduct a detailed assessment of EPA-R10’s estimation technique of PP emission factors. The outcome of this assessment found inconsistencies with the Mill 112 source descriptions provided in TB768 that impact EPA-R10’s estimation of PP emission factors.

1. The first issue relates to the description of drying equal amounts of PP and DF furnish during the 112-XDV2 tests. The description provided for the combined dryer test in Table 4.2.4 of TB768, and included as Appendix A-1, indicates a 50/50 PP/DF mix was dried in the no. 2 and no. 3 dryers. However, the two dryers are not the same size. The no. 2 dryer has 6 decks with an average production rate of approximately 9 MSF 3/8/hr and the no. 3 dryer has 8 decks with an average production rate of 16 MSF 3/8/hr[1]. Based on the dryer description on page 31 of TB768, the no. 2 dryer dried Ponderosa pine and the no. 3 dryer dried Douglas-fir, therefore, a more accurate furnish feed ratio appears to be 34/66 PP/DF mix instead of a 50/50 mix.

2. The second inconsistency in TB768 appears in the description of the wood species processed by the no. 2 dryer at Mill 112. Table 4.2.1, provided as Appendix A-2, indicates that the wood species processed for the test program at Mill 112 followed this trend:

   - For the combined dryer tests XDV1 and XDV2
     - Runs 1-3 processed 100% DF furnish.
     - Runs 4-6 processed a 50%PP/50%DF furnish mix.

   - For the no. 2 dryer dry end (211-2DV5) and green end (211-2DV6) tests
     - Runs 1-3 conducted with 100% DF furnish.
     - Runs N4-6 conducted with a 50%PP/50%DF furnish mix.

   However, the information provided in Table 4.2.4 (Appendix A-1) shows that Runs 4-6 for the no. 2 dryer processed 100% Ponderosa pine and not the 50%PP/50%DF mix. This information compares with the last paragraph of Section 4.2.1 *Softwood Veneer Dryer, Mill 112,* provided on page 31 of TB768, which also states that 2DV5 and 2DV6 Runs 4-6 tests were processing only Ponderosa pine.

With these two new perspectives, Ponderosa pine emission data were collected from the no. 2 dryer (112-2DV5&6N4-6) at the same time as the PP/DF mix testing was conducted at the combined dryer WESP inlet, 112-XDV2. This means that the PP:DF mass ratio does not need to be estimated but can be determined directly from the measured data.

- Step 1 of Table 4 shows how EPA-R10’s calculation methodology has been modified by substituting the 34%PP/66%DF mix for the original 50%PP/50%DF mix and how the DF methanol lb/MSF3/8 factor can be calculated from the measured PP and PP&DF datasets.

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[1] As calculated from the total production rate of 26 MSF 3/8/hr for both dryers – 9 MSF 3/8/hr for the no. 2 dryer.

- Step 2 of Table 4 calculates the DF methanol lb/MSF3/8 factor.

- Step 3 compares the estimated DF methanol emission factor (0.0216 lb/MSF3/8) to the average measured DF methanol emission factor (0.0243 lb/MSF3/8). This favorable comparison indicates that the 34%PP/66%DF mix is a reasonable correction.

- Step 4 of Table 4 compares the PP:DF mass ratios from the measured datasets (1.62) to
  - The value derived from the no. 2 dryer PP and DF datasets only (1.52)
  - The value derived within EPA-R10's 'Heating PP VOC' worksheet (4.07)
  - The value derived in EPA-R10's 'Heating HAP' worksheet (1.44)

The consequence of the two discrepancies within TB768 is two-fold: (1) actual heated zone dryer PP test data are available from the testing of the no. 2 dryer, and (2) the PP:DF mass ratio can be directly calculated from measured datasets. Table 5 shows the comparison of the PP:DF mass ratios for THC, acetaldehyde, formaldehyde and methanol derived by EPA-R10 and the measured DF and PP datasets.

The PP and DF methanol mass emission rates for building vent 1MF1 that have been estimated by EPA-R10 are compared to the values derived from the revised PP:DF methanol mass ratio and actual dryer wood furnish mix in Table 6. The revised numbers are significantly lower than determined by EPA.

Table 4. Comparison of EPA-R10's Estimated Values for Ponderosa Pine Methanol lb/MSF3/8

Step 1 - Assume that the actual PP/DF percentages of furnish processed are:

no. 2 dryer %PP furnish processed	=	34%
no. 3 dryer %DF furnish processed	=	66%

Step 2 - Verify this assumption by estimating the DF lb/MSF3/8:

Measured PP&DF methanol lb/MSF3/8	=	34% methanol-PP + 66% methanol-DF
Estimated DF methanol lb/MSF3/8	=	(methanol-PP&DF - 34%methanol-PP)/66%

	No. 2 Dryer Heated Zone Data			Combined Dryer WESP Inlet			
Test Date	Source	Revised Wood Species	Measured Methanol lb/MSF3/8	Source	Wood Species	Measured Methanol lb/MSF3/8	Estimated DF Methanol lb/MSF3/8
7/31/1997	112-2DV5&6N4	PP	0.0470	112-XDV2N4	PP&DF	0.0380	0.033
7/31/1997	112-2DV5&6N5	PP	0.0290	112-XDV2N5	PP&DF	0.0210	0.017
8/1/1997	112-2DV5&6N6	PP	0.0420	112-XDV2N6	PP&DF	0.0240	0.015
		3-run average value	0.0393			0.0277	0.0216

Step 3 - Then compare the estimated and measured DF methanol lb/MSF3/8 values:

Source	Test Date	Wood Species	Measured Methanol lb/MSF3/8	Estimated DF Methanol lb/MSF3/8	Percent Difference
112-XDV2N1	7/29/1997	DF	0.0150		
112-XDV2N2	7/29/1997	DF	0.0320		
112-XDV2N3	7/29/1997	DF	0.0210		
112-2DV5&6N1	7/29/1997	DF	0.0250		
112-2DV5&6N2	7/29/1997	DF	0.0274		
112-2DV5&6N3	7/29/1997	DF	0.0254		
		6-run average DF value	0.0243	0.0216	12%

Step 4 - Check the Measured PP:DF mass ratio to EPA- R10's 2 PP:DF mass ratios:

		%difference
Calculated PP:DF mass ratio from measured combined dryer and no. 2 dryer PP and DF datasets =	1.62	
Calculated PP:DF mass ratio from measured no. 2 dryer PP and DF datasets =	1.52	-7%
Calculated PP:DF mass ratio from EPA's 'Heating PP VOC' worksheet =	4.07	86%
Calculated PP:DF mass ratio from EPA's 'Heating HAP' worksheet =	1.44	-12%

Table 5. Comparison of the Ponderosa Pine to Douglas Fir Mass Ratio as EPA-R10's Estimated by EPA-R10 and Calculated by the Measured Dataset

	EPA-R10 VOC as WPP1 Determination	EPA-R10 HAP Determination		No. 2 Dryer PP and DF Datasets		Combined Dryer and No. 2 Dryer PP and DF Datasets
		90th percentile	Average	90th percentile	Average	Average
THC as carbon	3.11			1.75	1.91	
Acetaldehyde	2.67	3.02	2.79	0.55	0.53	
Formaldehyde	3.53	17.2	14.0	0.92	0.96	
Methanol	4.07	1.60	1.44	1.70	1.52	1.62

Table 6. Building Vent (1MF1) Methanol Emissions (lb/MSF 3/8)

	EPA-R10 Determination		Combined Dryer and No. 2 Dryer PP and DF Datasets	
PP:DF ratio & mix	4.07	50/50	1.62	34/66
Wood Species	90th percentile	Average	90th percentile	Average
PP/DF	0.0458	0.0242	0.0033	0.0031
DF	0.0181	0.0096	0.0027	0.0026
PP	0.0735	0.0389	0.0044	0.0042

No. 2 and No. 3 Dryers
representative production rates

Table 4.2.4. Process Operating Conditions During Testing of the Softwood Veneer Dryers, Mill 112									
Source ID	Run No.	Furnish	Production Rate, MSF as 3/8"/hr	Veneer Thickness	Target Redry, %**	Average Green End Temperature, °F		Average Dry End Temperature, °F	
						Dryer 2	Dryer 3	Dryer 2	Dryer 3
XDV1, XDV2	1	DF	26.3	1/6" (20%),	30	345	340	375	350
	2	DF	26.5	1/8" (80%)	30	335	340	380	350
	3	DF	26.2		30	335	340	375	350
	4	50/50 PP/DF	15.9	1/8"	30	340	335	375	350
	5	50/50 PP/DF	29.7	1/8"	30	335	335	375	350
	6	50/50 PP/DF	23.9	1/8"	30	340	340	380	350
2DV5, 2DV6	1	DF	9.0	1/6" (50%),	30	345	-	375	-
	2	DF	9.0	1/8" (50%)	30	335	-	380	-
	3	DF	8.7		30	335	-	375	-
	4	PP	7.9	1/8"	30	340	-	375	-
	5	PP	7.9	1/8"	30	335	-	375	-
	6	PP	8.5	1/8"	30	340	-	380	-
2DV3, 2DV4, 1MF1	1	50/50 PP/DF	8.0	1/8"	30	345	-	375	-
	2	50/50 PP/DF	1.5	1/8"	30	345	-	370	-
	3	50/50 PP/DF	8.8	1/8"	30	345	-	380	-

*PP = Ponderosa Pine; DF = Douglas Fir

**Drying operating parameters are adjusted so that approximately 30% of the veneer passing through the dryer need further drying (usually in the RF dryers). Redry is counted in production during its first pass through the dryer.

No. 2 Dryer
representative production rate

No. 2 Dryer
heated sections

No. 2 Dryer
non-representative production rate

No. 2 Dryer
cooling sections

Table 4.2.1. Emission Test Program, Mill 112

Unit	Source Code	Source Description	Emission Testing Procedure*			Test Schedule		
			NICM	CO	M25A	Run	Date	Time
Softwood Veneer Dryer	XDV1	WESP Exhaust	X			1	7/29/97	1245-1345
		Douglas-fir Furnish	X		X	2	7/29/97	1520-1620
			X		X	3	7/29/97	1733-1833
		WESP Exhaust	X			4	7/31/97	1225-1325
		Pine/Fir Furnish	X		X	5	7/31/97	1440-1520
			X		X	6	8/1/97	0937-1037
	XDV2	WESP Inlet	X		X	1	7/29/97	1245-1345
		Douglas-fir Furnish	X			2	7/29/97	1520-1620
			X			3	7/29/97	1733-1833
		WESP Inlet	X		X	4	7/31/97	1225-1325
		Pine/Fir Furnish	X			5	7/31/97	1440-1520
			X			6	8/1/97	0937-1037
	2DV5	Dryer No. 2, Dry End Exhaust	X		X	1	7/29/97	1245-1345
		Douglas-fir Furnish	X			2	7/29/97	1520-1620
			X		X	3	7/29/97	1733-1833
		Dryer No. 2, Dry End Exhaust	X			4	7/31/97	1225-1325
Pine furnish		Pine/Fir Furnish	X		X	5	7/31/97	1440-1520
			X		X	6	8/1/97	0937-1037
	2DV6	Dryer No. 2, Green End Exhaust	X			1	7/29/97	1245-1345
		Douglas-fir Furnish	X		X	2	7/29/97	1520-1620
			X			3	7/29/97	1733-1833
		Dryer No. 2, Green End Exhaust	X		X	4	7/31/97	1225-1325
		Pine/Fir Furnish	X			5	7/31/97	1440-1520
			X			6	8/1/97	0937-1037
	2DV3	Dryer No. 2, Board Cooling Section	X			1	7/28/97	1455-1555
		Exhaust No. 2	X		X	2	7/28/97	1723-1817
			X		X	3	7/28/97	1955-2055
	2DV4	Dryer No. 2, Board Cooling Section	X			1	7/28/97	1455-1555
		Exhaust No. 1	X			2	7/28/97	1723-1817
			X			3	7/28/97	1955-2055

Table 4.2.1. (Cont'd) Emission Test Program, Mill 112

Unit	Source Code	Source Description	Emission Testing Procedure*			Test Schedule		
			NICM	CO	M25A	Run	Date	Time
Softwood Veneer Dryer (Cont'd)	1MF1	Veneer Dryer No. 2, Building Exhaust	X			1	7/28/97	1455-1555
			X			2	7/28/97	1723-1817
			X			3	7/28/97	1955-2055
Softwood Plywood Hot Board Press	1PB1	Powered Vent Above Board Press	X		X	1	7/30/97	1135-1235
			X		X	2	7/30/97	1400-1500
			X		X	3	7/30/97	1547-1647
Radio Frequency Dryer	1DM1	RF Dryer Exhaust	X		X	1	7/30/97	1212-1312
			X		X	2	7/31/97	0735-0835
			X		X	3	7/31/97	0928-1028
Log Steaming Vat	1ML1	Vat Exhaust	X			1	7/28/97	1100-1200
			X			2	7/28/97	1240-1340
			X			3	7/28/97	1455-1555

*NICM: NCASI Impinger/Canister Method; CO: Bacharach Combustion Analysis; M25A: Modified Method 25A (Total Hydrocarbon Analyzer)

From:	Varma, Vipin
To:	Meyer, Dan; Law, Ric (SRC)
Cc:	"Kyle Heitkamp"; Crawford, Robert (SRC); Word, David (SRC); "David Critchfield"
Subject:	RE: Request for Information Related to Mill 112 from NCASI TB 768
Date:	Wednesday, February 03, 2016 6:29:00 AM

Hi Dan,

Yes, we contacted Mill 112 about (a) the layout of vent 1MF1 and (b) what the emissions from this vent would include. We have received confirmation from the mill that both veneer dryers were operational during that general time period. In fact, the mill provided confirmation that, in their old configuration (at the time of NCASI testing) VD2 and VD3 were in poor condition—and the floors, doors and cooling sections had fugitives.

Additionally, mill has opined that 1MF1 likely also included fugitive emissions from the layup line, VD2 and VD3.

Unfortunately, as I had speculated when we met in Seattle in December, the mill does not have production data etc. dating that far back.

Please let me know if you have any additional questions.

Vipin

From: Meyer, Dan [mailto:Meyer.Dan@epa.gov]
Sent: Monday, February 01, 2016 2:40 PM
To: Law, Ric (SRC)
Cc: 'Kyle Heitkamp'; Varma, Vipin; Crawford, Robert (SRC); Word, David (SRC); 'David Critchfield'
Subject: RE: Request for Information Related to Mill 112 from NCASI TB 768

Hi Ric,

Just checking to see whether you were intending to try and hunt down historical operating records for Mill 112 as outlined below. The records would help clear up a few data points presented in technical bulletin 768. EPA Region 10 is leaning on the technical bulletin to develop species-specific veneer dryer emission factors, and the value for some factors is somewhat unsettled in my mind without the additional information requested below. If you could help, that would be great.

Dan Meyer
206.553.4150
Office of Air, Waste and Toxics
Air Permits and Diesel Unit
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

From: Meyer, Dan
Sent: Friday, October 30, 2015 9:06 AM
To: Ric Law <rlaw@src-ncasi.org>
Cc: Kyle Heitkamp <kheitkamp@environcorp.com>; Varma, Vipin <vvarma@ncasi.org>; Rob

Crawford <rcrawford@src-ncasi.org>; David Word <dword@src-ncasi.org>; David Critchfield <critchfield@emsource.com>
Subject: Request for Information Related to Mill 112 from NCASI TB 768

Thanks Ric for reviewing my spreadsheets and sharing your analysis. I've read through your comments, and I need some help with the following items:

1. Mill 112 Veneer Dryer No. 2 Production Records for Source Codes 2DV3N2, 2DV4N2 and 1MF1N2.
Can you provide me a copy of veneer dryer operating records for source codes 2DV3N2, 2DV4N2 and 1MF1N2? I'm referring to records that would convey information about Mill 112 Veneer Dryer No. 2's production rate during the common test run for these three source codes.

2. Mill 112 Veneer Dryer No. 3 Production Records for Time Period Associated with Source Codes 1MF1N1, 1MF1N2 and 1MF1N3
Can you provide me a copy of Veneer Dryer No. 3 operating records for time period associated with source codes 1MF1N1, 1MF1N2 and 1MF1N3? I'm referring to records that would convey information about Mill 112 Veneer Dryer No. 3's production rate during the following three time periods on July 28, 1997: 1455 – 1555, 1723 – 1817 and 1955 – 2055.

3. Mill 112 Plot Plan for Building Housing Veneer Dryers and Presses
Can you provide me a copy of a plot plan for the building housing the veneer dryers and presses at Mill 112? I'm referring to a drawing/diagram which shows the location of all building vents in relation to the veneer dryers and presses inside the building. I'm referring to a plot plan representative of the building and its contents as they existed at the time emissions testing was conducted in support of the creation of Technical Bulletin No. 768.

Let me know if you think this is something you can help me with. Any assistance you can provide would be appreciated.

Dan Meyer
206.553.4150
Office of Air, Waste and Toxics
Air Permits and Diesel Unit
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

From: Ric Law [mailto:rlaw@src-ncasi.org]
Sent: Wednesday, October 14, 2015 2:36 PM
To: Meyer, Dan
Cc: Kyle Heitkamp; Varma, Vipin; Rob Crawford; David Word; David Critchfield
Subject: NCASI Assessment of EPA-R10 Plywood mill HAP Emission Factor Determination

Dear Dan,

At the direction of Dr. Vipin Varma, attached you will find Vipin's letter to you with supporting information reviewing EPA-R10's analysis and assumptions used in calculating HAP emission factors for a generic plywood manufacturing facility in the Pacific Northwest.

The pdf file, "Letter to Dan Meyer," contains the summary, Attachment 1, Appendix A-1 and Appendix A-2. Also attached are two Excel spreadsheets, "veneer dryer voc & hap ef rev1" and "plywood mill voc & hap ef rev2," which are the original files that EPA used, and an Excel file "NCASI plywood mill voc & hap ef rev5," which NCASI compiled to evaluate the impact of the changes being recommended.

As stated in the letter, please feel free to contact Vipin or me if you have any questions or wish to discuss our technical assessment.

--

Ric Law, P.E.
Project Engineer
NCASI- Southern Regional Center
402 SW 140th Terrace
Newberry, FL 32669
rlaw@src-ncasi.org
Phone: 352.244.0913
Fax: 352.331.1766