AP42 Section:	10.1
Related:	1
Title:	Contractor letters, industry, state and local agency comments and some source test material 1993 - 2000

Steve Shedd

07/31/00 01:59 PM

To: D_word@src-ncasi.org

cc: JPinkerton@ncasi.org, Dallas Safriet/RTP/USEPA/US@EPA

Subject: Re: Lumber Mill Particulate Matter Data

David, Thanks for the information and I will pass it along to the requestor and the AP-42 people. Steve

D_word@src-ncasi.org

D_word@src-ncasi.or g

07/31/2000 11:16 AM
Please respond to D_word

To: Steve Shedd/RTP/USEPA/US@EPA

cc: JPinkerton@ncasi.org

Subject: Lumber Mill Particulate Matter Data

Steve:

As requested, I have attached some particulate matter data generated at sawmills and other "similar" sources. I had previously pulled this data together to provide folks with a "guesstimate" of their PM emissions for various purposes. There are a number of problems in trying to transfer these emission factors to another facility. The primary problem I see is that these PM tests were collected after cyclones. Since we do not know what particle size "cut" the cyclones were designed for, or how efficiently they were working, we really don't know how well they would emulate another cyclone in similar service. Another problem is that saws, planers, etc. vary considerably, and along with their variation, so varies the particles created. A planer designed for dry southern pine may not emulate a planer at a western softwood mill. I encourage you to pass these data along as "ball park" type estimates of emissions from sources similar to those found at sawmills.

The attached spreadsheet is divided into 3 worksheets, marked as pages. The first page provides flow rate and production information. The second page attempts to describe the sources tested. The third page provides the emissions information. For these sources it is important that the comments be carefully reviewed in each page. The comments will help the mill cull out inapplicable sources.

If you, or the mill, have questions about these data, please feel free to give me a call.

DW

David Word
Program Manager
NCASI
PO Box 141020
Gainesville, FL 32614-1020

(352) 377-4708 x 241 (phone)
(352) 371-6557 (fax)

- SAW-RPTS.XLS

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MISCELLANEOUS EQUIPMENT TABLE
PARTICULATE EMISSIONS FROM MISCELLANEOUS SOURCES, INCLUDING SAWS AND SANDERS *

Test Code	Unit Code	Run	Description	Production Rate	Pro-duct	Initial PC	Final PCD	Wood Species 1	% Sp. 1
043-032492A	1I043	1	Boiler fuel bin cyclone	7.23 ODTH	PB		CYC	SY PINE	100
043-032492A	1I043	2	Boiler fuel bin cyclone	7.23 ODTH	PB		CYC	SY PINE	100
043-032492A	1I043	3	Boiler fuel bin cyclone	7.23 ODTH	PB		CYC	SY PINE	100
043-032592A	3I043	1	Hog fuel bin	.85 WET ton/hr	PB		FFIL	SY PINE	100
043-032592A	3I043	2	Hog fuel bin	.80 WET ton/hr	PB		FFIL	SY PINE	100
043-032592A	3I043	3	Hog fuel bin	.73 WET ton/hr	PB		FFIL	SY PINE	100
043-040192A	1W043	1	Globe trim saw	21.4 MSF3/4 /hr	PB		CYC	SY PINE	100
043-040192A	1W043	2	Globe trim saw	20.7 MSF3/4 /hr	PB		CYC	SY PINE	100
043-040192A	1W043	3	Globe trim saw	28.9 MSF3/4 /hr	PB		CYC	SY PINE	100
043-040992B	1Z043	1	Forming line reject system	32.3 ODTH	PB		FFIL	SY PINE	100
043-040992B	1Z043	2	Forming line reject system	32.3 ODTH	PB		FFIL	SY PINE	100
043-040992B	1Z043	3	Forming line reject system	30.8 ODTH	PB		FFIL	SY PINE	100
167-102190A	1Z167	1	Muffler vent	9.986 MSF 3/4	PB	NONE		ASPEN	
192-050592B	1Z192	1	Refiner reject cyclone	9000 lb/hr	MDF		CYC	PINE SP	100
192-050592C	2Z192	1	Mat reject cyclone	27,700 lb/hr	MDF		CYC	PINE SP	100
192-050592C	2Z192	2	Mat reject cyclone	27,700 lb/hr	MDF		CYC	PINE SP	100
192-050592C	2Z192	3	Mat reject cyclone	27,700 lb/hr	MDF		CYC	PINE SP	100
214-080189A	1A214	1	Planer cyclone	2.13 ODTH	PLY-S		CYC	SY PINE	
214-080189A	1A214	2	Planer cyclone	2.13 ODTH	PLY-S		CYC	SY PINE	
214-080189A	1A214	3	Planer cyclone	2.13 ODTH	PLY-S		CYC	SY PINE	
214-080189B	2A214	1	Planer cyclone	3.72 ODTH	PLY-S		CYC	SY PINE	
214-080189B	2A214	2	Planer cyclone	3.72 ODTH	PLY-S		CYC	SY PINE	
214-080189B	2A214	3	Planer cyclone	3.72 ODTH	PLY-S		CYC	SY PINE	
214-080289A	9Z214	1	Sawdust cyclone	2.6 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080289A	9Z214	2	Sawdust cyclone	2.6 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080389A	3I214	1	Chip bin cyclone	8.85 ODTH	PLY-S		CYC	SY PINE	100
214-080389A	3I214	2	Chip bin cyclone	8.85 ODTH	PLY-S		CYC	SY PINE	100
214-080389A	3I214	3	Chip bin cyclone	8.85 ODTH	PLY-S		CYC	SY PINE	100
214-080389B	4I214	1	Chip bin cyclone	1.9 ODTH	PLY-S		CYC	SY PINE	100
214-080389B	4I214	2	Chip bin cyclone	1.9 ODTH	PLY-S		CYC	SY PINE	100
214-080389B	4I214	3	Chip bin cyclone	1.9 ODTH	PLY-S		CYC	SY PINE	100
214-080489A	5I214	1	Shavings bin cyclone	1.02 ODTH	PLY-S		CYC	SY PINE	100
214-080489A	5I214	2	Shavings bin cyclone	1.02 ODTH	PLY-S		CYC	SY PINE	100
214-080489A	5I214	3	Shavings bin cyclone	1.02 ODTH	PLY-S		CYC	SY PINE	100
214-080589A	2Z214	1	Chips cyclone	7.81 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080589A	2Z214	2	Chips cyclone	7.81 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080589A	2Z214	3	Chips cyclone	7.81 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080789A	3Z214	1	Trim cyclone	3.08 ODTH	PLY-S		CYC	SY PINE	100
214-080789A	3Z214	2	Trim cyclone	3.08 ODTH	PLY-S		CYC	SY PINE	100
214-080789A	3Z214	3	Trim cyclone	3.08 ODTH	PLY-S		CYC	SY PINE	100
214-080889C	2W214	1	Sawdust cyclone	0.22 ODTH	PLY-S		CYC	SY PINE	100
214-080889C	2W214	2	Sawdust cyclone	0.22 ODTH	PLY-S		CYC	SY PINE	100
214-080889C	2W214	3	Sawdust cyclone	0.22 ODTH	PLY-S		CYC	SY PINE	100
214-080989A	4Z214	1	Trim cyclone	1.02 ODTH	PLY-S		CYC	SY PINE	100
214-080989A	4Z214	2	Trim cyclone	1.02 ODTH	PLY-S		CYC	SY PINE	100
214-080989A	4Z214	3	Trim cyclone	1.02 ODTH	PLY-S		CYC	SY PINE	100
214-080989B	1I214	1	Fuel bin cyclone	1.34 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080989B	1I214	2	Fuel bin cyclone	1.34 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080989B	1I214	3	Fuel bin cyclone	1.34 WET ton/hr	PLY-S			SY PINE	100
214-080989C	2I214	1	Fuel bin cyclone	14.1 WET ton/hr	PLY-S			SY PINE	100
214-080989C	2I214	2	Fuel bin cyclone	14.1 WET ton/hr	PLY-S		CYC	SY PINE	100
214-080989C	2I214	3	Fuel bin cyclone	14.1 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089A	5Z214	1	Chip cyclone	67.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089A	5Z214	2	Chip cyclone	67.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089A	5Z214	3	Chip cyclone	67.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089B	6Z214	1	Chip cyclone	71.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089B	6Z214	2	Chip cyclone	71.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089B	6Z214	3	Chip cyclone	71.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089C	7Z214	1	Chip cyclone	62.3 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081089C	7Z214	2	Chip cyclone	62.3 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081189A	8Z214	1	Chip cyclone	71.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081189A	8Z214	2	Chip cyclone	71.9 WET ton/hr	PLY-S		CYC	SY PINE	100
214-081189A	8Z214	3	Chip cyclone	71.9 WET ton/hr	PLY-S		CYC	SY PINE	100
219-051893A	1I219	1	Chip bin cyclone	12.6 ODTH	LU			SY PINE	
219-051893A	1I219	2	Chip bin cyclone	11.5 ODTH	LU			SY PINE	
219-051893B	1Z219	1	Chip transfer cyclone	9.7 ODTH	LU			SY PINE	
219-051893B	1Z219	2	Chip transfer cyclone	7.7 ODTH	LU			SY PINE	
219-051893C	2I219	1	Chip bin cyclone	8.3 ODTH	LU			SY PINE	
219-051893C	2I219	2	Chip bin cyclone	8.6 ODTH	LU			SY PINE	

MISCELLANEOUS EQUIPMENT TABLE, page 2
PARTICULATE EMISSIONS FROM MISCELLANEOUS SOURCES, INCLUDING SAWS AND SANDERS *

Test Code	Unit Code	Run	Comments
043-032492A	1I043	1	Boiler fuel bin cyclone processing sanderdust.
043-032492A	1I043	2	Boiler fuel bin cyclone processing sanderdust.
043-032492A	1I043	3	Boiler fuel bin cyclone processing sanderdust.
043-032592A	3I043	1	Fuel Bin receives hog fuel for dryer burners; baghouse.
043-032592A	3I043	2	Fuel Bin receives hog fuel for dryer burners; baghouse.
043-032592A	3I043	3	Fuel Bin receives hog fuel for dryer burners; baghouse.
043-040192A	1W043	1	This trim saw cuts 64" x 224" pressed panels to specified sizes prior to sanding.
043-040192A	1W043	2	This trim saw cuts 64" x 224" pressed panels to specified sizes prior to sanding.
043-040192A	1W043	3	This trim saw cuts 64" x 224" pressed panels to specified sizes prior to sanding.
043-040992B	1Z043	1	This is a baghouse that receives pneumatically transferred material from the forming line saws (rejects).
043-040992B	1Z043	2	This is a baghouse that receives pneumatically transferred material from the forming line saws (rejects).
043-040992B	1Z043	3	This is a baghouse that receives pneumatically transferred material from the forming line saws (rejects).
167-102190A	1Z167	1	Vent associated with press; small steam vent, steam through press.
192-050592B	1Z192	1	Described as refiner reject start-up Vault-cyclone.
192-050592C	2Z192	1	Cyclone handling mat reject.
192-050592C	2Z192	2	Cyclone handling mat reject.
192-050592C	2Z192	3	Cyclone handling mat reject.
214-080189A	1A214	1	Cyclone handling dry planar shavings, unknown number of planers.
214-080189A	1A214	2	Cyclone handling dry planar shavings, unknown number of planers.
214-080189A	1A214	3	Cyclone handling dry planar shavings, unknown number of planers.
214-080189B	2A214	1	Cyclone handling dry planar shavings, unknown number of planers.
214-080189B	2A214	2	Cyclone handling dry planar shavings, unknown number of planers.
214-080189B	2A214	3	Cyclone handling dry planar shavings, unknown number of planers.
214-080289A	9Z214	1	Cyclone handling green pine chips from sawmill, assume sawdust, unknown number of saws.
214-080289A	9Z214	2	Cyclone handling green pine chips from sawmill, assume sawdust, unknown number of saws.
214-080389A	3I214	1	Cyclone for chip bin, handling dry pine planar shavings.
214-080389A	3I214	2	Cyclone for chip bin, handling dry pine planar shavings.
214-080389A	3I214	3	Cyclone for chip bin, handling dry pine planar shavings.
214-080389B	4I214	1	Cyclone for chip bin, handling dry pine planar shavings.
214-080389B	4I214	2	Cyclone for chip bin, handling dry pine planar shavings.
214-080389B	4I214	3	Cyclone for chip bin, handling dry pine planar shavings.
214-080489A	5I214	1	Cyclone for bin storing dry veneer shavings.
214-080489A	5I214	2	Cyclone for bin storing dry veneer shavings.
214-080489A	5I214	3	Cyclone for bin storing dry veneer shavings.
214-080589A	2Z214	1	Cyclone handling green pine chips from plywood operation.
214-080589A	2Z214	2	Cyclone handling green pine chips from plywood operation.
214-080589A	2Z214	3	Cyclone handling green pine chips from plywood operation.
214-080789A	3Z214	1	Cyclone handling dry pine shavings from plywood trim.
214-080789A	3Z214	2	Cyclone handling dry pine shavings from plywood trim.
214-080789A	3Z214	3	Cyclone handling dry pine shavings from plywood trim.
214-080889C	2W214	1	Cyclone for sawdust from plywood saw.
214-080889C	2W214	2	Cyclone for sawdust from plywood saw.
214-080889C	2W214	3	Cyclone for sawdust from plywood saw.
214-080989A	4Z214	1	Cyclone for dry end plywood trim.
214-080989A	4Z214	2	Cyclone for dry end plywood trim.
214-080989A	4Z214	3	Cyclone for dry end plywood trim.
214-080989B	1I214	1	Cyclone for hog fuel bin.
214-080989B	1I214	2	Cyclone for hog fuel bin.
214-080989B	1I214	3	Cyclone for hog fuel bin.
214-080989C	2I214	1	Cyclone for hog fuel bin for sawmill derived hog fuel.
214-080989C	2I214	2	Cyclone for hog fuel bin for sawmill derived hog fuel.
214-080989C	2I214	3	Cyclone for hog fuel bin for sawmill derived hog fuel.
214-081089A	5Z214	1	Cyclone for green chip railroad loadout.
214-081089A	5Z214	2	Cyclone for green chip railroad loadout.
214-081089A	5Z214	3	Cyclone for green chip railroad loadout.
214-081089B	6Z214	1	Cyclone for green chip and sawdust railroad loadout.
214-081089B	6Z214	2	Cyclone for green chip and sawdust railroad loadout.
214-081089B	6Z214	3	Cyclone for green chip and sawdust railroad loadout.
214-081089C	7Z214	1	Cyclone for green chip and sawdust railroad loadout.
214-081089C	7Z214	2	Cyclone for green chip and sawdust railroad loadout.
214-081189A	8Z214	1	Cyclone for green chip and sawdust railroad loadout.
214-081189A	8Z214	2	Cyclone for green chip and sawdust railroad loadout.
214-081189A	8Z214	3	Cyclone for green chip and sawdust railroad loadout.
219-051893A	1I219	1	Cyclone for truck chip bin at chip and saw operations - 1I219.
219-051893A	1I219	2	Cyclone for truck chip bin at chip and saw operations - 1I219.
219-051893B	1Z219	1	Cyclone receiving wood refuse from trim saw and planar at chip and saw operations - 1Z219.
219-051893B	1Z219	2	Cyclone receiving wood refuse from trim saw and planar at chip and saw operations - 1Z219.
219-051893C	2I219	1	Those materials move on to another cyclone 2I219.
219-051893C	2I219	2	Those materials move on to another cyclone 2I219.

* does not include all miscellaneous sources, selected for possible sources at sawmills
file = c:\misc\saw-misc.wb2

Particulate Matter Table (front half or filterable particulate)
PARTICULATE EMISSIONS FROM MISCELLANEOUS SOURCES, INCLUDING SAWS AND SANDERS *

Test Code	Unit Code	Run	Method	Gr/DSCF	Lb/hr	Lb/ODT	Lb/MSF 3/	Other (units)	Comments
043-032492A	1I043	1	M5	0.443	5.57	0.77			Assumed sanderdust weight to be OD; moistures not provided.
043-032492A	1I043	2	M5	0.583	8.89	1.23			Assumed sanderdust weight to be OD; moistures not provided.
043-032492A	1I043	3	M5	0.448	7.08	0.98			Assumed sanderdust weight to be OD; moistures not provided.
043-032592A	3I043	1	M5	0.002	0.06			.071 lb/wet ton	Moisture content of hogged fuel unknown; may be trim.
043-032592A	3I043	2	M5	0.002	0.07			.088 lb/wet ton	Moisture content of hogged fuel unknown; may be trim.
043-032592A	3I043	3	M5	0.004	0.11			.151 lb/wet ton	Moisture content of hogged fuel unknown; may be trim.
043-040192A	1W043	1	M5	0.032	6.2		0.29		Trim Saw
043-040192A	1W043	2	M5	0.043	8.5		0.41		Trim Saw
043-040192A	1W043	3	M5	0.034	6.7		0.23		Trim Saw
043-040992B	1Z043	1	M5	0.008	2.22		0.069		Former reject system.
043-040992B	1Z043	2	M5	0.006	1.84		0.057		Former reject system.
043-040992B	1Z043	3	M5	0.007	1.9		0.062		Former reject system.
192-050592B	1Z192	1	OD8	3.92	2.2				
192-050592C	2Z192	1	OD8	0.178	41.7				
192-050592C	2Z192	2	OD8	0.128	30.1				
192-050592C	2Z192	3	OD8	0.118	25.8				
214-080189A	1A214	1	OD8	0.027	6.9	3.2			Dry material being handled.
214-080189A	1A214	2	OD8	0.025	6.22	2.9			Dry material being handled.
214-080189A	1A214	3	OD8	0.021	5.35	2.5			Dry material being handled.
214-080189B	2A214	1	OD8	0.016	3.24	0.9			Dry material being handled.
214-080189B	2A214	2	OD8	0.01	2.02	0.5			Dry material being handled.
214-080189B	2A214	3	OD8	0.01	2.05	0.6			Dry material being handled.
214-080289A	9Z214	1	OD8	0.001	0.09	0.1			Green material being handled.
214-080289A	9Z214	2	OD8	0.001	0.08	0.1			Green material being handled.
214-080389A	3I214	1	OD8	0.01	0.28	0.03			Dry material being handled.
214-080389A	3I214	2	OD8	0.01	0.29	0.03			Dry material being handled.
214-080389A	3I214	3	OD8	0.009	0.26	0.03			Dry material being handled.
214-080389B	4I214	1	OD8	0.002	0.07	0.04			Dry material being handled.
214-080389B	4I214	2	OD8	0.001	0.04	0.02			Dry material being handled.
214-080389B	4I214	3	OD8	0.001	0.04	0.02			Dry material being handled.
214-080489A	5I214	1	OD8	0	0	0			Dry material being handled.
214-080489A	5I214	2	OD8	0.001	0.01	0			Dry material being handled.
214-080489A	5I214	3	OD8	0	0	0			Dry material being handled.
214-080589A	2Z214	1	OD8	0.001	0.01	0.003			Green material being handled.
214-080589A	2Z214	2	OD8	0.001	0.01	0.003			Green material being handled.
214-080589A	2Z214	3	OD8	0.001	0.01	0.003			Green material being handled.
214-080789A	3Z214	1	OD8	0.007	0.27	0.09			Dry material being handled.
214-080789A	3Z214	2	OD8	0.006	0.17	0.06			Dry material being handled.
214-080789A	3Z214	3	OD8	0.006	0.16	0.05			Dry material being handled.
214-080889C	2W214	1	OD8	0.006	0.53	2.41			Dry material being handled.

214-080889C	2W214	2	OD8	0.005	0.48	2.18		Dry material being handled.
214-080889C	2W214	3	OD8	0.006	0.51	2.32		Dry material being handled.
214-080989A	4Z214	1	OD8	0.001	0.2	0.2		Dry material being handled.
214-080989A	4Z214	2	OD8	0.004	0.9	0.88		Dry material being handled.
214-080989A	4Z214	3	OD8	0.001	0.11	0.11		Dry material being handled.
214-080989B	1I214	1	OD8	0.013	2.92		2.18 lb/Green Ton	Green material being handled.
214-080989B	1I214	2	OD8	0.011	2.75		2.05 lb/Green Ton	Green material being handled.
214-080989B	1I214	3	OD8	0.011	2.45		1.83 lb/Green Ton	Green material being handled.
214-080989C	2I214	1	OD8	0.001	0.09	0.013		Green material being handled.
214-080989C	2I214	2	OD8	0.001	0.08	0.011		Green material being handled.
214-080989C	2I214	3	OD8	0.001	0.07	0.01		Green material being handled.
214-081089A	5Z214	1	OD8	0.005	0.042		0.006 lb/Green Ton	Green material being handled.
214-081089A	5Z214	2	OD8	0.007	0.56		0.008 lb/Green Ton	Green material being handled.
214-081089A	5Z214	3	OD8	0.012	0.97		0.014 lb/Green Ton	Green material being handled.
214-081089B	6Z214	1	OD8	0.001	0.04		0.006 lb/Green Ton	Green material being handled.
214-081089B	6Z214	2	OD8	0.0004	0.03		0.0004 lb/Green Ton	Green material being handled.
214-081089B	6Z214	3	OD8	0.0003	0.02		0.0003 lb/Green Ton	Green material being handled.
214-081089C	7Z214	1	OD8	0.0003	0.01		0.0002 lb/Green ton	Green material being handled.
214-081089C	7Z214	2	OD8	0.0002	0.01		0.0002 lb/Green ton	Green material being handled.
214-081189A	8Z214	1	OD8	0.002	0.016		0.002 lb/Green Ton	Green material being handled.
214-081189A	8Z214	2	OD8	0.003	0.029		0.004 lb/Green Ton	Green material being handled.
214-081189A	8Z214	3	OD8	0.002	0.019		0.003 lb/Green Ton	Green material being handled.
219-051893A	1I219	1	OD8		0.055	0.0044		
219-051893A	1I219	2	OD8		0.043	0.0037		
219-051893B	1Z219	1	OD8		5.8	0.6		
219-051893B	1Z219	2	OD8		4.7	0.61		
219-051893C	2I219	1	OD8		0.025	0.003		
219-051893C	2I219	2	OD8		0.033	0.0038		

* does not include all miscellaneous sources, selected for possible sources at sawmills
file = c:\misc\saw-pm.wb2

PARTICULATE EMISSIONS FROM MISCELLANEOUS SOURCES, INCLUDING SAWS AND PLANERS *

Test Code	Unit Code	Run	Production Rate (units)	Stack Flow (dscfm)	Stack Temp (F)	Stack Mois. (%)	Comments
043-032492A	1I043	1	7.23 ODTH	1464	78	1.6	Sanderdust cyclone for fuel bin.
043-032492A	1I043	2	7.23 ODTH	1796	86	1.7	Sanderdust cyclone for fuel bin.
043-032492A	1I043	3	7.23 ODTH	1838	90	2	Sanderdust cyclone for fuel bin.
043-032592A	3I043	1	.85 WET ton/hr	3299	78	1.1	Hogged wood refuse silo's baghouse.
043-032592A	3I043	2	.80 WET ton/hr	3307	85	0.9	Hogged wood refuse silo's baghouse.
043-032592A	3I043	3	.73 WET ton/hr	3278	84	1	Hogged wood refuse silo's baghouse.
043-040192A	1W043	1	21.4 MSF 3/4/hr	22727	67	0.9	This is a globe trim saw; lb/hr production figures are for weight of panels processed.
043-040192A	1W043	2	20.7 MSF 3/4/hr	23041	70	0.5	This is a globe trim saw; lb/hr production figures are for weight of panels processed.
043-040192A	1W043	3	28.9 MSF 3/4/hr	22761	70	0.7	This is a globe trim saw; lb/hr production figures are for weight of panels processed.
043-040992B	1Z043	1	32.3 ODTH	32730	98	1.8	Forming line reject system; baghouse.
043-040992B	1Z043	2	32.3 ODTH	33308	101	2.4	Forming line reject system; baghouse.
043-040992B	1Z043	3	30.8 ODTH	32814	95	2.4	Forming line reject system; baghouse.
192-050592B	1Z192	1	9,000 lb/hr	66	210	95	
192-050592C	2Z192	1	27,700 lb/hr	27385	78	0.5	
192-050592C	2Z192	2	27,700 lb/hr	27449	78	0.5	
192-050592C	2Z192	3	27,700 lb/hr	25487	78	0.5	
214-080189A	1A214	1	2.13 ODTH	28300			Unknown number of planers.
214-080189A	1A214	2	2.13 ODTH	28300			Unknown number of planers.
214-080189A	1A214	3	2.13 ODTH	28300			Unknown number of planers.
214-080189B	2A214	1	3.72 ODTH	22900			Unknown number of planers.
214-080189B	2A214	2	3.72 ODTH	22900			Unknown number of planers.
214-080189B	2A214	3	3.72 ODTH	22900			Unknown number of planers.
214-080289A	9Z214	1	2.6 wet tons/hr	8800			Unknown number of saws.
214-080289A	9Z214	2	2.6 wet tons/hr	8800			Unknown number of saws.
214-080389A	3I214	1	8.85 ODTH	3300			Cyclone for storage bin for planer shavings.
214-080389A	3I214	2	8.85 ODTH	3300			Cyclone for storage bin for planer shavings.
214-080389A	3I214	3	8.85 ODTH	3300			Cyclone for storage bin for planer shavings.
214-080389B	4I214	1	1.9 ODTH	3100			Cyclone for storage bin for planer shavings.
214-080389B	4I214	2	1.9 ODTH	3100			Cyclone for storage bin for planer shavings.
214-080389B	4I214	3	1.9 ODTH	3100			Cyclone for storage bin for planer shavings.
214-080489A	5I214	1	1.02 ODTH	1000			Cyclone for bin for dry veneer shavings.
214-080489A	5I214	2	1.02 ODTH	1000			Cyclone for bin for dry veneer shavings.
214-080489A	5I214	3	1.02 ODTH	1000			Cyclone for bin for dry veneer shavings.
214-080589A	2Z214	1	7.81 wet tons/hr	4800			Cyclone handles green pine chips from a plywood operation, source of chips unknown.
214-080589A	2Z214	2	7.81 wet ton/hr	4800			Cyclone handles green pine chips from a plywood operation, source of chips unknown.
214-080589A	2Z214	3	7.81 wet ton/hr	4800			Cyclone handles green pine chips from a plywood operation, source of chips unknown.
214-080789A	3Z214	1	3.08 ODTH	4400			Cyclone handles plywood trim dry pine shavings, source of shavings unknown.
214-080789A	3Z214	2	3.08 ODTH	4400			Cyclone handles plywood trim dry pine shavings, source of shavings unknown.
214-080789A	3Z214	3	3.08 ODTH	4400			Cyclone handles plywood trim dry pine shavings, source of shavings unknown.
214-080889C	2W214	1	0.22 ODTH	10200			Cyclone handles "Dry pine dust" from plywood saw.
214-080889C	2W214	2	0.22 ODTH	10200			Cyclone handles "Dry pine dust" from plywood saw.
214-080889C	2W214	3	0.22 ODTH	10200			Cyclone handles "Dry pine dust" from plywood saw.
214-080989A	4Z214	1	1.02 ODTH	26100			Cyclone handles "Dry end trim" from a plywood operation, source of trim unknown.
214-080989A	4Z214	2	1.02 ODTH	26100			Cyclone handles "Dry end trim" from a plywood operation, source of trim unknown.
214-080989A	4Z214	3	1.02 ODTH	26100			Cyclone handles "Dry end trim" from a plywood operation, source of trim unknown.
214-080989B	1I214	1	1.34 wet tons/hr	26300			Hog fuel dust handled by cyclone to hog bin, plywood operation.
214-080989B	1I214	2	1.34 wet tons/hr	26300			Hog fuel dust handled by cyclone to hog bin, plywood operation.
214-080989B	1I214	3	1.34 wet tons/hr	26300			Hog fuel dust handled by cyclone to hog bin, plywood operation.
214-080989C	2I214	1	14.07 wet tons/hr	12600			Cyclone handling "Hog fuel dust from sawmill" going to a "Hog shed".

214-080989C	2I214	2	14.07 wet tons/hr	12600	Cyclone handling "Hog fuel dust from sawmill" going to a "Hog shed".
214-080989C	2I214	3	14.07 wet tons/hr	12600	Cyclone handling "Hog fuel dust from sawmill" going to a "Hog shed".
214-081089A	5Z214	1	67.9 wet tons/hr	9100	Cyclone load-out for green hardwood chips (rail loadout).
214-081089A	5Z214	2	67.9 wet tons/hr	9100	Cyclone load-out for green hardwood chips (rail loadout).
214-081089A	5Z214	3	67.9 wet tons/hr	9100	Cyclone load-out for green hardwood chips (rail loadout).
214-081089B	6Z214	1	71.9 wet tons/hr	9000	Cyclone load-out for green chips and sawdust (rail loadout).
214-081089B	6Z214	2	71.9 wet tons/hr	9000	Cyclone load-out for green chips and sawdust (rail loadout).
214-081089B	6Z214	3	71.9 wet tons/hr	9000	Cyclone load-out for green chips and sawdust (rail loadout).
214-081089C	7Z214	1	62.3 wet tons/hr	6100	Cyclone load-out for green chips and sawdust (rail loadout).
214-081089C	7Z214	2	62.3 wet tons/hr	6100	Cyclone load-out for green chips and sawdust (rail loadout).
214-081189A	8Z214	1	71.9 wet tons/hr	9700	Cyclone load-out for green chips (rail loadout).
214-081189A	8Z214	2	71.9 wet tons/hr	9700	Cyclone load-out for green chips (rail loadout).
214-081189A	8Z214	3	71.9 wet tons/hr	9700	Cyclone load-out for green chips (rail loadout).
219-051893A	1I219	1	12.6 ODTH		Stack test report not provided.
219-051893A	1I219	2	11.5 ODTH		Stack test report not provided.
219-051893B	1Z219	1	9.7 ODTH		Stack test report not provided.
219-051893B	1Z219	2	7.7 ODTH		Stack test report not provided.
219-051893C	2I219	1	8.3 ODTH		
219-051893C	2I219	2	8.6 ODTH		

* does not include all miscellaneous sources, selected for possible sources at sawmills

MRI

MIDWEST RESEARCH INSTITUTE
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-2412
Telephone (919) 677-0249
FAX (919) 677-0065

Date: June 22, 1994

Subject: Lumber AP-42 Section
Review and Update of Wood Products Industry Sections of Chapter 10, AP-42
EPA Contract 68-D2-0159, Work Assignment I-10
MRI Project 4601-10

From: Richard Marinshaw

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

Enclosed is the revised AP-42 Section 10.1, Lumber and Wood Products Manufacturing and Woodworking Operations, and the corresponding backgroud report. Also enclosed is a memo to the project file explaining how the external review comments were addressed.

In general, the section contains all new emission factors, which were developed from the test reports provided by the National Council of the Paper Industry for Air and Stream Improvement (NCASI). The enclosed memo explains the specific changes made to the report. Also note that Method 25A results are reported as total organic compounds (TOC) rather than as total hydrocarbons, in accordance with *Techincal Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections*, pages 38-39.

Please let me know of any changes or if you have any questions about the revised draft report.

MRI

MIDWEST RESEARCH INSTITUTE
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-2412
Telephone (919) 677-0249
FAX (919) 677-0065

January 27, 1995

Mr. David Word
National Council of the Paper Industry
for Air and Stream Improvement, Inc.
Post Office Box 141020
Gainesville, Florida 32614-1020

Dear Mr. Word:

As we discussed by telephone on January 16, 1995, I am sending you the results of our preliminary analysis of the additional lumber kiln test reports that were submitted recently to Mr. Dallas Safriet of the U. S. Environmental Protection Agency for the purpose of updating Section 10.1 of AP-42. Enclosure 1 includes a brief description of the references reviewed and an assessment of the quality of the data contained in those references; Enclosure 2 consists of a draft table (Table 4-5) that summarizes the emission factors calculated from the data in the test reports; and Enclosure 3 consists of a set of printouts of the spreadsheets used to calculate emission factors. Please note that the enclosed materials are considered draft and still must undergo internal review by Midwest Research Institute prior to being submitted to Mr. Safriet for his review.

Please do not hesitate to call me if you have any questions concerning the enclosed material or need additional information. I look forward to hearing your comments.

Sincerely,

Richard J. Marinshaw
Senior Environmental Engineer

Enclosures

cc: Dallas Safriet, EPA (MD-14)

Enclosure 1

DRAFT

LUMBER AP-42
SUMMARY OF ADDITIONAL TEST REPORTS AND RELATED CORRESPONDENCE

4.2.9. Reference 21

This document consists of a letter that provides supplemental data on the emission tests documented in References 22 to 25 and a summary of the results of those tests. The following paragraphs describe the tests and results in detail.

4.2.10. Reference 22

This report documents the results of measurements of emissions of filterable PM, TOC, CO, SO_2, NO_x, and particle size from a direct-fired lumber kiln. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 12 vents with 6 on each side of the kiln. During the test, one vent on each side was blocked off. Southern yellow pine was dried from an unspecified green moisture content to a final moisture content of approximately 13.5 percent. The kiln cycles ranged from 16.9 hours to 17.4 hours.

Filterable PM emissions were quantified using Method 5, Method 25A was used to measure TOC, CO was measured using Method 10, and Method 7E was used to quantify NO_x emissions. Method 6 was used to measure SO_2 emissions, but none were detected during any of the test runs. Particle size was determined using cascade impactors. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A.

The two initial Method 5 runs were anisokinetic, but an additional three valid runs were conducted. For the other sampling trains, emissions were sampled throughout each of three kiln cycles. Emissions were sampled from a pair of vents. For each of the remaining vents, one velocity measurement was made, and the emission rates for the entire kiln were estimated by assuming the same pollutant concentrations through all vents.

Emission factors were developed for emissions of filterable PM, TOC, CO, NO_x, and CO_2. The emission data are rated B. The test methods were sound, but because emissions were sampled from a single pair of vents, a higher rating is not warranted.

4.2.11. Reference 23

This report documents the results of measurements of emissions of filterable PM, TOC, CO, and NO_x from a direct-fired lumber kiln. The tests were conducted in 1994 to demonstrate compliance with State regulations.

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The kiln tested has a total of 12 vents with 6 on each side of the kiln. During the test, one vent on each side was blocked off. Southern yellow pine was dried from an unspecified green moisture content to a final moisture content of approximately 16 percent. The kiln cycles ranged from 18.2 hours to 20.3 hours.

Filterable PM emissions were quantified using Method 5, Method 25A was used to measure TOC, CO was measured using Method 10, and Method 7E was used to quantify NO_x emissions. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A.

A total of five Method 5 runs were conducted: two during the first kiln cycle and three during the second kiln cycle. For the other sampling trains, emissions were sampled throughout each of three kiln cycles. Emissions were sampled from a pair of vents. For each of the remaining vents, one velocity measurement was made, and the emission rates for the entire kiln were estimated by assuming the same pollutant concentrations through all vents.

Emission factors were developed for emissions of filterable PM, TOC, CO, NO_x, and CO_2. The emission data are rated B. The test methods were sound, but because emissions were sampled from a single pair of vents, a higher rating is not warranted.

4.2.12. Reference 24

This report documents the results of measurements of emissions of TOC from a steam-heated lumber kiln. The test was conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 10 vents with 5 on each side of the kiln. Southern yellow pine was dried from an unspecified green moisture content to a final moisture content of approximately 16 percent. The kiln cycles ranged from 18.8 hours to 19.8 hours.

Method 25A was used to measure TOC emissions, which were sampled throughout each of three kiln cycles. Emissions were sampled from a pair of vents. For each of the remaining vents, one velocity measurement was made, and the emission rates for the entire kiln were estimated by assuming the same pollutant concentrations through all vents.

An emission factor was developed for emissions of TOC from the kiln. The emission data are rated B. The test method was sound, but because emissions were sampled from a single pair of vents, a higher rating is not warranted.

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4.2.13. Reference 25

This report documents the results of measurements of emissions of TOC from a steam-heated lumber kiln. The test was conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 10 vents with 5 on each side of the kiln. During the test, one vent on each side was blocked off. Southern yellow pine was dried from an unspecified green moisture content to a final moisture content of approximately 16 percent. The kiln cycles ranged from 17.6 hours to 18.9 hours.

Method 25A was used to measure TOC emissions, which were sampled throughout each of three kiln cycles. Emissions were sampled from a pair of vents, and the emission rates for the entire kiln were estimated by assuming the same pollutant concentrations and flow rates through all vents.

An emission factor was developed for emissions of TOC from the kiln. The emission data are rated B. The test method was sound, but because emissions were sampled from a single pair of vents, a higher rating is not warranted.

4.2.14. Reference 26

This reference does not present emission data, but it does provide supplemental information for the emission tests documented in References 27, 28, and 42.

4.2.15. Reference 27

This report documents the results of measurements of emissions of TOC from an indirect-fired lumber kiln that uses a Wellons thermal oil heating system. The test was conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 10 vents with 5 on each side of the kiln. During the test, all 10 vents were manifolded to combine the emissions into a single exhaust stream for sampling. Exhaust gas velocities were measured by means of propeller anemometers placed on each vent stack.

During the test, southern yellow pine was dried from a green moisture content of approximately 50 percent to a final moisture content of approximately 15 percent over a period of approximately 14 hours.

Method 25A was used to measure TOC emissions, which were measured throughout the entire kiln cycle and quantified for each 1-minute interval. An emission factor was developed for emissions of TOC from the kiln. The emission data are rated A. The test method was sound, and emissions were sampled throughout an entire kiln cycle.

4.2.16. Reference 28

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, CO, NO_x, methanol and aldehydes and ketones from a direct-fired lumber kiln that uses a suspension burner. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of eight vents with four on each side of the kiln. Southern yellow pine was dried from a green moisture content of approximately 50 percent to a final moisture content of approximately 15 percent over a period of approximately 14.2 hours.

Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. Method 25A was used to measure TOC emissions. Emissions of CO were measured using Method 10, and Method 7E was used to quantify NO_x emissions. Emissions of aldehydes and ketones were measured using Method 0011. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A.

To measure gaseous emissions (TOC, CO, NO_x, and CO_2), all eight vents were manifolded to combine the emissions into a single exhaust stream for sampling; emissions of other pollutants were measured at each vent. Exhaust gas velocities were measured by means of propeller anemometers placed on each vent stack. Total organic compounds, CO, and NO_x emissions were measured throughout the entire kiln cycle and quantified for each 1-minute interval. The Method 5/202 sampling train was operated for three runs that ranged from one to three hours, and the Method 0011 sampling train was operated for six runs that ranged from one to three hours and spanned the entire kiln cycle. Methanol emissions were measured using Method 18 for 13 40-minute runs over the entire kiln cycle.

A tracer gas study was also conducted to estimate the total kiln, including the flow through the vents and fugitive emissions. The tracer gas used was sulfur hexafluoride (SF_6), which was injected and sampled in the duct that returns kiln gas to the combustion chamber. However, the tracer apparently was not thoroughly diluted throughout the kiln, and the results of the tracer study were inconclusive. Exhaust flowrates also were estimated based on combustion rates and an F factor (Method 19).

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The Method 0011 samples were analyzed for formaldehyde, acetaldehyde, hexaldehyde, acetone, and methyl ethyl ketone. However, hexaldehyde, acetone, and methyl ethyl ketone emissions were below the quantitation limit for all runs.

Emission factors were developed for process and fugitive emissions of filterable PM, condensible inorganic PM, condensible organic PM, TOC, CO, NO_x, CO_2, formaldehyde, acetaldehyde, methanol. [EMISSION RATES FOR PM PRESENTED ON PAGE 3/TABLE 1.1 ARE INCONSISTENT WITH THE RUN-BY-RUN PM DATA IN APPENDICES; HAVE REQUESTED CLARIFICATION FROM BOTH WEYERHAEUSER AND TESTING CONTRACTOR BUT HAVE NOT YET RECEIVED RESPONSE.] The factors for fugitive emissions were estimated as the difference in factors based on the emission rates determined using measured flowrates and estimated flowrates based on combustion rates.

The TOC, NO_x, CO, methanol, and aldehyde and ketone process emission data are rated A. The test methods were sound, and emissions were sampled throughout an entire kiln cycle. The PM emission data are rated D because the report presents only average emission rates and the results of only one run, for which two of the four vents were less than 50 percent isokinetic. The fugitive emission data are rated D because the flowrates were estimated based on fuel combustion.

4.2.17. Reference 29

This reference does not present emission data, but it does provide supplemental information for the emission tests documented in References 30 to 32 and 34 to 39.

4.2.18. Reference 30

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, CO, NO_x, and aldehydes and ketones from a direct-fired lumber kiln that uses a suspension burner. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 14 vents with 7 on each side of the kiln. During the test, all 14 vents were manifolded to combine the emissions into a single exhaust stream for sampling. Exhaust gas velocities were measured by means of propeller anemometers placed on each vent stack.

During the tests, southern yellow pine was dried from a green moisture content of approximately 40 percent to a final moisture content of approximately 12.5 percent. The two kiln cycles lasted 22.5 hours and 25.5 hours.

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Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. Method 25A was used to measure TOC both before (hot) and after (cold) the gas stream was passed through a condenser. (The cold TOC data represents noncondensible TOC.) Emissions of CO were measured using Method 10, and Method 7E was used to quantify NO_x emissions. Emissions of aldehydes and ketones were measured using Method 0011. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A.

Total organic compounds, CO, and NO_x emissions were measured throughout two entire kiln cycles and quantified for each 15-minute interval. The Method 5/202 and Method 0011 sampling trains were operated for two 1-hour runs during the first kiln cycle and for one 1-hour run during the second kiln cycle. Two of the Method 5 runs were anisokinetic.

The Method 0011 samples were analyzed for formaldehyde, acetaldehyde, hexaldehyde, acetone, and methyl ethyl ketone. However, methyl ethyl ketone emissions were below the quantitation limit for all three runs, and hexaldehyde emissions were below the quantitation limit for two of the three runs.

Emission factors were developed for emissions of filterable PM, condensible inorganic PM, condensible organic PM, TOC, noncondensible TOC, CO, NO_x, CO_2, formaldehyde, acetaldehyde, and acetone. The factors for formaldehyde, acetaldehyde, and acetone emissions were adjusted to account for the fact that emissions were not sampled throughout an entire kiln cycle. The adjustment factor was determined as the ratio of the average TOC emission rate for both kiln cycles to the average TOC emission rate for the three Method 0011 runs (4.15/6.33 = 0.65).

The TOC, NO_x, and CO emission data are rated A. The test methods were sound, and emissions were sampled throughout two entire kiln cycles. The condensible PM, CO_2, and aldehyde and ketone emission data are rated B. The test methods were sound. However, a higher rating is not warranted because emissions were not sampled throughout an entire kiln cycle. The filterable PM data are rated C because two of the three runs were anisokinetic.

4.2.19 Reference 31

This report documents the results of measurements of emissions of TOC from a direct-fired lumber kiln. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 12 vents with 6 on each side of the kiln. During the test, all 12 vents were manifolded to combine the emissions into a single exhaust stream for sampling. Exhaust gas velocities were measured by means of propeller anemometers placed on each vent stack.

Emissions were sampled during two kiln cycles. During the first kiln cycle, spruce was dried from a green moisture content of 25.4 percent to a final moisture content of approximately 11.6 percent over a period of 24 hours; during the second cycle, mixed fir was dried from a green moisture content of 37.5 percent to a final moisture content of approximately 13.7 percent over a period of 54 hours.

Method 25A was used to measure TOC emissions, which were sampled continuously and quantified at 1-minute intervals throughout both kiln cycles. The exhaust stream was sampled for TOC without (hot) and with (cold) a precondenser. A tracer gas study was also conducted to estimate the total kiln, including the flow through the vents and fugitive emissions. The tracer gas used was sulfur hexafluoride (SF_6), which was injected into the center of the kiln at a constant rate of 1 liter per minute (L/min) (0.035 cubic feet per minute [ft^3/min]), and SF_6 concentrations were measured periodically during the kiln cycles. Based on the results of the tracer study, the ratio of fugitive to process emissions was 21.9 for the first kiln cycle and 9.6 for the second cycle.

Emission factors were developed for both process and fugitive emissions of TOC and noncondensible TOC from the kiln. The factor for fugitive emissions was estimated as the difference in factors based on the emission rates determined using flowrates through the vents and using flowrates determined by the dilution of the tracer.

The process emission data are rated A. The test method was sound, and emissions were sampled throughout two entire kiln cycles. The fugitive TOC emission data are rated D because they are based on the assumptions that the tracer is uniformly diluted throughout the kiln and that the calculated emission rates of the tracer are proportional to the combined TOC emission rates for process and fugitive emissions.

4.2.20. Reference 32

This report documents the results of measurements of emissions of TOC from a steam-heated lumber kiln. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 14 vents with 7 on each side of the kiln. During the test, all 14 vents were manifolded to combine the emissions into a single exhaust stream for sampling. Exhaust gas velocities were measured by means of propeller anemometers placed on each vent stack.

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Emissions were sampled throughout a single kiln cycle, during which southern yellow pine was dried from a green moisture content of 44 percent to a final moisture content of approximately 10.4 percent over a period of 22 hours.

Method 25A was used to measure TOC emissions, which were sampled continuously and quantified at 1-minute intervals throughout both kiln cycles. The exhaust stream was sampled for TOC both without (hot) and with (cold) a condenser. A tracer gas study was also conducted to estimate the total kiln, including the flow through the vents and fugitive emissions. The tracer gas used was SO_2, which was injected into the center of the kiln at a constant rate. However, the results of the tracer study were inconclusive.

An emission factor was developed for emissions of TOC and noncondensible TOC from the kiln. The emission data are rated A. The test method was sound, and emissions were sampled throughout an entire kiln cycle.

4.2.21. Reference 33

This document consist of a letter that provides supplemental data on the emission tests documented in References 34 to 39. However, the letter contains no emission data.

4.2.22. Reference 34

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, and aldehydes and ketones from a steam-heated lumber kiln. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested is equipped with a heat exchanger, exhaust fan, and a single stack on the vent system. During the test, southern yellow pine was dried from a green moisture content of approximately 44 percent to a final moisture content of approximately 13 percent over a period of 23 hours.

Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. Method 25A was used to measure TOC both without (hot) and with (cold) a condenser. Emissions of aldehydes and ketones were measured using Method 0011.

Total organic compound emissions were measured throughout the entire kiln cycle and quantified on an hourly basis. The Method 5/202 and Method 0011 sampling trains were operated for three 1-hour runs during the kiln cycle. One of the Method 5 runs was anisokinetic, but the emission rate for that run was consistent with the rates for the other two runs.

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The Method 0011 samples were analyzed for formaldehyde, acetaldehyde, hexaldehyde, acetone, and methyl ethyl ketone. All five compounds were detected above the quantitation in each of the three runs.

Emission factors were developed for emissions of filterable PM, condensible inorganic PM, condensible organic PM, TOC, noncondensible TOC, formaldehyde, acetaldehyde, hexaldehyde, acetone, and methyl ethyl ketone. The factors for aldehyde and ketone emissions were adjusted to account for the fact that emissions were not sampled throughout an entire kiln cycle. The adjustment factor was determined as the ratio of the average TOC emission rate for the entire kiln cycle to the average TOC emission rate for the three Method 0011 runs (4.26/4.14 = 1.03).

The TOC emission data are rated A. The test method was sound, and emissions were sampled throughout an entire kiln cycle. The filterable and condensible PM and aldehyde and ketone emission data are rated B. The test methods were sound. However, a higher rating is not warranted because emissions were not sampled throughout an entire kiln cycle.

4.2.23. Reference 35

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, CO, and NO_x from a direct-fired lumber kiln that uses a suspension burner fired with planer shavings. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln has 12 roof vents. Stack extensions were erected on four of the vents; the other eight vents were blocked for the test. In addition, when sampling from one of the four vents with stack extensions, the other vents were closed. An effort also was made to seal other openings, but leakage was evident during the test. Southern yellow pine was dried from a green moisture content of approximately 41 percent to a final moisture content of approximately 12 percent over a period of 20.25 hours.

Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. Method 25A was used to measure TOC emissions. Emissions of CO were measured using Method 10, and Method 7E was used to quantify NO_x emissions. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A. Velocity measurements were made only during the three PM test runs. However, exhaust flowrates were estimated for each 1-hour period based on combustion rates and an F factor (Method 19).

Total organic compound, CO, and NO_x emissions were measured throughout the entire kiln cycle and quantified on an hourly basis. The Method 5/202 sampling train was operated for three 1-hour runs during the kiln cycle.

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Process and fugitive emission factors were developed for emissions of filterable PM, condensible inorganic PM, condensible organic PM, TOC, CO, NO_x, and CO_2. The process emission factors for TOC, CO, and NO_x were determined by multiplying the total mass of pollutant emitted during the drying cycle based on the F factor flowrates by the ratio of the measured flowrates for the three PM runs to the F factor-based flowrates. For example, based on f-factor flowrates, 245 lb of TOC were emitted during the drying cycle of 106,720 board feet, and TOC emissions for the three Method 5 runs averaged 21.235 lb/hr based on F factor flowrates and 33.864 lb/hr based on measured flowrates. Therefore, the process emission factor was determined to be:

(21.235/33.864)(245) = 154 lb TOC emitted during the cycle

154/106.720 = 1.4 lb/thousand board feet.

The emission factors for fugitive emissions were estimated as the difference in the emission factors based on F factor flowrates and the process emission factors. For example, the TOC fugitive emission factor was determined to be:

(245-154)/106.720 = 0.85 lb/thousand board feet.

The TOC, CO, NO_x, and CO_2 process emission data are rated B because flowrates were not measured throughout the kiln cycle. The filterable and condensible PM emission data also are rated B. Although the test methods were sound, a higher rating is not warranted because emissions were not sampled throughout an entire kiln cycle. The fugitive emission data are rated D because the flowrates were estimated based on fuel combustion.

4.2.24. Reference 36

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, CO, and NO_x from a direct-fired lumber kiln. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested is fired with green sawdust and has 16 roof vents. During the first kiln cycle southern yellow pine was dried from an unspecified green moisture content to a final moisture content of approximately 16 percent over a period of 17.25 hours. During the second kiln cycle, southern yellow pine was dried from a green moisture content of 51 percent to a final moisture content of approximately 18 percent over a period of 17.75 hours.

Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. Method 25A was used to measure TOC both before (hot) and after (cold) the gas stream was passed through a condenser. Emissions of CO were measured using

Method 10, and Method 7E was used to quantify NO_x emissions. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A. Emissions were sampled in the blend chamber return duct, and flow measurements were made on each roof vent at a later time using propeller anemometers placed on each vent stack.

Total organic compound, CO, and NO_x emissions were measured throughout the entire kiln cycle and quantified for each 15- minute interval. The Method 5/202 sampling train was operated for three 1-hour runs during the second kiln cycle.

Emission factors were developed for emissions of filterable PM, condensible inorganic PM, condensible organic PM, TOC, noncondensible TOC, CO, NO_x, and CO_2. The condensible PM, TOC, CO, NO_x, and CO_2 emission data are rated B. The test method was sound, and emissions were sampled throughout an entire kiln cycle, but flowrates were not measured during the test. The filterable PM emission data are rated D, because all three test runs were anisokinetic, flowrates were not measured during the test, and emissions were not sampled throughout an entire kiln cycle.

4.2.25. Reference 37

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, CO, NO_x, formaldehyde, and phenol from two direct-fired lumber kilns. One of the kilns (Kiln No. 2) corresponds to the kiln for Reference 34. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kilns tested are fired with green sawdust and each has 16 roof vents. Testing was conducted during one cycle of one kiln (Kiln No. 1) and during two cycles of the other kiln (Kiln No. 2). Kiln No. 1 was tested while drying southern yellow pine from a green moisture content of 44 percent to a final moisture content of approximately 19 percent over a period of 26.45 hours. Kiln No. 2 was tested while drying southern yellow pine was dried from a green moisture content of 50 percent to a final moisture content of approximately 14 percent over periods of 17.52 hours (first cycle) and 15.03 hours (second cycle).

Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. However, condensible inorganic PM emissions were not quantified. Method 25A was used to measure TOC both without (hot) and with (cold) a precondenser. Emissions of CO were measured using Method 10, and Method 7E was used to quantify NO_x emissions. Formaldehyde emissions were measured using Method 0011, and phenol emissions were quantified with Method 0010. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A. Emissions were sampled in the blend chamber return ducts for each kiln, and flow measurements were made on each roof vent at a later time.

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Total organic compound, CO, and NO_x emissions were measured throughout the entire kiln cycle and quantified for each 15- minute interval. The Method 5/202 sampling train was operated for three 1-hour runs.

Emission factors were developed for emissions of filterable PM, condensible PM, TOC, CO, NO_x, CO_2, formaldehyde, and phenol. The factors for formaldehyde and acetaldehyde emissions were adjusted to account for the fact that emissions were not sampled throughout an entire kiln cycle. The adjustment factor was determined as the ratio of the average TOC emission rate for the corresponding kiln cycles to the average TOC emission rate for the formaldehyde and phenol test runs (23.1/18.49 = 1.25 for Kiln No. 1 and 21.0/14.1 = 1.49 for Kiln No. 2).

The TOC, noncondensible TOC, CO, NO_x, and CO_2 process emission data are rated B. The test methods were sound, and emissions were sampled throughout an entire kiln cycle, but flowrates were not measured during the test. The filterable and condensible PM, formaldehyde, and phenol emission data are rated C because flowrates were not measured during the test, and emissions were not sampled throughout an entire kiln cycle.

4.2.26. Reference 38

This report documents the results of measurements of emissions of TOC from one steam-heated lumber kiln (Kiln No. 1) and one direct-fired kiln (Kiln No. 9), which was fired with natural gas. The tests were conducted in 1994 to demonstrate compliance with State regulations.

Both of the kilns tested have a total of 16 vents with 8 on each side of the kiln. During the tests, all 16 vents on each kiln were manifolded to combine the emissions into a single exhaust stream for sampling. Exhaust gas velocities were measured by means of propeller anemometers placed on each vent stack.

Emissions were sampled during two cycles on Kiln No. 1 and one cycle on Kiln No. 9. During the first cycle on Kiln No. 1, southern yellow pine was dried from a green moisture content of 44 percent to a final moisture content of approximately 12 percent over a period of 26.57 hours; during the second cycle, southern yellow pine was dried from a green moisture content of 37 percent to a final moisture content of approximately 12 percent over a period of 25.4 hours. During the drying cycle on Kiln No. 9, southern yellow pine was dried from a green moisture content of 38 percent to a final moisture content of approximately 15.5 percent over a period of 95.87 hours.

Method 25A was used to measure TOC emissions, which were sampled continuously and quantified at 1-minute intervals throughout all kiln cycles. The exhaust streams were sampled for TOC without (hot) and with (cold) a precondenser in the sampling train. In addition to TOC, Kiln No. 9 was sampled for CO using Method 10 and NO_x using Method 7E.

A tracer gas study was also conducted on both kilns to estimate total kiln emissions, including the flow through the vents and fugitive emissions. The tracer gas used was sulfur hexafluoride (SF_6), which was injected into the center of the kiln at a constant rate of 1 L/min (0.035 ft^3/min), and SF_6 concentrations were measured periodically during the kiln cycles. Based on the results of the tracer study on Kiln No. 1, the ratio of fugitive to process emissions was 1.09 for the first kiln cycle and 2.15 for the second cycle. Based on the results of the tracer study on Kiln No. 9, the ratio of fugitive to process emissions was 5.14.

Emission factors were developed for both process and fugitive emissions of TOC and noncondensible TOC from the both kilns and for CO and NO_x from Kiln No. 9. The factor for fugitive emissions was estimated as the difference in factors based on the emission rates determined using flowrates through the vents and using flowrates determined by the dilution of the tracer.

The process emission data are rated A. The test methods were sound, and emissions were sampled throughout entire kiln cycles. The fugitive emission data are rated D because they are based on the assumptions that the tracer is uniformly diluted throughout the kiln and that the calculated emission rates of the tracer are proportional to the combined TOC emission rates for process and fugitive emissions.

4.2.27. Reference 39

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, aldehydes and ketones, and phenol from a steam-heated lumber kiln. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has a total of 18 roof vents with 9 vents on each side. Flow measurements using propeller anemometers were to be made on the 9 vents that were exhausting the kiln during various periods of the drying cycle. However, based on the information provided in Reference 31, there was some difficulty is moving the anemometers when the fans reversed and the exhaust and inlet vents switched. Testing was conducted during one kiln cycle only. During the test, southern yellow pine was dried from a green moisture content of 41.4 percent to an unspecified final moisture content over a period of 24.67 hours.

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Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. Two of the three runs were anisokinetic. Method 25A was used to measure TOC both without (hot) and with (cold) a precondenser. Aldehyde and ketone emissions were measured using Method 0011, and the sample was analyzed for formaldehyde, acetaldehyde, hexaldehyde, acetone, and methyl ethyl ketone. However, hexaldehyde emissions were below the quantitation limit on all three runs. Phenol emissions were measured using Method 0010, but also were below the quantitation limit on all three runs.

Total organic compound, CO, and NO_x emissions were measured throughout the entire kiln cycle and quantified for each 15- minute interval. The Method 5/202 sampling train was operated for three 1-hour runs.

Emission factors were developed for emissions of filterable PM, condensible inorganic PM, condensible organic PM, TOC, noncondensible TOC, formaldehyde, acetaldehyde, acetone, and methyl ethyl ketone. Due to a lack of information in the report, it was not possible to adjust the factors for formaldehyde, acetaldehyde, acetone, and methyl ethyl ketone emissions to account for the fact that emissions were not sampled throughout an entire kiln cycle.

The TOC emission data are rated B. The test method was sound, and emissions were sampled throughout an entire kiln cycle, but there is some question about the accuracy of the flowrate measurements. The condensible PM emission data are rated C because of the problem of measuring the flowrates, and because emissions were not sampled throughout an entire kiln cycle. The aldehyde and ketone emission data also are rated C because of the problem of measuring the flowrates, because emissions were not sampled throughout an entire kiln cycle, and because the factors could not be adjusted to account for emissions over the entire kiln cycle. The filterable PM data are rated D because, in addition to the reasons stated previously, two of the three runs were anisokinetic.

4.2.28. Reference 40

This reference does not present emission data, but it does provide supplemental information for the emission tests documented in Reference 41.

4.2.29. Reference 41

This report documents the results of measurements of emissions of TOC from two lumber kilns. One of the kilns (Kiln No. 1) is heated by means of a closed loop steam-heated heat exchanger, and the other kiln is direct-fired with natural gas. The tests were conducted in 1994 to provide in house emission data for engineering use.

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Testing was conducted during one drying cycle for each of the two kilns. During both tests, southern yellow pine was dried from a green moisture content of approximately 50 percent to a final moisture content of approximately 14 percent. The drying cycles for the kilns lasted 17 hours and 72 hours, for Kiln No. 1 and Kiln No. 5, respectively.

Total organic compound emissions were measured continuously throughout the entire drying cycle for each kiln using Method 25A. Emissions were sampled through an existing opening in the side of the kiln of each kiln. For Kiln No. 1, volumetric flowrates were estimated based on the volume of gas that corresponds to the moisture loss during the drying cycle, the mass of water attributed to fuel combustion, and the volumes of nitrogen and CO_2 exiting the kiln during the drying cycle. The emission rates determined for the two tests represent total (process and fugitive) emissions from the kilns.

Emission factors were developed for TOC emissions. The TOC emission data are rated B. Although the test method was sound, and emissions were sampled throughout an entire kiln cycle, emission concentrations were sampled from a single point and the volumetric flowrate was estimated by mass balance rather than by direct measurement.

4.2.30. Reference 42

This report documents the results of measurements of emissions of filterable and condensible PM, TOC, CO, NO_x, aldehydes, and ketones from a direct-fired lumber kilns. The tests were conducted in 1994 to demonstrate compliance with State regulations.

The kiln tested has 16 roof vents. Testing was conducted during one cycle while drying southern yellow pine from a green moisture content of 38 percent to a final moisture content of approximately 11 percent over a period of 24 hours.

Filterable and condensible PM emissions were quantified using Methods 5 and 202, respectively. However, condensible inorganic PM emissions were not quantified. Method 25A was used to measure TOC emissions. Emissions of CO were measured using Method 10, and Method 7E was used to quantify NO_x emissions. Aldehyde and ketone emissions were measured using Method 0011. In addition, CO_2 concentrations in the exhaust stream were measured using Method 3A.

Emissions were sampled in the kiln recirculation duct. Stack extensions were installed on each vent, and the volumetric flowrates for the gas stream exiting the kiln was measured using a propeller anemometer on each vent stack. Volumetric flowrates also were estimated based on combustion rates and an F factor (Method 19). However, the estimated F factor flowrate, which should represent process and fugitive emissions, was less than the flowrate measured at the vent stacks.

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Total organic compound, CO, and NO_x emissions were measured continuously throughout the entire kiln cycle. The Method 5/202 sampling train was operated for six 2-hour runs, which spanned the entire kiln drying cycle; four of the six runs were anisokinetic. The Method 0011 train was operated for two 1-hour runs during each of the six Method 5/202 runs.

Emission factors were developed for emissions of filterable PM, condensible organic and inorganic PM, TOC, CO, NO_x, CO_2, formaldehyde, acetaldehyde, hexaldehyde, methyl ethyl ketone, and acetone. [EMISSION FACTORS ON PAGE 6 OF REPORT ARE NOT CONSISTENT WITH EMISSION RATES ON PAGE 5 OF REPORT; HAVE REQUESTED CLARIFICATION FROM BOTH WEYERHAEUSER AND TESTING CONTRACTOR BUT HAVE NOT RECEIVED RESPONSE.]

The TOC, CO, NO_x, condensible PM, aldehyde and ketone, and CO_2 process emission data are rated B. The test methods were sound, and emissions were sampled throughout an entire kiln cycle, but emissions were not sampled at the vents. The filterable PM emission data are rated C for the reasons stated previously and because the majority of the test runs were anisokinetic.

4.2.31. <u>Reference 43</u>

This reference presents summary emission data only, but it does provide supplemental information for the emission tests documented in Reference 41.

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REFERENCE LIST

21. Written communication from Thomas F. Duckert, International Paper, Dallas, TX, to Dallas Safriet, U. S. Environmental Protection Agency, Research Triangle Park, NC, December 8, 1994.

22. *Source Emissions Survey of International Paper Company, Henderson, Texas, January, February, and March 1994*, METCO Environmental, Addison, Texas, 1994.

23. *Source Emissions Survey of International Paper Company, North and South Lumber Kiln Stacks, Moundville, AL, September 1994*, METCO Environmental, Addison, Texas, 1994.

24. *Source Emissions Survey of International Paper Company, Number 3 Lumber Kiln, North and South Stacks, Maplesville, AL, April 1994*, METCO Environmental, Addison, Texas, 1994.

25. *Source Emissions Survey of International Paper Company, Lumber Kiln Number 2, East and West Stacks and Boiler Stack, Morton, MS, September 1994*, METCO Environmental, Addison, Texas, 1994.

26. Personal communication from Charles Vaught, Weyerhaeuser Company, New Bern, NC, to Richard Marinshaw, Midwest Research Institute, Cary, NC, December 22, 1994 and January 3, 1995.

27. S. Steinsberger, *Emission Test Results for Total Hydrocarbons at an Indirect-Fired Wood Drying Kiln, Weyerhaeuser Company, Greenville, NC Facility*, Deeco, Cary, NC, August 28, 1994.

28. S. Steinsberger, *Emission Test Results for Carbon Monoxide, Oxides of Nitrogen, Total Hydrocarbons, Filterable and Condensible Particulate Matter, Methanol, and Aldehyde and Ketones at a Direct-Fired Wood Drying Kiln, Weyerhaeuser Company, New Bern, North Carolina*, Deeco, Cary, NC, September 12, 1994.

29. Personal communication from F. Larson Harsey, Georgia-Pacific Corporation, Atlanta, Georgia, to Richard Marinshaw, Midwest Research Institute, Cary, NC, January 4 and __, 1995.

30. C. Cress, *Emission Test Results for Carbon Monoxide, Oxides of Nitrogen, Hot and Cold Total Hydrocarbons, Filterable and Condensible Particulate Matter, Aldehydes, and Ketones From A Direct-Fired Wood Drying Kiln, Georgia-Pacific Company,*

Wakefield, Virginia, CH2M Hill Corporation, Montgomery, Alabama, October 21, 1994.

31. W. Cody Cress, *Emission Test Results for Hot and Cold Total Hydrocarbons From An Indirect-Fired Wood Drying Kiln, Georgia-Pacific Company, Woodland, Maine*, CH2M Hill Corporation, Montgomery, Alabama, November 3, 1994.

32. J. Evans and S. Appleton, *Emission Test Results for Hot and Cold Total Hydrocarbons Of An Indirect-Fired Wood Drying Kiln, Georgia-Pacific Company, Prosperity, South Carolina Facility*, CH2M Hill Corporation, Montgomery, Alabama, October 10, 1994.

33. Written communication from F. Larson Harsey, Georgia-Pacific Corporation, Atlanta, Georgia, to Dallas Safriet, U. S. Environmental Protection Agency, Research Triangle Park, NC, December 6, 1994.

34. *Report of Air Emissions Tests For Georgia-Pacific Corporation, Bay Springs Lumber Mill, No. 3 Lumber Kiln, Bay Springs, Mississippi, June 28 and 29, 1994*, Environmental Monitoring Laboratories, Ridgeland, Mississippi, July 25, 1994.

35. *Report of Air Emissions Tests For Georgia-Pacific Corporation, No. 2 Dry Kiln, Columbia Lumber Mill, Columbia, Mississippi, February 7 and 8, 1994*, Environmental Monitoring Laboratories, Ridgeland, Mississippi, April 28, 1994.

36. J. Evans and S. Appleton, *Emission Test Results for Carbon Monoxide, Carbon Dioxide, Oxides of Nitrogen, Oxygen, Hot and Cold Total Hydrocarbons, Filterable and Condensible Particulate Matter At A Direct-Fired Wood Drying Kiln, Georgia-Pacific Company, Cross City, Florida*, CH2M Hill Corporation, Montgomery, Alabama, September 25, 1994.

37. *Results of the February 22-25, 1994 Source Emission Test on the Kiln No. 1 and Kiln No. 2 Returns at the Georgia-Pacific Facility Located in Cross City, Florida*, Pace Incorporated, Golden Valley, MN, April 28, 1994.

38. S. Steinsberger, *Emission Test Results for Methane, Carbon Monoxide, Oxides of Nitrogen and Total Hydrocarbons At Two Wood Drying Kilns, Georgia-Pacific Company, El Dorado, Arkansas Facility*, CH2M Hill Corporation, Montgomery, Alabama, September 22, 1994.

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39. M. Hamilton, *Particulate Matter, Condensible Particulate Matter, Aldehydes, Ketones, and Total Hydrocarbons Emission Testing on the Wood Kiln, Georgia-Pacific Wood Kiln, Whiteville, NC*, Deeco, Cary, NC, May 14, 1994.

40. Personal communication from Marvin Glass, MacMillan Bloedel, Inc., Pine Hill, Alabama, to Richard Marinshaw, Midwest Research Institute, Cary, NC, January 9, 1995.

41. *Various Wood Products Facility Emission Sources, Total Hydrocarbon and Formaldehyde Emission Test Report, MacMillan Bloedel, Inc., Pine Hill, Alabama, June, July, September 1994*, Roy F. Weston, Inc., Auburn, AL, September 1994.

42. C. Cress and B. Buynitzky, *Emission Test Results for Carbon Monoxide, Oxides of Nitrogen, Total Hydrocarbons, Filterable and Condensible Particulate Matter, Aldehydes and Ketones From A Direct-Fired Wood Drying Kiln, Weyerhaeuser, Barnesville, Georgia*, Deeco, Cary, NC, October 29, 1994.

43. Written communication from Victor Dallons, Weyerhaeuser Company, Takoma, Washington, to Dallas Safriet, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1994.

Enclosure 2

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TABLE 4-5. SUMMARY OF EMISSION FACTOR DATA FOR LUMBER DRYING KILNS

Kiln type	Pollutant(a)	Kiln Cycle, hr.	P/F(b)	Emission factor, lb/TBF(c)	Rating	Ref.	Wood species	Moisture cont., %(d)	
								Green	Dry
Steam-heated	Condensible org. PM	100	P	0.11	D	12	Ponderosa Pine	50	12-18
Steam-heated	Condensible inorg. PM	100	P	0.049	D	12	Ponderosa Pine	50	12-18
Steam-heated	TOC	100	P	1.3	D	12	Ponderosa Pine	50	12-18
Direct-fired	CO2	17	P/F	380	B	15	Southern yellow pine	40	17
Direct-fired	NOx	17	P/F	0.20	B	15	Southern yellow pine	40	17
Direct-fired	CO	17	P/F	1.1	B	15	Southern yellow pine	40	17
Direct-fired	TOC	17	P/F	3.8	B	15	Southern yellow pine	40	17
Steam-heated	TOC	19.3	P	2.1	B	15	Southern yellow pine	60	19.6
Steam-heated	Filterable PM	18.2	P	0.068	B	16	Southern yellow pine	49	8.4
Steam-heated	Condensible org. PM	18.2	P	0.12	B	16	Southern yellow pine	49	8.4
Steam-heated	Condensible inorg. PM	18.2	P	0.0071	B	16	Southern yellow pine	49	8.4
Steam-heated	Formaldehyde	18.2	P	0.0068	C	16	Southern yellow pine	49	8.4
Steam-heated	CO	18.2	P	0.028	B	16	Southern yellow pine	49	8.4
Steam-heated	TOC	18.2	P	2.9	B	16	Southern yellow pine	49	8.4
Steam-heated	CO	17.2	P	0.027	A	17	Southern yellow pine	48	9.2
Steam-heated	TOC	17.2	P	3.1	A	17	Southern yellow pine	48	9.2
Steam-heated	TOC	18.0	P	1.9	C	18	Southern yellow pine	51	12
Direct-fired	TOC	17.1	P	2.4	B	22	Southern yellow pine		13.5
Direct-fired	TOC	17.4	P	2.7	B	22	Southern yellow pine		13.5
Direct-fired	TOC	16.9	P	2.7	B	22	Southern yellow pine		13.5
Direct-fired	CO	17.1	P	0.44	B	22	Southern yellow pine		13.5
Direct-fired	CO	17.4	P	0.52	B	22	Southern yellow pine		13.5
Direct-fired	CO	16.9	P	0.57	B	22	Southern yellow pine		13.5
Direct-fired	NOx	17.1	P	0.29	B	22	Southern yellow pine		13.5
Direct-fired	NOx	17.4	P	0.30	B	22	Southern yellow pine		13.5
Direct-fired	NOx	16.9	P	0.29	B	22	Southern yellow pine		13.5
Direct-fired	Filterable PM	17.1	P	0.47	B	22	Southern yellow pine		13.5
Direct-fired	Filterable PM	17.4	P	0.51	B	22	Southern yellow pine		13.5
Direct-fired	Filterable PM	16.9	P	0.47	B	22	Southern yellow pine		13.5

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TABLE 4-5. (Continued)

Kiln type	Pollutant(a)	Kiln Cycle, hr.	P/F(b)	Emission factor, lb/TBF(c)	Rating	Ref.	Wood species	Moisture cont., %(d) Green	Dry
Direct-fired	CO2	17.1	P	420	B	22	Southern yellow pine		13.5
Direct-fired	CO2	17.4	P	317	B	22	Southern yellow pine		13.5
Direct-fired	CO2	16.9	P	395	B	22	Southern yellow pine		13.5
Direct-fired	TOC	20.3	P	2.8	B	23	Southern yellow pine		16
Direct-fired	TOC	19.95	P	2.7	B	23	Southern yellow pine		16
Direct-fired	TOC	18.2	P	2.8	B	23	Southern yellow pine		16
Direct-fired	CO	20.3	P	0.95	B	23	Southern yellow pine		16
Direct-fired	CO	19.95	P	1.0	B	23	Southern yellow pine		16
Direct-fired	CO	18.2	P	0.92	B	23	Southern yellow pine		16
Direct-fired	NOx	20.3	P	0.29	B	23	Southern yellow pine		16
Direct-fired	NOx	19.95	P	0.29	B	23	Southern yellow pine		16
Direct-fired	NOx	18.2	P	0.33	B	23	Southern yellow pine		16
Direct-fired	Filterable PM	20.3	P	0.42	B	23	Southern yellow pine		16
Direct-fired	Filterable PM	20.3	P	0.34	B	23	Southern yellow pine		16
Direct-fired	Filterable PM	20.3	P	0.48	B	23	Southern yellow pine		16
Direct-fired	Filterable PM	19.95	P	0.41	B	23	Southern yellow pine		16
Direct-fired	Filterable PM	18.2	P	0.33	B	23	Southern yellow pine		16
Direct-fired	CO2	20.3	P	584	B	23	Southern yellow pine		16
Direct-fired	CO2	19.95	P	569	B	23	Southern yellow pine		16
Direct-fired	CO2	18.2	P	516	B	23	Southern yellow pine		16
Steam-heated	TOC	19.8	P	3.8	B	24	Southern yellow pine		16
Steam-heated	TOC	18.8	P	4.3	B	24	Southern yellow pine		16
Steam-heated	TOC	19.7	P	4.8	B	24	Southern yellow pine		16
Steam-heated	TOC	18.3	P	5.3	B	25	Southern yellow pine		16
Steam-heated	TOC	17.6	P	5.2	B	25	Southern yellow pine		16
Steam-heated	TOC	18.9	P	5.0	B	25	Southern yellow pine		16
Indirect-fired (e)	TOC	14.0	P	3.3	A	27	Southern yellow pine	50	15
Direct-fired	TOC	14.2	P	1.7	A	28	Southern yellow pine	50	15
Direct-fired	TOC	14.2	F	1.5	D	28	Southern yellow pine	50	15
Direct-fired	CO	14.2	P	0.57	A	28	Southern yellow pine	50	15
Direct-fired	CO	14.2	F	0.20	D	28	Southern yellow pine	50	15

TABLE 4-5. (Continued)

Kiln type	Pollutant(a)	Kiln Cycle, hr.	P/F(b)	Emission factor, lb/TBF(c)	Rating	Ref.	Wood species	Moisture cont., %(d) Green	Dry
Direct-fired	NOx	14.2	P	0.13	A	28	Southern yellow pine	50	15
Direct-fired	NOx	14.2	F	0.042	D	28	Southern yellow pine	50	15
Direct-fired	Filterable PM	14.2	P	0.16	D	28	Southern yellow pine	50	15
Direct-fired	Filterable PM	14.2	F	0.20	D	28	Southern yellow pine	50	15
Direct-fired	Condensible PM	14.2	P	0.031	D	28	Southern yellow pine	50	15
Direct-fired	Condensible PM	14.2	F	0.078	D	28	Southern yellow pine	50	15
Direct-fired	Formaldehyde	14.2	P	0.024	A	28	Southern yellow pine	50	15
Direct-fired	Formaldehyde	14.2	F	0.0083	D	28	Southern yellow pine	50	15
Direct-fired	Acetaldehyde	14.2	P	0.020	A	28	Southern yellow pine	50	15
Direct-fired	Acetaldehyde	14.2	F	0.0064	D	28	Southern yellow pine	50	15
Direct-fired	Methanol	14.2	P	0.070	A	28	Southern yellow pine	50	15
Direct-fired	Methanol	14.2	F	0.025	D	28	Southern yellow pine	50	15
Direct-fired	CO2	14.2	P	20	A	28	Southern yellow pine	50	15
Direct-fired	CO2	14.2	F	7.2	D	28	Southern yellow pine	50	15
Direct-fired	TOC	22.5	P	0.93	A	30	Southern yellow pine	40	15
Direct-fired	TOC	25.5	P	0.61	A	30	Southern yellow pine	40	15
Direct-fired	Noncondensible TOC	22.5	P	0.72	A	30	Southern yellow pine	40	15
Direct-fired	Noncondensible TOC	25.5	P	0.44	A	30	Southern yellow pine	40	15
Direct-fired	NOx	22.5	P	0.089	A	30	Southern yellow pine	40	15
Direct-fired	NOx	25.5	P	0.059	A	30	Southern yellow pine	40	15
Direct-fired	CO	22.5	P	0.24	A	30	Southern yellow pine	40	15
Direct-fired	CO	25.5	P	0.14	A	30	Southern yellow pine	40	15
Direct-fired	Filterable PM	22.5	P	0.076	C	30	Southern yellow pine	40	15
Direct-fired	Condensible inorg. PM	22.5	P	0.055	B	30	Southern yellow pine	40	15
Direct-fired	Condensible org. PM	22.5	P	0.018	B	30	Southern yellow pine	40	15
Direct-fired	Formaldehyde	22.5	P	0.012	B	30	Southern yellow pine	40	15
Direct-fired	Acetaldehyde	22.5	P	0.0097	B	30	Southern yellow pine	40	15
Direct-fired	Acetone	22.5	P	0.0026	B	30	Southern yellow pine	40	15
Direct-fired	CO2	22.5	P	76	B	30	Southern yellow pine	40	15
Direct-fired	TOC	24.0	P	0.18	A	31	Spruce	25.4	11.6
Direct-fired	Noncondensible TOC	24.0	P	0.16	A	31	Spruce	25.4	11.6

TABLE 4-5. (Continued)

Kiln type	Pollutant(a)	Kiln Cycle, hr.	P/F(b)	Emission factor, lb/TBF(c)	Rating	Ref.	Wood species	Moisture cont., %(d) Green	Dry
Direct-fired	TOC	24.0	F	3.7	D	31	Spruce	25.4	11.6
Direct-fired	Noncondensible TOC	24.0	F	3.3	D	31	Spruce	25.4	11.6
Direct-fired	TOC	54.0	P	0.25	A	31	Mixed fir	37.5	13.7
Direct-fired	Noncondensible TOC	54.0	P	0.12	A	31	Mixed fir	37.5	13.7
Direct-fired	TOC	54.0	F	2.1	D	31	Mixed fir	37.5	13.7
Direct-fired	Noncondensible TOC	54.0	F	1.0	D	31	Mixed fir	37.5	13.7
Steam-heated	TOC	22.0	P	1.9	A	32	Southern yellow pine	44	10.4
Steam-heated	Noncondensible TOC	22.0	P	1.4	A	32	Southern yellow pine	44	10.4
Steam-heated	TOC	23.0	P	0.63	A	34	Southern yellow pine	44	13
Steam-heated	Noncondensible TOC	23.0	P	0.60	A	34	Southern yellow pine	44	13
Steam-heated	Filterable PM	23.0	P	0.0092	B	34	Southern yellow pine	44	13
Steam-heated	Condensible inorg. PM	23.0	P	0.00044	B	34	Southern yellow pine	44	13
Steam-heated	Condensible org. PM	23.0	P	0.0031	B	34	Southern yellow pine	44	13
Steam-heated	Formaldehyde	23.0	P	0.00084	B	34	Southern yellow pine	44	13
Steam-heated	Acetaldehyde	23.0	P	0.0015	B	34	Southern yellow pine	44	13
Steam-heated	Hexaldehyde	23.0	P	0.00026	B	34	Southern yellow pine	44	13
Steam-heated	Acetone	23.0	P	0.00081	B	34	Southern yellow pine	44	13
Direct-fired	NOx	20.3	P	0.27	B	35	Southern yellow pine	41	12
Direct-fired	NOx	20.3	F	0.15	D	35	Southern yellow pine	41	12
Direct-fired	CO	20.3	P	1.4	B	35	Southern yellow pine	41	12
Direct-fired	CO	20.3	F	0.87	D	35	Southern yellow pine	41	12
Direct-fired	TOC	20.3	P	2.9	B	35	Southern yellow pine	41	12
Direct-fired	TOC	20.3	F	1.7	D	35	Southern yellow pine	41	12
Direct-fired	Filterable PM	20.3	P	0.64	B	35	Southern yellow pine	41	12
Direct-fired	Filterable PM	20.3	F	0.38	D	35	Southern yellow pine	41	12
Direct-fired	Condensible inorg. PM	20.3	P	0.0051	B	35	Southern yellow pine	41	12
Direct-fired	Condensible org. PM	20.3	F	0.017	D	35	Southern yellow pine	41	12
Direct-fired	CO2	20.3	P	467	B	35	Southern yellow pine	41	12
Direct-fired	CO2	20.3	F	275	D	35	Southern yellow pine	41	12
Direct-fired	TOC	17.3	P	3.2	B	36	Southern yellow pine		16
Direct-fired	TOC	17.8	P	2.9	B	36	Southern yellow pine	51	18

TABLE 4-5. (Continued)

Kiln type	Pollutant(a)	Kiln Cycle, hr.	P/F(b)	Emission factor, lb/TBF(c)	Rating	Ref.	Wood species	Moisture cont., %(d)	
								Green	Dry
Direct-fired	Noncondensible TOC	17.3	P	2.1	B	36	Southern yellow pine		16
Direct-fired	Noncondensible TOC	17.8	P	1.6	B	36	Southern yellow pine	51	18
Direct-fired	NOx	17.3	P	0.0010	B	36	Southern yellow pine		16
Direct-fired	NOx	17.8	P	0.0013	B	36	Southern yellow pine	51	18
Direct-fired	CO	17.3	P	0.0092	B	36	Southern yellow pine		16
Direct-fired	CO	17.8	P	0.0097	B	36	Southern yellow pine	51	18
Direct-fired	Filterable PM	17.3	P	0.056	D	36	Southern yellow pine		16
Direct-fired	Condensible inorg. PM	17.3	P	0.14	B	36	Southern yellow pine		16
Direct-fired	Condensible org. PM	17.3	P	0.099	B	36	Southern yellow pine		16
Direct-fired	CO2	17.3	P	260	B	36	Southern yellow pine		16
Direct-fired	TOC	26.5	P	4.7	B	37	Southern yellow pine	44	19
Direct-fired	Noncondensible TOC	26.5	P	3.7	B	37	Southern yellow pine	44	19
Direct-fired	NOx	26.5	P	0.14	B	37	Southern yellow pine	44	19
Direct-fired	CO	26.5	P	0.67	B	37	Southern yellow pine	44	19
Direct-fired	Filterable PM	26.5	P	0.23	C	37	Southern yellow pine	44	19
Direct-fired	Condensible org. PM	26.5	P	0.15	C	37	Southern yellow pine	44	19
Direct-fired	CO2	26.5	P	561	C	37	Southern yellow pine	44	19
Direct-fired	Formaldehyde	26.5	P	0.035	C	37	Southern yellow pine	44	19
Direct-fired	Phenol	26.5	P	0.023	C	37	Southern yellow pine	44	19
Direct-fired	TOC	17.5	P	2.9	B	37	Southern yellow pine	50	14
Direct-fired	TOC	15.0	P	2.8	B	37	Southern yellow pine	50	14
Direct-fired	Noncondensible TOC	17.5	P	2.4	B	37	Southern yellow pine	50	14
Direct-fired	NOx	17.5	P	0.018	B	37	Southern yellow pine	50	14
Direct-fired	NOx	15.0	P	0.050	B	37	Southern yellow pine	50	14
Direct-fired	CO	17.5	P	0.17	B	37	Southern yellow pine	50	14
Direct-fired	CO	15.0	P	0.15	B	37	Southern yellow pine	50	14
Direct-fired	Filterable PM	17.5	P	0.14	C	37	Southern yellow pine	50	14
Direct-fired	Condensible org. PM	17.5	P	0.074	C	37	Southern yellow pine	50	14
Direct-fired	CO2	17.5	P	378	C	37	Southern yellow pine	50	14
Direct-fired	Formaldehyde	17.5	P	0.024	C	37	Southern yellow pine	50	14
Direct-fired	Phenol	17.5	P	0.0032	C	37	Southern yellow pine	50	14

TABLE 4-5. (Continued)

Kiln type	Pollutant(a)	Kiln Cycle, hr.	P/F(b)	Emission factor, lb/TBF(c)	Rating	Ref.	Wood species	Moisture cont., %(d) Green	Dry
Steam-heated	TOC	26.6	P	2.0	A	38	Southern yellow pine	44	12
Steam-heated	TOC	25.4	P	1.4	A	38	Southern yellow pine	44	12
Steam-heated	Noncondensible TOC	26.6	P	2.0	A	38	Southern yellow pine	44	12
Steam-heated	TOC	26.6	F	0.18	D	38	Southern yellow pine	44	12
Steam-heated	TOC	25.4	F	1.6	D	38	Southern yellow pine	44	12
Steam-heated	Noncondensible TOC	26.6	F	0.18	D	38	Southern yellow pine	44	12
Direct-fired	TOC	95.9	P	0.37	A	38	Southern yellow pine	38	15.5
Direct-fired	Noncondensible TOC	95.9	P	0.28	A	38	Southern yellow pine	38	15.5
Direct-fired	TOC	95.9	F	1.5	D	38	Southern yellow pine	38	15.5
Direct-fired	Noncondensible TOC	95.9	F	1.2	D	38	Southern yellow pine	38	15.5
Direct-fired	NOx	95.9	P	0.012	A	38	Southern yellow pine	38	15.5
Direct-fired	NOx	95.9	F	0.050	D	38	Southern yellow pine	38	15.5
Direct-fired	CO	95.9	P	0.22	A	38	Southern yellow pine	38	15.5
Direct-fired	CO	95.9	F	0.89	D	38	Southern yellow pine	38	15.5
Direct-fired	TOC	24.7	P	0.86	B	39	Southern yellow pine	41.4	
Direct-fired	Noncondensible TOC	24.7	P	0.78	B	39	Southern yellow pine	41.4	
Direct-fired	Filterable PM	24.7	P	0.0017	D	39	Southern yellow pine	41.4	
Direct-fired	Condensible inorg. PM	24.7	P	0.0076	C	39	Southern yellow pine	41.4	
Direct-fired	Condensible org. PM	24.7	P	0.0064	C	39	Southern yellow pine	41.4	
Direct-fired	Formaldehyde	24.7	P	0.0043	C	39	Southern yellow pine	41.4	
Direct-fired	Acetaldehyde	24.7	P	0.0078	C	39	Southern yellow pine	41.4	
Direct-fired	Acetone	24.7	P	0.011	C	39	Southern yellow pine	41.4	
Direct-fired	Methyl ethyl ketone	24.7	P	0.0012	C	39	Southern yellow pine	41.4	
Steam-heated	TOC	17.0	P/F	1.7	B	41	Southern yellow pine	50	14
Gas-fired	TOC	72.0	P/F	1.4	B	41	Southern yellow pine	50	14
Direct-fired	TOC	23.95	P	2.7	B	42	Southern yellow pine	38	11
Direct-fired	NOx	23.95	P	0.37	B	42	Southern yellow pine	38	11
Direct-fired	CO	23.95	P	1.3	B	42	Southern yellow pine	38	11
Direct-fired	Filterable PM	23.95	P	0.56	C	42	Southern yellow pine	38	11
Direct-fired	Condensible inorg. PM	23.95	P	0.038	B	42	Southern yellow pine	38	11
Direct-fired	Condensible org. PM	23.95	P	0.093	B	42	Southern yellow pine	38	11

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TABLE 4-5. (Continued)

Kiln type	Pollutant(a)	Kiln Cycle, hr.	P/F(b)	Emission factor, lb/TBF(c)	Rating	Ref.	Wood species	Moisture cont., %(d)	
								Green	Dry
Direct-fired	Formaldehyde	23.95	P	0.075	B	42	Southern yellow pine	38	11
Direct-fired	Acetaldehyde	23.95	P	0.068	B	42	Southern yellow pine	38	11
Direct-fired	Hexaldehyde	23.95	P	0.019	B	42	Southern yellow pine	38	11
Direct-fired	Acetone	23.95	P	0.092	B	42	Southern yellow pine	38	11
Direct-fired	Methyl ethyl ketone	23.95	P	0.0075	B	42	Southern yellow pine	38	11
Direct-fired	CO2	23.95	P	399	B	42	Southern yellow pine	38	11

(a) TOC = Total organic compounds as carbon, measured using EPA Method 25A.
Noncond. TOC = total organic compounds as carbon, measured using EPA Method 25A with a condenser.
(b) P = process emissions, measured from kiln vents.
F = fugitive emissions, based on difference between vent flow rates and flowrates estimated using F-factor or tracer gas.
P/F = combined process and fugitive emissions.
(c) Emission factors in units of pounds per thousand board feet.
(d) Average moisture content on wet basis.
(e) Uses Wellons thermal oil heating system.

Enclosure 3

Source category: Lumber
Plant name : International Paper
Process : Drying

Filename: LUM_RF22.WQ1
Location: Henderson, TX
Test date: February 2-4, 1994

Date: 01/27/95
Ref. No.: 4/22
Process rate basis: production

Source	Type of control	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Flow factor for vents	Concen., ppm	Emission rate per vent, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln	none	TOC	2	25A	17.1	4.46	355	3.4	255	105	45.0	2.4	2.3	4.6	
		TOC	3		17.4	4.46	371	3.7	286	105	45.0	2.7	2.5	5.1	
		TOC	4		16.9	4.46	403	3.8	283	105	45.0	2.7	2.5	5.1	
											Average	2.6	2.5	4.9	B
		CO	2	7E	17.1	4.46	78	0.6	46	105	45.0	0.44	0.41	0.82	
		CO	3		17.4	4.46	87	0.7	54	105	45.0	0.52	0.49	0.97	
		CO	4		16.9	4.46	106	0.8	60	105	45.0	0.57	0.54	1.1	
											Average	0.51	0.48	0.95	B
		NOx	2	7E	17.1	4.46	30	0.4	31	105	45.0	0.29	0.27	0.54	
		NOx	3		17.4	4.46	34	0.4	31	105	45.0	0.30	0.28	0.55	
		NOx	4		16.9	4.46	35	0.4	30	105	45.0	0.29	0.27	0.54	
											Average	0.29	0.27	0.55	B
		Filt. PM	3	5	17.1	4.46		0.65	50	105	45.0	0.47	0.44	0.89	
		Filt. PM	4		17.4	4.46		0.69	54	105	45.0	0.51	0.48	0.96	
		Filt. PM	5		16.9	4.46		0.65	49	105	45.0	0.47	0.44	0.87	
											Average	0.48	0.45	0.91	B
							%								
		CO2	3	Orsat	17.1	4.46	5.1	579	44,132	105	45.0	420	394	788	
		CO2	4		17.4	4.46	3.8	429	33,257	105	45.0	317	297	594	
		CO2	5		16.9	4.46	4.8	551	41,522	105	45.0	395	371	741	
											Average	377	354	708	B

Basis for rating: Only one pair of vents sampled.
Problems noted:
Other notes:

Source category: Lumber
Plant name : International Paper
Process : Drying

Filename: LUM_RF23.WQ1
Location: Moundville, AL
Test date: September 26-30, 1994

Date: 01/26/95
Ref. No.: 4/23
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Flow factor for vents	Concen., ppm	Emission rate per vent, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
Direct-fired kiln	none	TOC	2	25A	20.3	4.78	458	3.8	373	133	45.0	2.8	2.6	5.3	
		TOC	3		20.0	4.78	445	3.8	359	131	45.0	2.7	2.6	5.1	
		TOC	4		18.2	4.78	492	4.3	370	133	45.0	2.8	2.6	5.2	
											Average	2.8	2.6	5.2	B
		CO	2	7E	20.3	4.78	190	1.3	126	133	45.0	0.95	0.89	1.78	
		CO	3		20.0	4.78	205	1.4	134	131	45.0	1.02	0.96	1.91	
		CO	4		18.2	4.78	206	1.4	122	133	45.0	0.92	0.86	1.7	
											Average	0.96	0.90	1.80	B
		NOx	2	10	20.3	4.78	37	0.4	39	133	45.0	0.29	0.27	0.55	
		NOx	3		20.0	4.78	39	0.4	38	131	45.0	0.29	0.27	0.55	
		NOx	4		18.2	4.78	41	0.5	43	133	45.0	0.33	0.31	0.61	
											Average	0.30	0.28	0.57	B
		Filt. PM	1	5	20.3	4.78		0.57	55	133	45.0	0.42	0.39	0.78	
		Filt. PM	2		20.3	4.78		0.47	46	133	45.0	0.34	0.32	0.64	
		Filt. PM	3		20.3	4.78		0.65	63	131	45.0	0.48	0.45	0.90	
		Filt. PM	4		20.0	4.78		0.56	53	131	45.0	0.41	0.38	0.76	
		Filt. PM	5		18.2	4.78		0.49	43	131	45.0	0.33	0.31	0.61	
											Average	0.39	0.37	0.74	B
							%								
		CO2	3	Orsat	20.3	4.78	7.7	788	76,466	131	45.0	584	547	1,094	
		CO2	4		20.0	4.78	7.8	782	74,592	131	45.0	569	534	1,068	
		CO2	5		18.2	4.78	7.6	777	67,575	131	45.0	516	484	967	
											Average	556	522	1,043	B

Basis for rating: Single pair of vents sampled, flow rates for other vents assumed to be constant throughout test.
Problems noted:
Other notes: TOC reported as carbon.

Source category: Lumber
Plant name : International Paper
Process : Drying

Filename: LUM_RF24.WQ1
Location: Maplesville, AL
Test date: April 18-23, 1994

Date: 01/26/95
Ref. No.: 4/24
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Flow factor for vents	Concen., ppm	Emission rate per vent, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Steam-heated kiln	none	TOC	2	25A	19.8	4.00	563	5.6	441	115	45.0	3.8	3.6	7.2	
		TOC	3		18.8	4.00	600	6.1	461	108	45.0	4.3	4.0	8.0	
		TOC	4		19.7	4.00	658	7.0	555	116	45.0	4.8	4.5	9.0	
											Average	4.3	4.0	8.1	B

Basis for rating: Sampled one pair of vents, flow rates for other vents assumed to be constant throughout test.
Problems noted:
Other notes: TOC reported as carbon.

Source category: Lumber
Plant name : International Paper
Process : Drying

Filename: LUM_RF25.WQ1
Location: Morton, MS
Test date: September 12-16, 1994

Date: 01/26/95
Ref. No.: 4/25
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Flow factor for vents	Concen., ppm	Emission rate per vent, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
Steam-heated kiln	none	TOC	2	25A	18.3	5.37	1005	8.1	794	150	45.0	5.3	5.0	10	
		TOC	3		17.6	5.37	1118	8.2	771	149	45.0	5.2	4.9	9.7	
		TOC	4		18.9	5.37	962	7.5	765	152	45.0	5.0	4.7	9.5	
											Average	5.2	4.9	9.7	B

Basis for rating: Single pair of vents sampled, flow rates for other vents assumed to be constant throughout test.
Problems noted:
Other notes: TOC reported as carbon.

Source category:	Lumber	Filename:	LUM_RF27.WQ1	Date: 01/26/95
Plant name:	Weyerhaeuser	Location:	Greenville, NC	Ref. No.: 4/27
Process:	Drying	Test date:	July 22-23, 1994	Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
Indirect-fired	none	TOC	1	25A	14.0		208.8	64.000	45.0	3.3	3.1	6.1	A

Notes:

Green moisture content - 100% (wet basis)

Dry moisture content - 18%

Kiln heated with Wellons thermal oil heating system.

Source Category:	Lumber	Filename:	LUM_RF28.WQ1	Date:	01/26/95
Plant name:	Weyerhaeuser	Location:	New Bern, NC	Ref. No.:	4/28
Process:	Drying	Test date:	July 14-15, 1994	Process rate basis:	production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln	none	TOC	1	25A	14.2		108	63.5		1.7	0.0	0.0	A
kiln fugitives		TOC	1	25A	14.2		96	63.5	45.0	1.5	1.4	2.8	D
Process		CO	1	25A	14.2		36.3	63.5	45.0	0.57	0.54	1.1	A
Fugitives		CO	2		14.2		12.5	63.5	45.0	0.20	0.18	0.37	D
Process		NOx	1	25A	14.2		7.9	63.5	45.0	0.13	0.12	0.23	A
Fugitives		NOx	2		14.2		2.7	63.5	45.0	0.042	0.040	0.080	D
						Emission rate, lb/hr							
Process		Filt. PM	1	5									
		Filt. PM	2										
		Filt. PM	3										
			Average		14.2	0.72	10.2	63.5	45.0	0.16	0.15	0.30	D
Fugitive		Filt. PM	1	5									
		Filt. PM	2										
		Filt. PM	3										
					14.2	0.88	12.5	63.5	45.0	0.20	0.18	0.37	D
Process		Condensible PM	1	202									
		Condensible PM	2										
		Condensible PM	3										
					14.2	0.14	2.0	63.5	45.0	0.031	0.029	0.059	D
Fugitive		Condensible PM	1	202									
		Condensible PM	2										
		Condensible PM	3										
					14.2	0.35	5.0	63.5	45.0	0.078	0.073	0.15	D

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
Process		Formaldehyde	1	0011	14.2	0.085	1.21	63.5	45.0	0.019	0.018	0.036	
		Formaldehyde	2		14.2	0.034	0.48	63.5	45.0	0.0076	0.0071	0.014	
		Formaldehyde	3		14.2	0.066	0.94	63.5	45.0	0.015	0.014	0.028	
		Formaldehyde	4		14.2	0.082	1.16	63.5	45.0	0.018	0.017	0.034	
		Formaldehyde	5		14.2	0.194	2.75	63.5	45.0	0.043	0.041	0.081	
		Formaldehyde	6		14.2	0.191	2.71	63.5	45.0	0.043	0.040	0.080	
									Average	0.024	0.023	0.045	A
Fugitive		Formaldehyde	1	0011	14.2	0.067	0.95	63.5	45.0	0.015	0.014	0.028	
		Formaldehyde	2		14.2	0.016	0.23	63.5	45.0	0.0036	0.0033	0.007	
		Formaldehyde	3		14.2	0.118	1.67	63.5	45.0	0.026	0.025	0.049	
		Formaldehyde	4		14.2	0.023	0.33	63.5	45.0	0.005	0.005	0.010	
		Formaldehyde	5		14.2	0	0.00	63.5	45.0	0.000	0.000	0.000	
		Formaldehyde	6		14.2	0	0.00	63.5	45.0	0.000	0.000	0.000	
									Average	0.0083	0.0078	0.016	D
Process		Acetaldehyde	1	0011	14.2	0.057	0.81	63.5	45.0	0.013	0.012	0.024	
		Acetaldehyde	2		14.2	0.056	0.79	63.5	45.0	0.013	0.012	0.023	
		Acetaldehyde	3		14.2	0.047	0.67	63.5	45.0	0.0105	0.0098	0.020	
		Acetaldehyde	4		14.2	0.07	0.99	63.5	45.0	0.016	0.015	0.029	
		Acetaldehyde	5		14.2	0.155	2.20	63.5	45.0	0.035	0.032	0.065	
		Acetaldehyde	6		14.2	0.145	2.06	63.5	45.0	0.032	0.030	0.061	
									Average	0.020	0.018	0.037	A
Fugitive		Acetaldehyde	1	0011	14.2	0.045	0.64	63.5	45.0	0.0100	0.0094	0.019	
		Acetaldehyde	2		14.2	0.027	0.38	63.5	45.0	0.0060	0.0057	0.011	
		Acetaldehyde	3		14.2	0.085	1.21	63.5	45.0	0.019	0.018	0.036	
		Acetaldehyde	4		14.2	0.016	0.23	63.5	45.0	0.0036	0.0033	0.007	
		Acetaldehyde	5		14.2	0	0.00	63.5	45.0	0.000	0.000	0.000	
		Acetaldehyde	6		14.2	0	0.00	63.5	45.0	0.000	0.000	0.000	
									Average	0.0064	0.0060	0.012	D

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Process		Methanol	1	18	14.2	0.045	0.64	63.5	45.0	0.0100	0.0094	0.019	
		Methanol	2		14.2	0.133	1.89	63.5	45.0	0.0297	0.0278	0.056	
		Methanol	3		14.2	0.247	3.50	63.5	45.0	0.055	0.052	0.103	
		Methanol	4		14.2	0.59	8.37	63.5	45.0	0.1318	0.1235	0.247	
		Methanol	5		14.2	0.425	6.03	63.5	45.0	0.095	0.089	0.178	
		Methanol	6		14.2	0.49	6.95	63.5	45.0	0.109	0.103	0.205	
		Methanol	7		14.2	0.441	6.25	63.5	45.0	0.0985	0.0923	0.185	
		Methanol	8		14.2	0.401	5.69	63.5	45.0	0.0895	0.0839	0.168	
		Methanol	9		14.2	0.33	4.68	63.5	45.0	0.074	0.069	0.138	
		Methanol	10		14.2	0.309	4.38	63.5	45.0	0.0690	0.0647	0.129	
		Methanol	11		14.2	0.171	2.42	63.5	45.0	0.038	0.036	0.072	
		Methanol	12		14.2	0.284	4.03	63.5	45.0	0.063	0.059	0.119	
		Methanol	13		14.2	0.217	3.08	63.5	45.0	0.048	0.045	0.091	
						0.314			Average	0.070	0.066	0.13	A
Fugitive		Methanol	1	18	14.2	0.015	0.21	63.5	45.0	0.0033	0.0031	0.006	
		Methanol	2		14.2	0.046	0.65	63.5	45.0	0.0103	0.0096	0.019	
		Methanol	3		14.2	0.085	1.21	63.5	45.0	0.019	0.018	0.036	
		Methanol	4		14.2	0.203	2.88	63.5	45.0	0.0453	0.0425	0.085	
		Methanol	5		14.2	0.146	2.07	63.5	45.0	0.033	0.031	0.061	
		Methanol	6		14.2	0.24	3.40	63.5	45.0	0.054	0.050	0.100	
		Methanol	7		14.2	0.151	2.14	63.5	45.0	0.0337	0.0316	0.063	
		Methanol	8		14.2	0.138	1.96	63.5	45.0	0.0308	0.0289	0.058	
		Methanol	9		14.2	0.114	1.62	63.5	45.0	0.025	0.024	0.048	
		Methanol	10		14.2	0.106	1.50	63.5	45.0	0.0237	0.0222	0.044	
		Methanol	11		14.2	0.059	0.84	63.5	45.0	0.013	0.012	0.025	
		Methanol	12		14.2	0.098	1.39	63.5	45.0	0.022	0.021	0.041	
		Methanol	13		14.2	0.075	1.06	63.5	45.0	0.017	0.016	0.031	
						0.114			Average	0.025	0.024	0.048	D

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
Process		CO_2	1	3A	14.2	6.60	973.10	63.5	45.0	15	14	29	
		CO_2	2		14.2	6.60	1176.96	63.5	45.0	19	17	35	
		CO_2	3		14.2	6.60	621.10	63.5	45.0	10	9	18	
		CO_2	4		14.2	6.60	1413.43	63.5	45.0	22	21	42	
		CO_2	5		14.2	6.60	1820.70	63.5	45.0	29	27	54	
		CO_2	6		14.2	6.60	1745.50	63.5	45.0	27	26	52	
									Average	20	19	38	A
Fugitive		CO_2	1	3A	14.2	6.60	763.35	63.5	45.0	12	11	23	
		CO_2	2		14.2	6.60	559.48	63.5	45.0	8.8	8.3	17	
		CO_2	3		14.2	6.60	1115.35	63.5	45.0	18	16	33	
		CO_2	4		14.2	6.60	323.01	63.5	45.0	5.1	4.8	10	
		CO_2	5		14.2	6.60		63.5	45.0	0	0	0	
		CO_2	6		14.2	6.60		63.5	45.0	0	0	0	
									Average	7.2	6.8	14	D

Basis for rating: For PM, average emission rates reported, could not substantiate using run-by-run data in appendices.
Fugitive factors based on f-factor, as difference between process and total f-factor emissions.

Other notes:

Source Category: Lumber
Plant name: Georgia-Pacific
Process: Drying

Filename: LUM_RF30.WQ1
Location: Wakefield, VA
Test date: September 28-30, 1994

Date: 01/27/95
Ref. No.: 4/30
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln	none	TOC	1	25A	22.5		115	124.287	45.0	0.93	0.87	1.7	
		TOC	2		25.5		81	133.824	45.0	0.61	0.57	1.1	
									Average	0.77	0.72	1.4	A
		Noncond. TOC	1	25A	22.5		89	124.287	45.0	0.72	0.67	1.3	
		Noncond. TOC	2		25.5		58	133.824	45.0	0.44	0.41	0.82	
									Average	0.58	0.54	1.1	A
		NOx	1	25A	22.5		11.0	124.287	45.0	0.089	0.083	0.17	
		NOx	2		25.5		7.9	133.824	45.0	0.059	0.055	0.11	
									Average	0.074	0.069	0.14	A
		CO	1	25A	22.5		29.4	124.287	45.0	0.24	0.22	0.44	
		CO	2		25.5		19.1	133.824	45.0	0.14	0.13	0.27	
									Average	0.19	0.18	0.36	A
						Emission rate, lb/hr							
		Filt. PM	1	5	22.5	0.673	15.1	124.287	45.0	0.12	0.11	0.23	
		Filt. PM	2		22.5	0.136	3.06	124.287	45.0	0.025	0.023	0.046	
		Filt. PM	3		22.5	0.447	10.0	124.287	45.0	0.081	0.076	0.15	
									Average	0.076	0.071	0.14	C
		Cond. inorg. PM	1	202	22.5	0.360	8.1	124.287	45.0	0.065	0.061	0.12	
		Cond. inorg. PM	2		22.5	0.276	6.21	124.287	45.0	0.050	0.047	0.094	
		Cond. inorg. PM	3		22.5	0.273	6.1	124.287	45.0	0.049	0.046	0.092	
									Average	0.055	0.051	0.10	B
		Cond. org. PM	1	202	22.5	0.121	2.7	124.287	45.0	0.022	0.020	0.041	
		Cond. org. PM	2		22.5	0.115	2.58	124.287	45.0	0.021	0.019	0.039	
		Cond. org. PM	3		22.5	0.0684	1.5	124.287	45.0	0.012	0.012	0.023	
									Average	0.018	0.017	0.034	B
		Formaldehyde	1	0011	22.5	0.132	2.97	124.287	45.0	0.024	0.022	0.045	
		Formaldehyde	2		22.5	0.122	2.74	124.287	45.0	0.022	0.021	0.041	
		Formaldehyde	3		22.5	0.056	1.26	124.287	45.0	0.010	0.0095	0.019	
									Average	0.019	0.018	0.035	

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
		Acetaldehyde	1	0011	22.5	0.097	2.18	124.287	45.0	0.018	0.016	0.033	
		Acetaldehyde	2		22.5	0.094	2.11	124.287	45.0	0.017	0.016	0.032	
		Acetaldehyde	3		22.5	0.054	1.21	124.287	45.0	0.010	0.0092	0.018	
									Average	0.015	0.014	0.028	
		Hexaldehyde	1	0011	22.5	<0.0007		124.287	45.0				
		Hexaldehyde	2		22.5	0.048	1.079	124.287	45.0	0.0087	0.0081	0.016	
		Hexaldehyde	3		22.5	<0.0007		124.287	45.0				
									Average	0.0087	0.0081	0.016	
		Acetone	1	0011	22.5	0.043	0.966	124.287	45.0	0.0078	0.0073	0.015	
		Acetone	2		22.5	0.019	0.427	124.287	45.0	0.0034	0.0032	0.0064	
		Acetone	3		22.5	0.004	0.090	124.287	45.0	0.00072	0.00068	0.0014	
									Average	0.0040	0.0037	0.0075	
		MEK	1	0011	22.5	<0.0007		124.287	45.0				
		MEK	2		22.5	<0.0007		124.287	45.0				
		MEK	3		22.5	<0.0007		124.287	45.0				
									Average				
						%							
		CO2	1	Orsat	22.5	5.0	9,447	124.287	45.0	76	71	143	
		CO2	2		22.5	5.0	9,447	124.287	45.0	76	71	143	
		CO2	3		22.5	5.0	9,447	124.287	45.0	76	71	143	
									Average	76	71	143	B
		ADJUSTED EMISSION FACTORS											
									Adj. factor				
		Formaldehyde							0.65	0.012	0.011	0.023	B
		Acetaldehyde							0.65	0.0097	0.0091	0.018	B
		Acetone							0.65	0.0026	0.0024	0.0049	B

Basis for rating: Runs 2 and 3 of PM test anisokinetic.

Problems noted:

Other notes: Volumetric flow rates seem low.

Emission factors for organics adjusted by the ratio of the TOC emission rate during the three 1-hour runs to the average overall TOC emission rate for both kiln cycles [i.e., ((5.11+3.18)/2)/6.33].

Source category:	Lumber	Filename:	LUM_RF31.WQ1	Date:	01/26/95
Plant name:	Georgia-Pacific	Location:	Woodland, ME	Ref. No.:	4/31
Process:	Drying	Test date:	October 11-14, 1994	Process rate basis:	production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr		Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor			
										lb/TBF	kg/Mg	lb/ton	Rating
Direct-fired kiln													
Process	none	TOC	a	25A	24.0		32	178.560	32.5	0.18	0.12	0.24	A
		Noncond. TOC	a		24.0		28	178.560	32.5	0.16	0.11	0.21	A
Fugitive		TOC	a		24.0		662.3	178.560	32.5	3.7	2.5	5.0	D
		Noncond. TOC	a		24.0		583.1	178.560	32.5	3.3	2.2	4.4	D
Process		TOC	b		54.0		44	178.560	32.5	0.25	0.17	0.33	A
		Noncond. TOC	b		54.0		22	178.560	32.5	0.12	0.084	0.17	A
Fugitive		TOC	b		54.0		375.2	178.560	32.5	2.1	1.4	2.8	D
		Noncond. TOC	b		54.0		186.9	178.560	32.5	1.0	0.71	1.4	D

Basis for rating: Fugitive emissions based on tracer gas and difference between vent flow and flow based on tracer dilution.

Notes: a--Test 1; b--Test 2.

	Test 1	Test 2
Green moisture content	25.4%	37.5%
Dry moisture content	11.6%	13.7 %
Wood Species	Spruce	Fir

Source category:	Lumber	Filename:	LUM_RF32.WQ1	Date:	01/26/95
Plant name:	Georgia-Pacific	Location:	Prosperity, SC	Ref. No.:	4/32
Process:	Drying	Test date:	September 22-23, 1994	Process rate basis:	production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor			
										lb/TBF	kg/Mg	lb/ton	Rating
Steam heated kiln	none	TOC	1	25A	22.0		171	88.500	45.0	1.9	1.8	3.6	A
		Nonc. TOC	1	25A	22.0		122	88.500	45.0	1.4	1.3	2.6	A

Notes:

Green moisture content - 44%

Dry moisture content - 10.4%

Source category: Lumber
Plant name: Georgia-Pacific
Process: Drying

Filename: LUM_RF34.WQ1
Location: Bay Springs, MS
Test date: June 28-29, 1994

Date: 01/27/95
Ref. No.: 4/34
Process Rate Basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Emission rate, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Steam heated kiln	none	TOC	1	25A	23.0	4.26	97.9	156.160	45.0	0.63	0.59	1.2	A
		Noncond. TOC	1	25A	23.0	4.06	93.5	156.160	45.0	0.60	0.56	1.1	A
		Filt. PM	1	5	23.0	0.074	1.7	156.160	45.0	0.011	0.010	0.020	
		Filt. PM	2		23.0	0.038	0.87	156.160	45.0	0.0056	0.0052	0.010	
		Filt. PM	3		23.0	0.075	1.7	156.160	45.0	0.011	0.010	0.021	
									Average	0.0092	0.0086	0.017	B
		Cond. inorg. PM	1	5	23.0	0.0020	0.046	156.160	45.0	0.00029	0.00028	0.00055	
		Cond. inorg. PM	2		23.0	0.0030	0.069	156.160	45.0	0.00044	0.00041	0.00083	
		Cond. inorg. PM	3		23.0	0.0040	0.092	156.160	45.0	0.00059	0.00055	0.0011	
									Average	0.00044	0.00041	0.00083	B
		Cond. org. PM	1	5	23.0	0.014	0.32	156.160	45.0	0.0021	0.0019	0.0039	
		Cond. org. PM	2		23.0	0.024	0.55	156.160	45.0	0.0035	0.0033	0.0066	
		Cond. org. PM	3		23.0	0.026	0.60	156.160	45.0	0.0038	0.0036	0.0072	
									Average	0.0031	0.0029	0.0059	B
		Formaldehyde	1	TO-5	23.0	0.0013	0.030	156.160	45.0	0.00019	0.00018	0.00036	
		Formaldehyde	2	(0011)	23.0	0.014	0.32	156.160	45.0	0.0021	0.0019	0.0039	
		Formaldehyde	3		23.0	0.0013	0.030	156.160	45.0	0.00019	0.00018	0.00036	
									Average	0.00081	0.00076	0.0015	
		Acetaldehyde	1	TO-5	23.0	0.0086	0.20	156.160	45.0	0.0013	0.0012	0.0024	
		Acetaldehyde	2	(0011)	23.0	0.013	0.30	156.160	45.0	0.0019	0.0018	0.0036	
		Acetaldehyde	3		23.0	0.0075	0.17	156.160	45.0	0.0011	0.0010	0.0021	
									Average	0.0014	0.0013	0.0027	

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Emission rate, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
		Hexaldehyde	1	TO-5	23.0	<0.0007		156.160	45.0				
		Hexaldehyde	2	(0011)	23.0	0.0017	0.039	156.160	45.0	0.00025	0.00023	0.00047	
		Hexaldehyde	3		23.0	<0.0007		156.160	45.0				
									Average	0.00025	0.00023	0.00047	
		Acetone	1	TO-5	23.0	0.0045	0.10	156.160	45.0	0.00066	0.00062	0.0012	
		Acetone	2	(0011)	23.0	0.0073	0.17	156.160	45.0	0.0011	0.0010	0.0020	
		Acetone	3		23.0	0.0043	0.099	156.160	45.0	0.00063	0.00059	0.0012	
									Average	0.00079	0.00074	0.0015	
		MEK	1	TO-5	23.0	<0.0007		156.160	45.0				
		MEK	2	(0011)	23.0	<0.0007		156.160	45.0				
		MEK	3		23.0	<0.0007		156.160	45.0				
									Average				
		ADJUSTED EMISSION FACTORS											
									Adj. factor	lb/TBF	kg/Mg	lb/ton	
		Formaldehyde							1.03	0.00084	0.00079	0.0016	B
		Acetaldehyde							1.03	0.0015	0.0014	0.0028	B
		Hexaldehyde							1.03	0.00026	0.00024	0.00048	B
		Acetone							1.03	0.00081	0.00076	0.0015	B

Notes:

Emission factors for organics adjusted by the ratio of the TOC emission rate during the three 1-hour runs to the average overall TOC emission rate for both kiln cycles [i.e., (4.26/4.14)].

Green moisture content - 44%

Dry moisture content - 13%

Wood Species - Southern Pine

Source category: Lumber
Plant name: Georgia-Pacific
Process: Drying

Filename: LUM_RF35.WQ1
Location: Columbia, MS
Test date: February 7-8, 1994

Date: 01/26/95
Ref. No.: 4/35
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Emission rate, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln	none												
Process		NOx	1	7E	20.25		29.1	106.720	45.0	0.27	0.26	0.51	B
Fugitive		NOx			20.25		15.9	106.720	45.0	0.15	0.14	0.28	D
Process		CO	1	10	20.25		151	106.720	45.0	1.4	1.3	2.6	B
Fugitive		CO			20.25		92.4	106.720	45.0	0.87	0.81	1.6	D
Process		TOC	1	25A	20.25		310	106.720	45.0	2.9	2.7	5.5	B
Fugitive		TOC	1		20.25		185	106.720	45.0	1.7	1.6	3.2	D
Process		Filt. PM	1	5	20.25	2.816	57.0	106.720	45.0	0.53	0.50	1.00	
		Filt. PM	2		20.25	4.185	84.75	106.720	45.0	0.79	0.74	1.49	
		Filt. PM	3		20.25	3.183	64.5	106.720	45.0	0.60	0.57	1.13	
									Average	0.64	0.60	1.21	B
Fugitive		Filt. PM	1	5	20.25	2.288	46.3	106.720	45.0	0.43	0.41	0.81	
		Filt. PM	2		20.25	2.584	52.33	106.720	45.0	0.49	0.46	0.92	
		Filt. PM	3		20.25	1.095	22.2	106.720	45.0	0.21	0.19	0.39	
									Average	0.38	0.35	0.71	D
Process		Cond. inorg. PM	1	202	20.25	0.042	0.9	106.720	45.0	0.0080	0.0075	0.015	
		Cond. inorg. PM	2		20.25	0.025	0.51	106.720	45.0	0.0047	0.0044	0.0089	
		Cond. inorg. PM	3		20.25	0.0130	0.3	106.720	45.0	0.0025	0.0023	0.0046	
									Average	0.0051	0.0047	0.0095	B
Fugitive		Cond. org. PM	1	202	20.25	0.153	3.10	106.720	45.0	0.029	0.027	0.054	
		Cond. org. PM	2		20.25	0.059	1.19	106.720	45.0	0.011	0.010	0.021	
		Cond. org. PM	3		20.25	0.055	1.11	106.720	45.0	0.010	0.010	0.020	
						%			Average	0.017	0.016	0.032	D

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Emission rate, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Process		CO2	1	3A	20.25	8.8	47,911	106.720	45.0	449	421	842	
		CO2	2		20.25	8.3	49,988	106.720	45.0	468	439	878	
		CO2	3		20.25	8.8	51,764	106.720	45.0	485	455	909	
									Average	467	438	876	B
Fugitive		CO2	1	3A	20.25	8.8	39,117	106.720	45.0	367	344	687	
		CO2	2		20.25	8.3	31,034	106.720	45.0	291	273	545	
		CO2	3		20.25	8.8	17,956	106.720	45.0	168	158	315	
									Average	275	258	516	D

Basis for ratings: Process factors downrated because NOx, CO, TOC, CO2 emission rates based on flow measured during three 1-hour runs; PM based on emissions for three 1-hour runs; fugitive emission factors based on f-factor flowrates.

Notes: Green moisture - 41%; dry moisture - 12%

Dry moisture - 12%

Factors for process NOx, CO, and TOC emissions adjusted by the ratio of the vent flow-based emission rates for 3 runs (pg 12) to the f-factor flow-based emission rates (pg 13).

Fugitive emission factor based on difference of emission factor based on vent flow and f-factor flow.

Source Category: Lumber
Plant name: Georgia-Pacific
Process: Drying

Filename: LUM_RF36.WQ1
Location: Cross City, FL
Test date: August 30 - September 3, 1994

Date: 01/26/95
Ref. No.: 4/36
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln	none	TOC	1	25A	17.3		330	104.448	45.0	3.2	3.0	5.9	
		TOC	2		17.8		302	104.448	45.0	2.9	2.7	5.4	
									Average	3.0	2.8	5.7	B
		Noncond. TOC	1	25A	17.3		216	104.448	45.0	2.1	1.9	3.9	
		Noncond. TOC	2		17.8		168	104.448	45.0	1.6	1.5	3.0	
									Average	1.8	1.7	3.4	B
		NOx	1	7E	17.3		0.11	104.448	45.0	0.0010	0.00094	0.0019	
		NOx	2		17.8		0.14	104.448	45.0	0.0013	0.0013	0.0025	
									Average	0.0012	0.0011	0.0022	B
		CO	1	10	17.3		1.0	104.448	45.0	0.0092	0.0087	0.017	
		CO	2		17.8		1.0	104.448	45.0	0.0097	0.0091	0.018	
									Average	0.0095	0.0089	0.018	B
						Emission rate, lb/hr							
		Filt. PM	1	5	17.3	0.39	6.78	104.448	45.0	0.065	0.061	0.12	
		Filt. PM	2		17.3	0.34	5.83	104.448	45.0	0.056	0.052	0.10	
		Filt. PM	3		17.3	0.29	4.95	104.448	45.0	0.047	0.044	0.09	
									Average	0.056	0.053	0.11	D
		Cond. inorg. PM	1	202	17.3	0.48	8.30	104.448	45.0	0.079	0.075	0.15	
		Cond. inorg. PM	2		17.3	0.87	15.04	104.448	45.0	0.14	0.14	0.27	
		Cond. inorg. PM	3		17.3	1.15	19.89	104.448	45.0	0.19	0.18	0.36	
									Average	0.14	0.13	0.26	B
		Cond. org. PM	1	202	17.3	0.59	10.13	104.448	45.0	0.097	0.091	0.18	
		Cond. org. PM	2		17.3	0.74	12.88	104.448	45.0	0.12	0.12	0.23	
		Cond. org. PM	3		17.3	0.47	8.02	104.448	45.0	0.077	0.072	0.14	
						%			Average	0.099	0.093	0.19	B
		CO2	1	202	17.3	7.2	26,598	104.448	45.0	255	239	477	
		CO2	2		17.3	7.8	27,666	104.448	45.0	265	248	497	
									Average	260	244	487	B

Notes: Dry moisture content Test 1 - 16%
Test 2 - 18%
Green moisture content Test 2 - 51%

Source Category: Lumber
Plant name: Georgia-Pacific
Process: Drying

Filename: LUM_RF37.WQ1
Location: Cross City, FL
Test date: February 23-24, 1994

Date: 01/26/95
Ref. No.: 4/37
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln #1	none	TOC	1	25A	26.5		612	130.000	45.0	4.7	4.4	8.8	B
		Noncond. TOC	1	25A	26.5		481	130.000	45.0	3.7	3.5	6.9	B
		NOx	1	7E	26.5		17.6	130.000	45.0	0.14	0.13	0.25	B
		CO	1	10	26.5		86.9	130.000	45.0	0.67	0.63	1.3	B
						Emission rate, lb/hr							
		Filterable PM	1	5	26.5	1.31	34.5	130.000	45.0	0.27	0.25	0.50	
		Filterable PM	2		26.5	0.99	26.1	130.000	45.0	0.20	0.19	0.38	
		Filterable PM	3		26.5	1.11	29.3	130.000	45.0	0.23	0.21	0.42	
									Average	0.23	0.22	0.43	C
		Cond. org. PM	1	5	26.5	0.77	20.5	130.000	45.0	0.16	0.15	0.30	
		Cond. org. PM	2		26.5	0.57	15.1	130.000	45.0	0.12	0.11	0.22	
		Cond. org. PM	3		26.5	0.87	23.1	130.000	45.0	0.18	0.17	0.33	
						%			Average	0.15	0.14	0.28	C
		CO2	1	3A	26.5	6.00	98038.5	130.000	45.0	754	707	1,414	
		CO2	2		26.5	4.40	71894.9	130.000	45.0	553	518	1,037	
		CO2	3		26.5	3.00	49019.3	130.000	45.0	377	354	707	
									Average	561	526	1,053	C
		Formaldehyde	1	TO-5	26.5	0.070	1.84	130.000	45.0	0.014	0.013	0.027	
		Formaldehyde	2		26.5	0.19	5.05	130.000	45.0	0.039	0.036	0.073	
		Formaldehyde	3		26.5	0.15	3.97	130.000	45.0	0.031	0.029	0.057	
									Average	0.028	0.026	0.052	
		Phenol	1	TO-8	26.5	0.14	3.76	130.000	45.0	0.029	0.027	0.054	
		Phenol	2		26.5	0.089	2.35	130.000	45.0	0.018	0.017	0.034	
		Phenol	3		26.5	0.039	1.03	130.000	45.0	0.008	0.007	0.015	
									Average	0.018	0.017	0.034	
		ADJUSTED EMISSION FACTORS							Factor				
		Formaldehyde							1.25	0.035	0.033	0.065	C
		Phenol							1.25	0.023	0.021	0.043	C

Notes: Green moisture content - 44%
Dry moisture content - 19%

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln #2	none	TOC	1	25A	17.5		367	128.000	45.0	2.9	2.7	5.4	
		TOC	2		15.0		363	128.000	45.0	2.8	2.7	5.3	
									Average	2.9	2.7	5.3	B
		Noncond. TOC	1	25A	17.5		310	128.000	45.0	2.4	2.3	4.5	
													B
		NOx	1	7E	17.5		2.3	128.000	45.0	0.018	0.017	0.034	
		NOx	2		15.0		6.4	128.000	45.0	0.050	0.047	0.093	
									Average	0.034	0.032	0.063	B
		CO	1	10	17.5		21.9	128.000	45.0	0.17	0.16	0.32	
		CO	2		15.0		18.8	128.000	45.0	0.15	0.14	0.28	
									Average	0.16	0.15	0.30	B
						Emission rate, lb/hr							
		PM	1	5	17.5	1.12	19.6	128.000	45.0	0.15	0.14	0.29	
		PM	2		17.5	1.29	22.7	128.000	45.0	0.18	0.17	0.33	
		PM	3		17.5	0.70	12.2	128.000	45.0	0.095	0.089	0.18	
									Average	0.14	0.13	0.27	C
		Cond. org. PM	1	5	17.5	0.59	10.4	128.000	45.0	0.081	0.076	0.15	
		Cond. org. PM	2		17.5	0.70	12.2	128.000	45.0	0.10	0.089	0.18	
		Cond. org. PM	3		17.5	0.34	6.0	128.000	45.0	0.047	0.044	0.088	
									Average	0.074	0.070	0.14	C
		CO2	1	3A	17.5	5.9	54,260	128.000	45.0	424	397	795	
		CO2	2		17.5	5.9	54,260	128.000	45.0	424	397	795	
		CO2	3		17.5	4.0	36,787	128.000	45.0	287	269	539	
									Average	378	355	710	C
		Formaldehyde	1	TO-5	17.5	0.082	1.4	128.000	45.0	0.011	0.010	0.021	
		Formaldehyde	2		17.5	0.075	1.3	128.000	45.0	0.010	0.010	0.019	
		Formaldehyde	3		17.5	0.20	3.5	128.000	45.0	0.027	0.026	0.051	
									Average	0.016	0.015	0.030	
		Phenol	1	TO-8	17.5	0.016	0.28	128.000	45.0	0.0022	0.0021	0.0041	
		Phenol	2		17.5	0.028	0.49	128.000	45.0	0.0038	0.0036	0.0072	
		Phenol	3		17.5	0.0035	0.061	128.000	45.0	0.00048	0.00045	0.00090	
									Average	0.0022	0.0020	0.0041	
		ADJUSTED EMISSION FACTORS							Factor				
		Formaldehyde							1.46	0.024	0.022	0.044	C
		Phenol							1.46	0.0032	0.0030	0.0059	C

Notes: Green moisture content - 50%
Dry moisture content - 14%

Source category: Lumber
Plant name: Georgia-Pacific
Process: Drying

Filename: LUM_RF38.WQ1
Location: El Dorado, AR
Test date: July 26 - August 2, 1994

Date: 01/26/95
Ref. No.: 4/38
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Steam heated kiln #1	none												
Process		TOC	1	25A	26.6		267	131.265	45.0	2.0	1.9	3.8	
		TOC	2		25.4		181	128.454	45.0	1.4	1.3	2.6	
									Average	1.7	1.6	3.2	A
		Noncond. TOC	1	25A	26.6		257	131.265	45.0	2.0	1.8	3.7	A
Fugitive		TOC	1	25A	26.6		24	131.265	45.0	0.18	0.17	0.34	
		TOC	2		25.4		208	128.454	45.0	1.6	1.5	3.0	
									Average	0.90	0.85	1.7	D
		Noncond. TOC	1	25A	26.6		23	131.265	45.0	0.18	0.17	0.33	D

Notes: Green moisture content - 37-44%
Dry moisture content - 12%

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired (gas) kiln #9	none												
Process		TOC	1	25A	95.9		50.6	138.225	45.0	0.37	0.34	0.69	A
		Noncond. TOC	1	25A	95.9		39.0	138.225	45.0	0.28	0.26	0.53	A
Fugitive		TOC	1	25A	95.9		209.5	138.225	45.0	1.5	1.4	2.8	D
		Noncond. TOC	1	25A	95.9		161.5	138.225	45.0	1.2	1.1	2.2	D
Process		NOx	1	7E	95.9	0.09	1.68	138.225	45.0	0.012	0.011	0.023	A
Fugitive		NOx	1	7E	95.9	0.09	6.95	138.225	45.0	0.050	0.047	0.094	D
Process		CO	1	10	95.9	1.6	29.85	138.225	45.0	0.22	0.20	0.40	A
Fugitive		CO	1	10	95.9	1.6	123.59	138.225	45.0	0.89	0.84	1.7	D

Notes: Green moisture content - 38%
Dry moisture content - 15.5%

Source Category:	Lumber	Filename:	LUM_RF39.WQ1	Date:	01/27/95
Plant name:	Georgia-Pacific	Location:	Whiteville, NC	Ref. No.:	4/39
Process:	Drying	Test date:	March 16-17, 1994	Process rate basis:	production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Emission rate, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
Direct-fired kiln	none	TOC	1	25A	24.7	4.46	110.2	127.584	45.0	0.86	0.81	1.6	B
		Noncond. TOC	1	25A	24.7	4.04	99.8	127.584	45.0	0.78	0.73	1.5	B
		Filt. PM	1	5	24.7	0.009	0.22	127.584	45.0	0.0017	0.0016	0.0033	
		Filt. PM	2		24.7	0.006	0.15	127.584	45.0	0.0012	0.0011	0.0022	
		Filt. PM	3		24.7	0.011	0.27	127.584	45.0	0.0021	0.0020	0.0040	
									Average	0.0017	0.0016	0.0031	D
		Cond. inorg. PM	1	202	24.7	0.049	1.2	127.584	45.0	0.0095	0.0089	0.018	
		Cond. inorg. PM	2		24.7	0.036	0.88	127.584	45.0	0.0069	0.0065	0.013	
		Cond. inorg. PM	3		24.7	0.032	0.80	127.584	45.0	0.0063	0.0059	0.012	
									Average	0.0076	0.0071	0.014	C
		Cond. org. PM	1	202	24.7	0.021	0.51	127.584	45.0	0.0040	0.0038	0.0075	
		Cond. org. PM	2		24.7	0.019	0.48	127.584	45.0	0.0038	0.0035	0.0070	
		Cond. org. PM	3		24.7	0.060	1.5	127.584	45.0	0.012	0.011	0.022	
									Average	0.0064	0.0060	0.012	C
		Phenols	1	TO-8	24.7	<0.0007		127.584	45.0				
		Phenols	2		24.7	<0.0008		127.584	45.0				
		Phenols	3		24.7	<0.0005		127.584	45.0				
									Average				
		Formaldehyde	1	5	24.7	0.025	0.62	127.584	45.0	0.0048	0.0045	0.0091	
		Formaldehyde	2		24.7	0.013	0.32	127.584	45.0	0.0025	0.0024	0.0047	
		Formaldehyde	3		24.7	0.029	0.72	127.584	45.0	0.0056	0.0053	0.011	
									Average	0.0043	0.0041	0.0081	C
		Acetaldehyde	1	202	24.7	0.029	0.72	127.584	45.0	0.0056	0.0053	0.011	
		Acetaldehyde	2		24.7	0.028	0.69	127.584	45.0	0.0054	0.0051	0.010	
		Acetaldehyde	3		24.7	0.064	1.58	127.584	45.0	0.012	0.012	0.023	
									Average	0.0078	0.0073	0.015	C

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Emission rate, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor			
										lb/TBF	kg/Mg	lb/ton	Rating
		Hexaldehyde	1	TO-5	22.5	<0.0007		127.584	45.0				
		Hexaldehyde	2		22.5	<0.0007		127.584	45.0				
		Hexaldehyde	3		22.5	<0.0005		127.584	45.0				
									Average				
		Acetone	1		22.5	0.057	1.281	127.584	45.0	*0.010*	*0.0094*	*0.019*	
		Acetone	2		22.5	0.065	1.461	127.584	45.0	0.011	0.011	0.021	
		Acetone	3		22.5	0.071	1.595	127.584	45.0	0.013	0.012	0.023	
									Average	0.011	0.011	0.021	C
		MEK	1		22.5	0.006	0.135	127.584	45.0	0.0011	0.0010	0.0020	
		MEK	2		22.5	0.005	0.112	127.584	45.0	0.0009	0.0008	0.0017	
		MEK	3		22.5	0.009	0.202	127.584	45.0	0.0016	0.0015	0.0030	
									Average	0.0012	0.0011	0.0022	C
		ADJUSTED EMISSION FACTORS											
									Factor				
		Formaldehyde											
		Acetaldehyde											
		Acetone											
		MEK											

Note: TOC not measured throughout kiln cycle, some question about flowrates. Filterable PM runs (2 of 3) anisokinetic.
Inadequate data in report to make determine adjustment factor for aldehydes and ketones.

Source category:	Lumber	Filename:	LUM_RF41.WQ1	Date:	01/27/95
Plant name :	MacMillan Bloedel, Inc.	Location:	Pine Hill, AL	Ref. No.:	4/41
Process :	Drying	Test date:	June-Sept. 1994	Process rate basis:	production

Source	APCD	Pollutant	Run No.	Kiln No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Emission factor Rating
Steam-heated kiln	none	TOC	1	1	25A	17		146	87	45.0	1.7	1.6	3.1	B
(closed loop)														
Gas-fired		TOC	2	5		72		267	198	45.0	1.4	1.3	2.5	B

Basis for rating: Flow rates based on water balance; moisture measurements madeat later date.

Problems noted:

Other notes: TOC reported as carbon; includes process and fugitive emissions.

Source Category: Lumber
Plant name: Weyerhaeuser
Process: Drying

Filename: LUM_RF42.WQ1
Location: Barnesville, GA
Test date: October 26-27, 1994

Date: 01/27/95
Ref. No.: 4/42
Process rate basis: production

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Emission rate, lb/hr	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
Direct-fired kiln	none	TOC	1	25A	23.95	19.26	461.3	168.96	45.0	2.7	2.6	5.1	B
		NOx	1	7E	23.95		62.5	168.96	45.0	0.37	0.35	0.69	B
		CO	1	10	23.95	8.96	214.6	168.96	45.0	1.3	1.2	2.4	B
		Filt. PM	1	5	23.95	4.96	118.8	168.96	45.0	0.70	0.66	1.3	
		Filt. PM	2		23.95	5.57	133.40	168.96	45.0	0.79	0.74	1.5	
		Filt. PM	3		23.95	6.04	144.7	168.96	45.0	0.86	0.80	1.6	
		Filt. PM	4		23.95	3.75	89.8	168.96	45.0	0.53	0.50	1.0	
		Filt. PM	5		23.95	1.92	46.0	168.96	45.0	0.27	0.26	0.51	
		Filt. PM	6		23.95	1.34	32.1	168.96	45.0	0.19	0.18	0.36	
									Average	0.56	0.52	1.0	C
		Cond. inorg. PM	1	202	23.95	0.228	5.5	168.96	45.0	0.032	0.030	0.061	
		Cond. inorg. PM	2		23.95	0.296	7.09	168.96	45.0	0.042	0.039	0.079	
		Cond. inorg. PM	3		23.95	0.288	6.9	168.96	45.0	0.041	0.038	0.077	
		Cond. inorg. PM	4		23.95	0.197	4.7	168.96	45.0	0.028	0.026	0.052	
		Cond. inorg. PM	5		23.95	0.156	3.7	168.96	45.0	0.022	0.021	0.041	
		Cond. inorg. PM	6		23.95	0.198	4.8	168.96	45.0	0.028	0.026	0.053	
									Average	0.038	0.036	0.072	B
		Cond. org. PM	1	202	23.95	0.512	12.3	168.96	45.0	0.073	0.068	0.14	
		Cond. org. PM	2		23.95	0.654	15.66	168.96	45.0	0.093	0.087	0.17	
		Cond. org. PM	3		23.95	0.802	19.2	168.96	45.0	0.11	0.11	0.21	
		Cond. org. PM	4		23.95	0.863	20.7	168.96	45.0	0.12	0.11	0.23	
		Cond. org. PM	5		23.95	0.854	20.5	168.96	45.0	0.12	0.11	0.23	
		Cond. org. PM	6		23.95	0.432	10.3	168.96	45.0	0.061	0.057	0.11	
									Average	0.093	0.087	0.17	B

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor			
										lb/TBF	kg/Mg	lb/ton	Rating
		Formaldehyde	1	0011	23.95	0.61	14.61	168.96	45.0	0.086	0.081	0.16	
		Formaldehyde	2		23.95	0.88	21.08	168.96	45.0	0.12	0.12	0.23	
		Formaldehyde	3		23.95	0.6	14.37	168.96	45.0	0.085	0.080	0.16	
		Formaldehyde	4		23.95	0.61	14.61	168.96	45.0	0.086	0.081	0.16	
		Formaldehyde	5		23.95	0.6	14.37	168.96	45.0	0.085	0.080	0.16	
		Formaldehyde	6		23.95	0.61	14.61	168.96	45.0	0.086	0.081	0.16	
		Formaldehyde	7		23.95	0.5	11.98	168.96	45.0	0.071	0.066	0.13	
		Formaldehyde	8		23.95	0.5	11.98	168.96	45.0	0.071	0.066	0.13	
		Formaldehyde	9		23.95	0.45	10.78	168.96	45.0	0.064	0.060	0.12	
		Formaldehyde	10		23.95	0.33	7.90	168.96	45.0	0.047	0.044	0.088	
		Formaldehyde	11		23.95	0.31	7.42	168.96	45.0	0.044	0.041	0.082	
		Formaldehyde	12		23.95	0.36	8.62	168.96	45.0	0.051	0.048	0.096	
									Average	0.075	0.070	0.14	B
		Acetaldehyde	1	0011	23.95	0.51	12.21	168.96	45.0	0.072	0.068	0.14	
		Acetaldehyde	2		23.95	0.73	17.48	168.96	45.0	0.10	0.097	0.19	
		Acetaldehyde	3		23.95	0.43	10.30	168.96	45.0	0.061	0.057	0.11	
		Acetaldehyde	4		23.95	0.51	12.21	168.96	45.0	0.072	0.068	0.14	
		Acetaldehyde	5		23.95	0.48	11.50	168.96	45.0	0.068	0.064	0.13	
		Acetaldehyde	6		23.95	0.46	11.02	168.96	45.0	0.065	0.061	0.12	
		Acetaldehyde	7		23.95	0.5	11.98	168.96	45.0	0.071	0.066	0.13	
		Acetaldehyde	8		23.95	0.39	9.34	168.96	45.0	0.055	0.052	0.10	
		Acetaldehyde	9		23.95	0.45	10.78	168.96	45.0	0.064	0.060	0.12	
		Acetaldehyde	10		23.95	0.42	10.06	168.96	45.0	0.060	0.056	0.11	
		Acetaldehyde	11		23.95	0.41	9.82	168.96	45.0	0.058	0.054	0.11	
		Acetaldehyde	12		23.95	0.45	10.78	168.96	45.0	0.064	0.060	0.12	
									Average	0.068	0.064	0.13	B

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
		Hexaldehyde	1	0011	23.95	0.029	0.695	168.96	45.0	0.0041	0.0039	0.008	
		Hexaldehyde	2		23.95	0.057	1.365	168.96	45.0	0.0081	0.0076	0.015	
		Hexaldehyde	3		23.95	0.035	0.838	168.96	45.0	0.0050	0.0047	0.0093	
		Hexaldehyde	4		23.95	0.035	0.838	168.96	45.0	0.0050	0.0047	0.0093	
		Hexaldehyde	5		23.95	0.035	0.838	168.96	45.0	0.0050	0.0047	0.0093	
		Hexaldehyde	6		23.95	0.047	1.126	168.96	45.0	0.0067	0.0062	0.012	
		Hexaldehyde	7		23.95	0.055	1.317	168.96	45.0	0.0078	0.0073	0.015	
		Hexaldehyde	8		23.95	0.077	1.844	168.96	45.0	0.011	0.010	0.020	
		Hexaldehyde	9		23.95	0.164	3.928	168.96	45.0	0.023	0.022	0.044	
		Hexaldehyde	10		23.95	0.201	4.814	168.96	45.0	0.028	0.027	0.053	
		Hexaldehyde	11		23.95	0.345	8.263	168.96	45.0	0.049	0.046	0.092	
		Hexaldehyde	12		23.95	0.492	11.783	168.96	45.0	0.070	0.065	0.131	
									Average	0.019	0.017	0.035	B
		Acetone	1	0011	23.95	1.82	43.589	168.96	45.0	0.26	0.24	0.48	
		Acetone	2		23.95	0.73	17.484	168.96	45.0	0.10	0.10	0.19	
		Acetone	3		23.95	0.77	18.442	168.96	45.0	0.11	0.10	0.20	
		Acetone	4		23.95	0.43	10.30	168.96	45.0	0.061	0.057	0.11	
		Acetone	5		23.95	0.36	8.62	168.96	45.0	0.051	0.048	0.10	
		Acetone	6		23.95	0.41	9.82	168.96	45.0	0.058	0.054	0.11	
		Acetone	7		23.95	0.56	13.41	168.96	45.0	0.079	0.074	0.15	
		Acetone	8		23.95	0.47	11.26	168.96	45.0	0.067	0.062	0.12	
		Acetone	9		23.95	0.55	13.17	168.96	45.0	0.078	0.073	0.15	
		Acetone	10		23.95	0.5	11.98	168.96	45.0	0.071	0.066	0.13	
		Acetone	11		23.95	0.56	13.41	168.96	45.0	0.079	0.074	0.15	
		Acetone	12		23.95	0.6	14.37	168.96	45.0	0.085	0.080	0.16	
									Average	0.092	0.086	0.17	B

Source	APCD	Pollutant	Run No.	Test Meth.	Kiln cycle, hr	Concen., ppm	Total est. emiss. per cycle, lb	Process rate, TBF	Average density, lb/cu.ft.	Emission factor lb/TBF	Emission factor kg/Mg	Emission factor lb/ton	Rating
		MEK	1	0011	23.95	0.094	2.25	168.96	45.0	0.013	0.012	0.025	
		MEK	2		23.95	0.096	2.30	168.96	45.0	0.014	0.013	0.026	
		MEK	3		23.95	0.051	1.22	168.96	45.0	0.0072	0.0068	0.014	
		MEK	4		23.95	0.044	1.05	168.96	45.0	0.0062	0.0058	0.012	
		MEK	5		23.95	0.046	1.10	168.96	45.0	0.0065	0.0061	0.012	
		MEK	6		23.95	0.045	1.08	168.96	45.0	0.0064	0.0060	0.012	
		MEK	7		23.95	0.113	2.71	168.96	45.0	0.016	0.015	0.030	
		MEK	8		23.95	0.026	0.62	168.96	45.0	0.0037	0.0035	0.0069	
		MEK	9		23.95	0.025	0.60	168.96	45.0	0.0035	0.0033	0.0066	
		MEK	10		23.95	0.03	0.72	168.96	45.0	0.0043	0.0040	0.0080	
		MEK	11		23.95	0.03	0.72	168.96	45.0	0.0043	0.0040	0.0080	
		MEK	12		23.95	0.038	0.91	168.96	45.0	0.0054	0.0050	0.010	
									Average	0.0075	0.0071	0.014	B
						%							
		CO2	1	Orsat	23.95	8.5	109,272	168.96	45.0	647	606	1,213	
		CO2	2		23.95	6.8	87,418	168.96	45.0	517	485	970	
		CO2	3		23.95	5.4	69,420	168.96	45.0	411	385	770	
		CO2	4		23.95	3.2	41,138	168.96	45.0	243	228	457	
		CO2	5		23.95	2.3	29,568	168.96	45.0	175	164	328	
		CO2.	6		23.95			168.96	45.0				
									Average	399	374	748	B

Basis for rating: For gases, emissions not sampled at vents, not sampled throughout kiln cycle; for filterable PM, most runs anisokinetic.

Problems noted:

Other notes:

INTEROFFICE MEMORANDUM

MIDWEST RESEARCH INSTITUTE

June 22, 1994

To: Project File--MRI Project 4601-10

From: Richard Marinshaw

Subject: Response to Comments on Section 10.1, Lumber and Wood Products Manufacturing and Woodworking Operations Review and Update of Wood Products Industry Sections of Chapter 10, AP-42

External review comments on the draft AP-42 Section 10.1, Lumber and Wood Products Manufacturing and Woodworking Operations, and the corresponding background report were received from Union Camp Corporation (Union Camp) (letter from Duane Marshall to Dallas Safriet, dated January 13, 1994), Georgia-Pacific Corporation (Georgia-Pacific) (letter from Lawrence Otwell to Dallas Safriet, dated January 11, 1994) and the National Council of the Paper Industry for Air and Stream Improvement (NCASI) (letter from David Word to Dallas Safriet, dated March 18, 1994). Union Camp and Georgia-Pacific had the same general comment--that the data upon which emission factors are based in the draft AP-42 section are questionable in quality and inadequate in quantity, and NCASI provided specific comments on the section and background report. Because the revised draft report includes the results from an additional five emission tests, no specific response to the comments of Union Camp and Georgia-Pacific is necessary. The following is a summary of the responses to the specific comments provided by NCASI on the draft AP-42 section and background report.

COMMENT: GENERAL COMMENTS

This entire AP-42 section is based on two reports referred to within the document as References 5 and 12. The applicable section of reference 5 is based on "field observation" and is completely lacking any test data. Reference 12 is a single stack test on a lumber kiln in which an unconventional source sampling method was used. This lack of data has resulted in tables that are mostly void of emission factors, and in factors that are all suspect and have little scientific basis.

RESPONSE: The draft background report and AP-42 section have been revised to incorporate an additional four emission test reports provided by NCASI. The emission factors taken from Reference 5 of the background report are reported as being unrated and are not included in the revised AP-42 section. The emission factors developed from Reference 12 of the background report were reevaluated and rated D. Consequently, neither factor is used as the basis for emission factors for the revised AP-42 section.

COMMENT: **2. INDUSTRY DESCRIPTION** - First paragraph

Sawdust and shavings are described as useful by-products of lumber production. The statement is correct in that virtually all wood residue is used, and very little, if any, should be considered waste. However, the term "waste" has been incorrectly applied to wood residue or wood by-products in other sections of the document. These references are discussed, in order, in subsequent sections of this letter.

RESPONSE: Description changed as suggested.

COMMENT: **2.2 PROCESS DESCRIPTION - Debarking**

In the second sentence, "One" should be substituted for "The major" in the second sentence (since logs are not chipped or pulped in the lumber manufacturing).

RESPONSE: Sentence changed as suggested.

COMMENT: **2.2 PROCESS DESCRIPTION - Wood Waste Handling**

As stated above, and consistent with the first paragraph under the heading INDUSTRY DESCRIPTION, references to wood waste should be deleted since sawdust, sanderdust, planer shavings, etc. are rarely disposed of, or treated, as a waste. The section heading should read "Wood Residue Handling". In the first sentence, "wood waste" should be changed to "wood residue." The second sentence should be rewritten as follows: "These systems are a convenient means of transporting the wood residue to common collection points where it may be used immediately or stored for future use." In the third sentence, "used primarily" should be replaced with "often used" since sawdust use will vary greatly from mill to mill. A similar change should be made in the fifth sentence with respect to use of planer shavings.

RESPONSE: Paragraph changed as suggested.

COMMENT: **2.3 EMISSIONS - First paragraph**

The movement of trucks and loading equipment in the storage pile area should not be described as a "substantial" source of dust. The relative importance of this source has not been adequately assessed and would vary considerably from one location to another.

RESPONSE: The sentence was changed to read that traffic is a potentially significant source of emissions.

COMMENT: **2.4 CONTROLS** - First paragraph

In the first sentence, the words "waste material" should be replaced by wood residue.

RESPONSE: Sentence changed as suggested.

COMMENT: **4.2.1.1 Reference 5**

The emission factors discussed in this section appear to be subjective estimates only. On page 2-333 of "Reference 5," the authors explain the method by which they developed their lumber and furniture industry emission factors. They state, "The fugitive emission factors are based solely on best engineering judgment and material balance information obtained during plant visits. Thus, listed emission factors are at best order of magnitude estimates." (Although not specifically stated, the Acknowledgement section of Reference 5 indicates that two furniture manufacturing facilities were visited.)

The fact that these emission factors were used previously is provided as a reason for their continued inclusion. This reasoning is invalid. We recommend that the factors based on this reference not be included in AP-42.

RESPONSE: The emission factors were labeled as unrated in the background report and were deleted from the AP-42 section.

COMMENT: **4.2.1.2 Reference 12** - Second paragraph

The "basis" for the initial moisture content should be stated. From the test report, it appears that the 50 percent moisture figure was reported on a wet or "as is" basis which would be equivalent to 100 percent moisture on a dry basis. The final moisture should be stated on the same basis.

RESPONSE: The sentence was changed to indicate that the moisture content was reported apparently on a wet basis.

COMMENT: **4.2.1.2 Reference 12** - Third paragraph

The sampling train was unconventional and was not a Method 5H train. (The condensible particulate matter lab analysis may have been conducted according to Method 5H.) It should be mentioned that the impingers were maintained at a temperature of approximately 45°F, since impinger temperature will affect the amount of material condensed.

RESPONSE: A more complete description of the sampling train was provided in the revised draft background report, indicating that the train was experimental.

COMMENT: **4.2.1.2 Reference 12** - Fourth paragraph

The VOC emissions should be based on a molecular weight of 12 (rather than 16) and expressed as lb C/TBF (pounds of carbon per thousand board feet). Note that propane was the calibration gas used, and Method 25A specifies that results should be expressed as propane (or some other calibration gas) or in terms of carbon. Additionally, expressing the results as carbon would be consistent with Method 25.

RESPONSE: All Method 25A data presented in the revised draft background report are reported as total organic compounds on a carbon basis.

COMMENT: **4.2.1.2 Reference 12** - Fifth paragraph

If temperature information is available on the probe, sample line and the impinger train outlet, that information should be provided. Since a front filter was not used, some of the material measured as condensible particulate matter may have been solid particulate matter and not condensible gaseous material.

RESPONSE: The test report did not include temperature data for the probe, sample line, and impinger train outlet.

COMMENT: **4.2.1.2 Reference 12** - Sixth paragraph

The VOC emission dated are rated C. This conclusion is based, in part, on the use of a "sound methodology." While the sampling method used may be appropriate for wood products drying operations, it is unconventional and would likely provide different results than a Method 25 or 25A sample train. If this single run is to be the basis for the lumber kiln VOC emission factor, then a footnote in the appropriate AP-42 tables should be included to explain the unconventional manner in which the sample was obtained.

RESPONSE: The VOC emission factor was downrated to D, and the paragraph was rewritten to state that the VOC measurements may not be comparable to other Method 25 and 25A data due to the nonconventional sampling train used.

COMMENT: **Table 4-3**

The table should specify if the emission factor is for wet or dry debarking.

RESPONSE: The emission factor for debarking was eliminated.

COMMENT: **Table 4-6**

For footnote "a," the moisture basis should be provided (i.e., wet or dry). For footnote "d," as discussed previously, a molecular weight of 12 would be more appropriate.

RESPONSE: Footnote changed as suggested.

COMMENT: **Tables 4-7 and 4-8**

Since these two tables differ only in the units used, the comments are combined below.

The emission factors for debarking should specify if they are for wet or dry debarking. The emission factors for lumber drying should specify that they are for a steam heated kiln.

Footnote "c" should read " . . . Method 202 (or equivalent)." Footnote "g" should provide the moisture basis for the percent moisture (e.g., wet or dry). Footnote "h" refers to a molecular weight of 16. A molecular weight of 12 would be more appropriate, as previously discussed.

In both tables conversions are made directly from "mass of pollutant/mass of logs" to "mass of pollutant/volume of lumber" by assuming a density for wood. This cannot be done since 100 percent of the log is not converted into lumber. Emissions from lumber drying should be expressed on a "mass of pollutant/volume of lumber dried" basis (e.g., 2 lb VOC/TBF). Emissions from log handling operations are best expressed as "mass of pollutant/mass of logs" basis (e.g., 0.05 lb PM/ton of logs). The moisture basis for the logs should be specified (i.e., wet (green) or dry).

RESPONSE: The emission factor for debarking was eliminated. Footnote c changed as suggested. As stated previously, all Method 25A data are reported on a carbon basis in the revised report. Units changed as suggested.

COMMENT: **10.1.1 General** - First paragraph

In the first sentence, "processing" should be substituted for "breakdown."

RESPONSE: Sentence changed as suggested.

COMMENT: **10.1.2 Debarking**

In the second sentence, "One" should be substituted for "The major," since lumber is neither chipped nor pulped.

RESPONSE: Sentence changed as suggested.

COMMENT: **10.1.2 Wood Waste Handling**

As previously discussed wood residue is seldom a "waste." The paragraph title should be Wood Residue Handling. In the first sentence, "wood waste" should be replaced with "wood residue." The second sentence should be deleted. The third sentence should be rewritten as follows: "These systems are a convenient means of transporting the wood residue to common collection points where it may be used immediately or stored for future use," In the fourth sentence, "used primarily" should be replaced with "often used" since sawdust use will vary greatly from mill to mill. A similar change should be made in the sixth sentence with respect to use of planer shavings.

RESPONSE: Paragraph changed as suggested.

COMMENT: **10.1.3 Emissions and Controls** - First paragraph

In the fifth sentence, the movement of trucks and loading equipment in the storage pile area should not be described as a "substantial" source of dust. The relative importance of this source has not been adequately assessed and would vary considerably from one location to another.

RESPONSE: The sentence was changed to read that traffic is a potentially significant source of emissions.

COMMENT: **10.1.3 Emissions and Controls** - Fourth paragraph

In the first and sixth sentences, "waste material" should be replaced by "wood residue." In the seventh, eight, and ninth sentences, the words "wastes" and "waste" should be replaced by "wood residue."

RESPONSE: Sentences changed as suggested.

COMMENT: **10.1.3 Emissions and Controls** - Sixth paragraph

This entire paragraph should be deleted. Since wet suppression systems were not observed and are not in general use in the industry, they may not be a feasible control system. Most solid wood products facilities do not treat or discharge wastewater and would not have the capability to manage wastewater from a spray system.

RESPONSE: Paragraph deleted as suggested.

COMMENT: **Tables 10.1-1 and 10.1-2**

Since these two tables differ only in the units used, the comments are combined below.

The emission factors for debarking should specify if they are for wet or dry debarking. The emission factors for lumber drying should specify that they are for a steam heated kiln.

Footnote "c" should read " . . . Method 202 (or equivalent)." Footnote "g" should provide the moisture basis for the percent moisture (e.g., wet or dry). Footnote "h" refers to a molecular weight of 16. A molecular weight of 12 would be more appropriate, as previously discussed.

In both tables conversions are made directly from "mass of pollutant/mass of logs" to "mass of pollutant/volume of lumber" by assuming a density for wood. This cannot be done since 100 percent of the log is not converted into lumber. Emissions from lumber drying should be expressed on a "mass of pollutant/volume of lumber dried" basis (e.g., 2 lb VOC/TBF). Emissions from log handling operations are best expressed as "mass of pollutant/mass of logs" basis (e.g., 0.05 lb PM/ton of logs). The moisture basis for the logs should be specified (i.e., wet (green) or dry).

RESPONSE: The emission factors for debarking were deleted. The tables indicate both direct-fired and steam-heated kilns as appropriate. Footnote "c" was changed as suggested. Emission factors developed from Method 25 and 25A data are reported on a carbon equivalent basis. The units for the emission factors were changed as suggested, and the basis for the wood moisture content is provided in the footnotes.

AMERICAN
FOREST &
PAPER
ASSOCIATION

1111 19TH STREET NW, SUITE 800, WASHINGTON, DC 20036
PHONE: (202) 463-2700 DEPARTMENT FAX: (202) 463-2423

ENVIRONMENT & HEALTH

Original sent to MRI 10-1-94

September 30, 1994

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

Dear ~~Mr. Safriet~~ Dallas:

The American Forest & Paper Association (AF&PA) is writing to request a three-month extension of the comment period on the August 5, 1994 Revised Draft of Emission Factor Documentation for AP-42, Section 10.1, "Lumber and Wood Products Manufacturing and Woodworking Operations." We are extremely concerned about a possible miscalculation of VOC emission factors for lumber dry kilns, and the possible misuse of these emission factors by regulatory and enforcement agency staff.

Our concerns stem from a meeting AF&PA held for industry representatives earlier this month; representatives from the National Council of the Paper Industry for Air and Stream Improvement (NCASI) and the companies responsible for prior lumber kiln testing were present, and noted that the VOC emission factor found on p. 26 of the August 5 draft report was four to eight times higher than expected, most likely due to a contractor miscalculation. Concerns about the unavailability of approved lumber kiln testing protocols and validated methods also were raised. David Word of NCASI has raised these issues in a September 12 letter to you similarly requesting a three-month extension of the comment period.

As Dr. Word noted in his letter, the industry is currently working on lumber manufacturing testing protocols, and a number of companies have testing underway. We believe that a three month delay in moving forward with lumber manufacturing emission factor development would allow several of these companies to submit testing results to you, greatly improving the quality of your measurement database.

The Agency is no doubt aware of the problems that might result if the miscalculated lumber kiln VOC emission factor was to be included in a final version of AP-42. Despite the usual EPA caveats about how the emission factors should and should not be used, and the general unreliability of these specific emission factors (Quality Rating = D), these factors will be reviewed by regulatory agency staff responsible for Title V permits, PSD/NSR permits, and even enforcement actions, and may be used by many sources unable to afford testing of their own. In light of the Title V, PSD, and enforcement implications that could result from use of an erroneous emission factor, the industry believes it would be in everyone's best interests to delay further work until more (and better) testing data are available.

As always, we look forward to working with you to ensure the Agency has the soundest technical basis for emission factor and standards development. Please feel free to call me if you have any questions.

Very truly yours,

Robert C. Kaufmann
Director, Air Quality Program

RCK/ms

cc: Jim Weigold - EPA-OAQPS
Barry Cullen - AF&PA
Bob Glowinski - AF&PA
Jo Cooper - AF&PA
John Pinkerton - NCASI
David Word - NCASI
Dave Mumper - Weyerhaeuser
Bill Nicholson - Potlatch
Lawrence Otwell - Georgia-Pacific
Richard Moser - Georgia-Pacific

STATE OF ARKANSAS
DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY
8001 NATIONAL DRIVE, P.O. BOX 8913
LITTLE ROCK, ARKANSAS 72219-8913
PHONE: (501) 562-7444
FAX: (501) 562-4632

May 24, 1994

Mr. Dallas Safriet (MD-14)
Emissions Inventory Branch
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Dear Mr. Safriet:

The Air Division of the Arkansas Department of Pollution Control & Ecology has reviewed the draft AP-42 section entitled "Lumber and Wood Products Manufacturing and Woodworking Operations". Despite the tardiness of these comments, the Air Division would like to offer the following remarks on the draft:

> It seems that the purpose of AP-42 is to provide emission factors for use in quantifying emissions. The draft AP-42 section provides very little information in the form of emission factors. Since this is the case, why issue the new AP-42 section? The process description is too general to be of any use to a permitting agency and process descriptions generally accompany permit applications anyway. I would like to suggest that EPA delay issuing the new AP-42 section until states have an opportunity to test some of the lumber kilns that are now being permitted because of the plywood initiative. I expect to have emission data from three different kilns within the next year and I suspect that the Air Division will be able to develop it's own emission data from all of the tests that will be conducted in the near future. If EPA would delay the issuance of this section, I'm sure the Department would share the emission test data.

The Air Division would like to thank the EPA for allowing comments on this new section of AP-42. If you have any questions, please contact me at (501) 562-7444.

Sincerely,

Roger Norton

Roger Norton
Engineer II, Air Division

Conversion Technology inc.
ENVIRONMENTAL CONSULTING ENGINEERS

March 7, 1994

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

Dear Mr. Safriet:

In a discussion with you on Wednesday, March 3, I asked you about an AP-42 emission factor for VOC emissions from dry kilns for lumber. At that time, you indicated that there was a proposed value for this factor currently out for comment. We at Conversion Technology, Inc. work closely with the Southeastern Lumber Manufacturers Association (SLMA) and have quite a few lumber mills as clients. This issue will greatly affect SLMA and other mills (especially with the Clean Air Act beginning to come into play). We need to be able to inform these facilities about the proposed factor. I would greatly appreciate your assistance in finding out what value is being proposed, when is the public comment period and how are the lumber mill operators being notified.

Thank you for your assistance. Please call me at (404) 263-6330 if you have any questions.

Sincerely,

Charles Quick

Charles (Bo) Quick
Project Engineer

CVQ:rkh

cc: Mr. Whit Joyner

Home Office: 3300 Holcomb Bridge Rd., Suite 250 • Norcross, GA. 30092 • 404/263-6330 • Fax: 404/263-8348

Georgia-Pacific Corporation
133 Peachtree Street NE (30303)
P.O. Box 105605
Atlanta, Georgia 30348-5605
Telephone (404) 652-4000

January 11, 1994

Mr. Dallas W. Safriet
U.S. Environmental Protection Agency
Emissions Inventory, Branch (MD-14)
Research Triangle Park, NC 27711

Re: Draft AP-42 Section
Lumber Manufacturing

Certified Mail
No: 291162810

Dear Mr. Safriet:

I am in receipt of the above-referenced draft AP-42 section. It was received in our offices on December 27, 1993 and, as such, has only received cursory review to date. One issue is; however, apparent with respect to the data used to establish the VOC emission factor. The single reference and non-standard methodology used to establish the factor is certainly not an adequate basis for a definitive, published national emission factor - especially in view of the ongoing discussion of the inadequacy of pollutant definition and existing test methodology as it relates to the wood products industry.

I understand that a meeting between AFPA/NCASI and EPA's RTP technical group is being discussed for late January/early February and that cooperative efforts to resolve these and other issues are on the tentative agenda. It would seem prudent to extend the comment period to allow the results of this timely meeting to be considered in the review of this draft AP-42 section. In any event, a minimum of a thirty (30) day extension of the comment period is requested by Georgia-Pacific to compensate for review time lost in transmittal of the draft over the holidays and to allow us to complete our company-specific review and file meaningful comments.

Please give me a call at (404) 652-5081 if you have any early questions or concerns.

Sincerely,

Lawrence P. E. Otwell
Manager, Environmental Technical Issues
Environmental Engineering Building Products

LPEO/mjw

cc: Mr. R. A. Moser
Mr. C. Bowling
Mr. F. L. Harsey

bc: S. S. Turnipseed
A. F. Hodges
G. R. Alphonso
S. F. Vogt
P. H. Wyckoff
A. Macbeth
D. T. Buente, Jr.
D. J. Hayes
L. J. Fisher

Georgia-Pacific Corporation

133 Peachtree Street NE (30303)
P.O. Box 105605
Atlanta, Georgia 30348-5605
Telephone (404) 652-4000

September 9, 1994

Original sent to MRI 9-15-94

Mr. Dallas W. Safriet
Environmental Engineer
Environmental Protection Agency
Emission Inventory Branch
MD-14
Research Triangle Park, NC 27711

Dear Dallas:

Georgia-Pacific is in the process of preparing a response as you requested on the revised draft of Section 10.1, Lumber and Wood Products Manufacturing, and Woodworking Operations that would be published in AP-42. We have several test reports from dry kilns (direct fired and indirect heated) conducted this Spring and Summer which are being reviewed and expect to have at least two (2) more reports completed and ready for review by the middle of October. Georgia-Pacific also has several dry kilns scheduled for testing through the middle of October which we would like to submit data on.

At this time Georgia-Pacific would like to request an extension of the current comment period deadline of September 30, 1994 until the middle of December. The extra time would allow a complete review of the test reports we wish to submit to EPA. I have talked to other companies which have dry kiln data and I think your office will be seeing test reports from some of them. The additional test reports should help broaden your data base on lumber dry kilns and improve the accuracy of EPA's emission factors.

Please give me a call if you have any questions at 404/652-4293.

Sincerely,

F. LARSON HARSEY
ENVIRONMENTAL ENGINEER
BUILDING PRODUCTS ENVIRONMENTAL ENGINEERING

FLH/jhd

cc: K. M. Bentley
L. P. E. Otwell
R. A. Moser
D. H. Word

Georgia-Pacific Corporation
133 Peachtree Street NE (30303)
P.O. Box 105605
Atlanta, Georgia 30348-5605
Telephone (404) 652-4000

December 6, 1994

Mr. Dallas W. Safriet
Environmental Engineer
EPA - Emission Inventory Branch
MD-14
Research Triangle Park, NC 27711

Re: Georgia-Pacific Corporation
Dry Kiln Test Reports
AP-42 Section 10.1
Lumber and Wood Product Manufacturing

Dear Mr. Safriet:

Enclosed are copies of six dry kiln emission test reports that we have completed to date. Also included in the test report is an emissions summary and at the back of each report is a section documenting process data. Below is a list of the facilities submitted.

Bay Springs, MS	6/94
Columbia, MS	2/94
Cross City, FL	2/94 & 9/94-(two reports)
El Dorado, AR	7-8/94
Whiteville, NC	3/94

Georgia-Pacific (G-P) will submit additional test reports before December 15 along with comments on AP-42 Section 10.1.

In an attempt to put G-Ps test program in perspective I have provided comments on several of the dry kiln tests. Please don't hesitate to call me with any questions you might have.
General Comments On Dry Kiln Operations

The dry kilns that G-P operates follow some general operating procedures to obtain desired lumber quality characteristics. Green rough cut lumber is stacked and loaded into the dry kilns. During the first 1½ to 3 hours of the kiln operating cycle the kilns are brought up to temperature and the roof vents remain closed. Dry kilns follow the facility specific drying cycle requirements for lumber quality which involves certain temperature set points for Wet Bulb/Dry Bulb (WB/DB) values which control the opening of the roof vents. After meeting the final moisture set points as determined by WB/DB readings, the kiln goes into a cool down mode which usually means cutting off heat to the kiln and leaving the recirculating fans operating. Each plant has slightly different operating conditions, but this "generally" outlines the basic drying cycles.

The testing program which G-P conducted progressed through several program modifications in scope and procedures. For testing purposes short temporary stacks were attached to kiln vents so as not to alter the normal operation of the venting cycle but provide acceptable sampling location. G-P is very hesitant to change the "normal " venting operation (plant specific) of any of the kilns for testing purposes. Manually overriding the vent controls and/or restricting the gas flow were considered but were not thought to represent normal kiln operation (considering lumber quality). Just for the record, every facility operates their respective kilns slightly different due to burners or steam coil configuration, wood species, time of year, and other site specific considerations.

Columbia, MS - Chip-N-Saw

The first dry kiln G-P tested in our kiln test program was a direct fired kiln. The burner was fired on dry planer shavings. A common control room section separated the kiln we tested from the adjacent kiln. On a pretest visit it appeared that the kiln was operating under a condition of positive pressure. The exhaust from the kiln was being blown out under and around the doors, the kiln building seams, and out the roof vents. This moisture laden gas which resembles a steam plume was being vented more aggressively than the normal leakage observed at most kilns. The burner was a suspension burner not unlike some of the ones found on direct fired drying operations although a good bit smaller. Combustion makeup air (ambient air) was being pulled from a duct inside the building housing both the control room and the burners. I think that this type of burner configuration caused the slight pressurization observed at this kiln.

The proposed sampling protocol required fitting several roof vents with stacks for testing. These vents were opened as needed for testing and were not vents opened by the kiln drying program. The constant gas stream which resulted was enough to allow isokenitic particulate sampling on the vents. The test team did have to relocate the sampling equipment during the drying cycle to correspond with the fan reversals (approximately every two to three hours) in order to maintain a positive gas flow at the sampling location. This condition of constant gas flow from roof vents could not be duplicated at the other kilns. As I stated above I feel that this testing condition was due to the type of burner installed on the kilns at this facility.

An air flow study was conducted on all of the vents which were controlled by the kiln drying program to try and quantify total air flow from the kiln. For this we had a lightweight stack which was moved from vent to vent The study was conducted the following day (less burner input and wood) and I feel might not reflect actual kiln operating conditions.

Cross City, FL - Chip-N-Saw

The second facility tested in our program had two (2) kilns that were also direct fired. Georgia-Pacific tested both kilns due to product differences which resulted in specific operational requirements. The kilns were free standing and located approximately sixty feet (60') apart. The heat source was a fixed grate green sawdust pile burner. Each kiln had it's own small combustion chamber to provide heat (the kilns were identical mirror images of each other).

The sampling probes were inserted in the blend chamber return duct. The gas sampled was the return/recycle/recirculated "air" from the kiln. This duct was located just prior to the actual blend chamber, before the addition of hot make-up combustion gas and should reflect the same concentrations of emissions which would be vented out of the various roof vents. By measuring air flow out of the roof vents and applying the gas concentrations from the return duct gas samples we hoped to accurately reflect the kilns emissions. The gas sample location did not meet Method 1 but we felt that the duct location was the best we could do.

We planned to use Method 2 for air flow measurement on the roof vents of the kilns by moving a single pre-fab stack made of light sheet metal from vent to vent while each individual vent showed a positive air flow (again we had to consider fan reversals). This worked for only a few of the vents. The moisture coming form the adjacent vents without stack extensions caused a visibility problem on the roof and proved to be a safety hazard. Another concern was the relatively low air velocity. As a result, all of the vents were not measured for gas flow during the "tested" drying cycle. Air flows were obtained later to provide a basis for emissions estimates. Our test plan did not call for any changes to the normal vent operating cycle. The operating mode at this facility during this test series was such that the vents remained open during the entire test except for the initial 1-3 hours. Total kiln drying time was approximately 18 hours for one of the kilns and approximately 27 hours for the other due to the different products produced.

Whiteville, NC - Chip-N-Saw

The kiln tested at the Whiteville facility had indirect steam heating. Steam is provided from a wood-waste boiler located at a plywood facility contiguous to the sawmill. Modifying the test approach somewhat from our first two tests, we added stacks (again made of light sheet metal) to each individual roof vent (19"x19" ID). There were a total of eighteen (18) vents per kiln at this facility. The additional stacks solved the problem of having to move a single temporary stack around during the test.

The stacks were attached so as not to alter the normal operation of the venting cycle. For the reasons described above, G-P is very hesitant to change the "normal " venting operation (plant specific) of any of the kilns for testing purposes. The kiln tested was located in the number three position of a single building comprised of four (4) dry kilns located side by side.

Flow measurements were again attempted using Method 2, but the extremely low, intermittent air flow conditions resulted in the consultant using their recommended backup method of propeller anemometers. The consultant had planned to try out this method anyway and brought with them what looked like a 10" ID stove pipe stack insert about four feet (4') long for the anemometers to sit in. The reduced cross-sectional area increased the velocity enough to maintain a measurable air flow while the monitored vents were open. With anemometers connected to a computer, air flow was recorded and tabulated during the entire test. Anemometers on the inlet vents measured air intake to the kiln. If my memory serves me correctly the consultant had only 8 to 10 anemometers. This left several "stacks" without any air flow data. The plan was to move the anemometers around so data could be collected from each vent during the drying cycle. After the kiln reached temperature and started it's normal cycle of venting moisture, the same visibility problem seen at other facilities made the process of changing instruments from stack to stack a safety hazard

During one of the consultants attempts at changing equipment they noticed an interesting phenomenon, some of a neighboring kiln's "steam" (moisture) exhaust was being pulled into the inlet stacks of the kiln being tested. By inlet stack or vent I mean the vent on the negative side of the recirculating fan inside the kiln. Depending on which direction the fan inside the kiln is turning, the kiln vents show a slight positive or slight negative air flow. The neighboring kiln's exhaust gas being pulled into the kiln would contain VOCs and condensable organics. This condition had not been anticipated. Also the wind direction would need to be from one specific direction for this condition to occur. There is no way of estimating the effect that this condition had on the total emissions measured at this facility.

El Dorado, AR - Sawmill

At the El Dorado facility G-P tested two kilns. One was steam heated and the other was direct fired by natural gas. The facility provided enough stacks so that each vent had it's own short stack. Propeller anemometers were installed at each vent location. This allowed constant monitoring of gas flow both positive and negative for both rows of vents for the complete drying cycle.

A series of heated sample lines were connected to each vent in an "octopus" type manifold arrangement on both vent rows and routed to separate 25A analyzers (one for each row). A critical orifice placed in each vent sample line insured equal flow from each vent to the manifold. This gave us a composite sample for VOCs from the ambient air (inlet vents) and the outlet vents as they exhaust. I use these terms to identify the relative net gas flow at the vent location. By monitoring air flow on all the vents for the entire cycle, equipment changes from vent to vent were eliminated.

One operational item that I have not described in detail up to this point is a condition that occurs during the fan reversal period. Before the fans reverse the direction of air flow in the kilns there is a period of 5-15 minutes (varies from facility to facility) that is programmed into the drying cycle to allow the fans to stop turning before they are powered up in the opposite direction. Usually during this period all of the vents open (both rows) so that the kiln does not implode upon cooling and fan restart. During this period the vents experience a natural draft condition (very low flow). Having anemometers on each vent records measurable air flows over the entire kiln drying cycle.

Bay Springs, MS - Chip-N-Saw

The kiln tested at the Bay Springs facility is a steam heated kiln and has a heat exchanger installed on the venting system. The heat exchanger has a single stack and also an exhaust fan. This setup provided a single test location and constant air flow which allowed us to perform particulate testing. The "octopus" method for VOC sampling was not needed at this facility.

Cross City, FL - Chip-N-Saw

The last test report which is enclosed was a retest at the Cross City facility using the octopus manifold sample train. Two separate tests were conducted on the same kiln. The vent operating conditions during the first test were set to open according to WB/DB set points. This operating procedure is the one in use currently at the plant to meet lumber quality requirements. The second test modified the vent operating procedure to allow the vents to remain open during testing.

The attached data were acquired using EPA Method 25A. This method, as you know, was developed for other types of emission sources and has never been promulgated nor validated as an applicable methodology for this industry. Georgia-Pacific will be transmitting to EPA shortly, a report which documents numerous problems with this methodology (as it is currently written) when applied to wood drying sources. Many of these technical issues are already documented in MRI's reports on Emission Factor Documentation for AP-42; Sections 10.5, 10.6.1, and 10.6.3 for, respectively, Plywood Manufacturing, Waferboard Manufacturing. As such, VOC data derived from Method 25A is of questionable utility for permitting, inventory, and compliance demonstration purposes and should be so noted.

In summary, these data sets are submitted for your review to see if they are acceptable to be included in the proposed AP-42 section on lumber drying. Looking at the range of results on tests conducted on mixed pine species I feel that the tests show a fairly broad range in emission rates from less than 1 LB/MBF to greater than 4 LB/MBF. Direct fired kilns appear to have slightly higher test results than indirect heated kilns. G-P's dry kiln testing program will continue to address the challenges presented by trying to test such an atypical point source. Any suggestions your group might have would be greatly appreciated.

As I stated above G-P will provide comments on the proposed AP-42 for lumber dry kilns and additional dry kiln test reports before December 15. If you or any of your staff have questions or need additional information on these reports please give me a call at 404/652-4293.

As I stated above G-P will provide comments on the proposed AP-42 for lumber dry kilns and additional dry kiln test reports before December 15. If you or any of your staff have questions or need additional information on these reports please give me a call at 404/652-4293.

Sincerely,

F. Larson Harsey
Environmental Engineer

FLH/jhd
Enclosure

cc: K. M. Bentley
R. A. Moser
F. D. Denney
L. P. E. Otwell
D. K. Phenicie
G. R. Alphonso
A. F. Hodges
D. Word - National Counsel of the Paper Industry for Air and Stream Improvement, Inc. (w/enclosure)

Georgia-Pacific Corporation
133 Peachtree Street NE (30303)
P.O. Box 105605
Atlanta, Georgia 30348-5605
Telephone (404) 652-4000

December 15, 1994

Mr. Dallas W. Safriet
Environmental Engineer
EPA - Emission Inventory Branch
MD-14
Research Triangle Park, NC 27711

Re: Georgia-Pacific Corporation
Dry Kiln Test Reports and Comments
AP-42 Section 10.1
Lumber and Wood Products Manufacturing and Wood Working Operations

Dear Mr. Safriet:

On December 9, 1994 Georgia-Pacific Corporation submitted test results regarding emissions measured from lumber dry kilns at five of the Company's manufacturing facilities. Enclosed please find additional dry kiln test data from The Prosperity, SC Chip-N-Saw (CNS), Wakefield, VA CNS, and Woodland, ME CNS facilities.

The specifics regarding these tests are very similar to the last couple of dry kiln tests previously submitted. The "octopus" manifold sample train was used to measure flows and VOCs from the dry kiln exhaust vents. An emissions data summary table is included at the beginning of each test report. Process rate information appears at the end. For your convenience, I have attached to this letter the emissions data summary tables from all of the facilities.

As the testing descriptions and data submissions demonstrate, testing procedures for these sources have not been standardized. Differing procedures will yield differing results. Also, numerous variations in individual manufacturing plant operating practices, dictated by differing raw material characteristics, differing dry kiln manufacturers and final product specifications, impart a sizable variation in plant to plant emission factors. This situation occurs to a greater extent in this industry segment than in some others. The process used for wood drying is dictated by facility specific characteristics.

Since AP-42 factors are often used to estimate emissions for permitting and other official purposes, it is extremely important to include these variations in the final published emission factors. Using the data provided by Georgia-Pacific, the National Council for Air and Stream Improvement (NCASI) and other manufactures, EPA should have the necessary information to develop expected ranges for each process category. There is precedent for the Agency to recognize and publish acknowledgments of these variations in that the existing version of AP-42, section 10.5 which pertains to plywood manufacturing, includes such language. We request that similar language, along with the appropriate emission factor range, be included in the final version of each Section that pertains to wood drying.

Georgia-Pacific has also supplied data regarding emissions from Medium Density Fiberboard Manufacturing operations. This information applies to EPA's draft emission factor report for AP-42 Section 10.6.3. In this manufacturing section as well, test methods have not been standardized and plant to plant variations occur due to equipment, wood species and operational differences. Georgia-Pacific believes that emission factors reported by the Agency for this sector should also include a range of possible values. We will share more of this data as it becomes available. We further request that the Agency not finalize emission factors for this sector until enough data is available to determine the proper range.

As stated in G-P's previous dry kiln test report submittal, the attached data were acquired using EPA Method 25A. This method, as you know, was developed for other types of emission sources and has never been promulgated nor validated as an applicable methodology for this industry. Georgia-Pacific will be transmitting to EPA shortly, a report which documents numerous problems with this methodology (as it is currently written) when applied to wood drying sources. Many of these technical issues are already documented in MRI's reports on Emission Factor Documentation for AP-42; Sections 10.5, 10.6.1, and 10.6.3 for, respectively, Plywood Manufacturing, Waferboard Manufacturing. As such, VOC data derived from Method 25A is of questionable utility for permitting, inventory, and compliance demonstration purposes and should be so noted.

Georgia-Pacific appreciates the opportunity to supply this data and these comments. We are anxious to work with the Agency to provide additional information and insight so that the best possible decision making information is available for use in finalizing these documents. Please let me know how we can assist further in this effort.

Sincerely,

F. Larson Harsey
Environmental Engineer

FLH/jhd
Enclosure

cc: K. M. Bentley
R. A. Moser
F. D. Denney
L. P. E. Otwell
D. K. Phenicie
G. R. Alphonso
A. F. Hodges
D. Word - National Counsel of the Paper Industry for Air and Stream Improvement, Inc. (w/enclosure)

BAY SPRINGS, MISSISSIPPI
EMISSION FACTORS
Test Dates: 6/28 & 6/29 1994

INDIRECT-FIRED DRYING KILN EMISSIONS
(kiln is equipped with a Vent-X-Changer to recover some of the heat provided)

TEST OPERATING PARAMETERS:
Green moisture content 44% average
Dry moisture content 13%
Nominal input total 156,160.78 board feet of 2" x 4" southern pine
Kiln Cycle time 23.008 hours
Kiln Dry Bulb Temperature Enter - 234 F and Exit - 212 F (ave)
Kiln Wet Bulb Temperature 169 F
Exhaust Temp following Vent-X-Changer = 153 F (ave)

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

HEAT EXCHANGER EXHAUST

Pollutant	Run 1			Run 2			Run 3			Average	max/ave
	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/mbf	
PM	9.00E-02	156.16078	1.33E-02	6.00E-02	156.16078	8.84E-03	1.10E-01	156.16078	1.62E-02	1.28E-02	1.27E+00
Formaldehyde*	1.28E-03	156.16078	1.88E-04	1.44E-02	156.16078	2.13E-03	1.28E-03	156.16078	1.88E-04	8.35E-04	2.55E+00
Acetaldehyde*	8.60E-03	156.16078	1.27E-03	1.27E-02	156.16078	1.86E-03	7.52E-03	156.16078	1.11E-03	1.41E-03	1.32E+00
Hexaldehyde*	6.83E-04	156.16078	1.01E-04	1.65E-03	156.16078	2.44E-04	8.82E-05	156.16078	1.30E-05	1.19E-04	2.05E+00
Acetone	4.50E-03	156.16078	6.63E-04	7.34E-03	156.16078	1.08E-03	4.32E-03	156.16078	6.37E-04	7.94E-04	1.36E+00
MEK*	6.61E-05	156.16078	9.74E-06	4.41E-05	156.16078	6.50E-06	4.41E-05	156.16078	6.50E-06	7.58E-06	1.29E+00

* results of individual runs not consistent, therefore additional test data should be reviewed from testing on similar units

HEAT EXCHANGER EXHAUST

Pollutant	lb/cycle	mbf/cycle	Range lb/hr		Average lb/hr		Average lb/mbf	max/ave
VOCs w/cond	9.35E+01	156.16078	2.17E+00	5.78E+00	4.06		5.99E-01	1.42E+00
VOCs	9.79E+01	156.16078	2.20E+00	5.89E+00	4.26		6.27E-01	1.38E+00

TEST METHODS
PM = Particulate Matter, Method 5
VOCs = Volatile Organic Compounds, Method 25A
Aldehydes and Ketones = Method TO-5
VOCs w/cond = Volatile Organic Compounds with Condenser, Method 25 with precondenser

8/18/94

CROSS CITY, FLORIDA
EMISSION FACTORS
Test Dates: 2/23 & 2/24 1994

DIRECT-FIRED DRYING KILN EMISSIONS (PILE BURNER)

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content 44% average
- Dry moisture content 19%
- Rough input total 130,000 board feet (Lumber Size - 4 X 4)
- Kiln Cycle Time - 26.45 hours
- Average Temperature - 232 F

DRY KILN #1

Pollutant	Run 1			Run 2			Run 3			Average	max/ave
	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/mbf	
PM	2.08E+00	130	4.23E-01	1.56E+00	130	3.17E-01	1.98E+00	130	4.03E-01	3.81E-01	1.11E+00
Formaldehyde	6.95E-02	130	1.41E-02	1.91E-01	130	3.89E-02	1.50E-01	130	3.05E-02	2.78E-02	1.40E+00
Phenol	1.42E-01	130	2.89E-02	8.90E-02	130	1.81E-02	3.90E-02	130	7.94E-03	1.83E-02	1.58E+00

DRY KILN #1

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)		Average lb/hr	Average lb/mbf	max/ave
THC	6.12E+02	130	1.44E+01	4.55E+01	2.31E+01	4.70E+00	1.97E+00
THC w/cond	4.81E+02	130	8.89E+00	4.00E+01	1.82E+01	3.70E+00	2.20E+00
NOx	1.76E+01	130	2.80E-01	1.16E+00	6.65E-01	1.35E-01	1.74E+00
CO	8.69E+01	130	8.00E-01	2.78E+01	3.29E+00	6.69E-01	8.46E+00

- Gas in recycle/return line was tested to determine pollutant concentrations in kiln exhaust. Concentrations were then applied to exit vent exhaust flow rates to establish lb/hr emissions.

TEST METHODS
- PM = Particulate Matter, Method 5
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser
- Formaldehyde, Method TO - 5
- Phenol, Method TO - 8
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

CROSS CITY, FLORIDA
EMISSION FACTORS
Test Dates: 2/23 & 2/24 1994

DIRECT-FIRED DRYING KILN EMISSIONS (PILE BURNER)

TEST OPERATING PARAMETERS:
- Green moisture content 50% average
- Dry moisture content 14%
- Rough input total 128,000 board feet (Lumber Size - 2 x 4)
- Kiln Cycle Time Test 1 - 17.52 hours, Test 2 - 15.03 hours
- Average Temperature - 215 F

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

DRY KILN #2 TEST 1

	Run 1			Run 2			Run 3			Average	
Pollutant	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/mbf	max/ave
PM	1.71E+00	128	2.33E-01	1.99E+00	128	2.72E-01	1.04E+00	128	1.42E-01	2.16E-01	1.26E+00
Formaldehyde	8.15E-02	128	1.12E-02	7.48E-02	128	1.02E-02	2.00E-01	128	2.74E-02	1.63E-02	1.68E+00
Phenol	1.60E-02	128	2.19E-03	2.83E-02	128	3.87E-03	3.50E-03	128	4.79E-04	2.18E-03	1.78E+00

DRY KILN #2 TEST 1

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)		Average lb/hr	Average lb/mbf	max/ave
THC	3.67E+02	128	1.17E+01	3.68E+01	2.10E+01	2.87E+00	1.76E+00
THC w/cond	3.10E+02	128	1.01E+01	3.21E+01	1.77E+01	2.42E+00	1.81E+00
NOx	2.30E+00	128	n/a	n/a	1.31E-01	1.80E-02	n/a
CO	2.19E+01	128	1.80E-01	3.70E+00	1.25E+00	1.71E-01	2.96E+00

- Gas in recycle/return line was tested to determine pollutant concentrations in kiln exhaust. Concentrations were then applied to exit vent exhaust flow rates to establish lb/hr emissions.

TEST METHODS
- PM = Particulate Matter, Method 5
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser
- Formaldehyde, Method TO - 5
- Phenol, Method TO - 8
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

CROSS CITY, FLORIDA
EMISSION FACTORS
Test Dates: 2/23 & 2/24 1994

DIRECT-FIRED DRYING KILN EMISSIONS (PILE BURNER)

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content 50% average
- Dry moisture content 14%
- Rough input total 128,000 board feet (Lumber Size - 2 x 4)
- Kiln Cycle Time Test 1 - 17.52 hours, Test 2 - 15.03 hours
- Average Temperature - 215 F

DRY KILN #2 TEST 2

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)		Average lb/hr	Average lb/mbf	max/ave
THC	3.63E+02	128	1.57E+01	3.58E+01	2.41E+01	2.83E+00	1.48E+00
NOx	6.36E+00	128	3.75E-02	1.18E+00	4.23E-01	4.97E-02	2.79E+00
CO	1.88E+01	128	2.50E-01	3.70E+00	1.25E+00	1.47E-01	2.96E+00

DRY KILN #2 AVERAGE OF TESTS 1 AND 2

Pollutant	lb/mbf
THC	2.85E+00
NOx	3.50E-02
CO	1.60E-01

- Gas in recycle/return line was tested to determine pollutant concentrations in kiln exhaust. Concentrations were then applied to exit vent exhaust flow rates to establish lb/hr emissions.

TEST METHODS
- PM = Particulate Matter, Method 5
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser
- Formaldehyde, Method TO - 5
- Phenol, Method TO - 8
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

WHITEVILLE, NORTH CAROLINA SAWMILL
EMISSION FACTORS
Test Dates: 3/16 & 3/17 1994

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

INDIRECT-FIRED DRYING KILN EMISSIONS

TEST OPERATING PARAMETERS:
Kiln Cycle Time 24.67 hr
127,584 board feet at lumber size 2" x 4"
Avg. Flow Rate 335 acfm/stack
Avg. Stack Temperature 172.8 F
Avg. Measured Moisture 41.4%

	Run 1			Run 2			Run 3			Average	
Pollutant	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/mbf	max/avg
Cond. PM	7.00E-02	127.584	1.35E-02	5.50E-02	127.584	1.06E-02	9.20E-02	127.584	1.78E-02	1.40E-02	1.27E+00
Total PM	7.90E-02	127.584	1.53E-02	6.10E-02	127.584	1.18E-02	1.03E-01	127.584	1.99E-02	1.57E-02	1.27E+00
Formaldehyde	2.50E-02	127.584	4.83E-03	1.30E-02	127.584	2.51E-03	2.90E-02	127.584	5.61E-03	4.32E-03	1.30E+00
Acetaldehyde	2.90E-02	127.584	5.61E-03	2.80E-02	127.584	5.41E-03	6.40E-02	127.584	1.24E-02	7.80E-03	1.59E+00
Hexaldehyde	7.00E-04	127.584	1.35E-04	7.00E-04	127.584	1.35E-04	5.00E-04	127.584	9.67E-05	1.22E-04	1.11E+00
Acetone	5.70E-02	127.584	1.10E-02	6.50E-02	127.584	1.26E-02	7.10E-02	127.584	1.37E-02	1.24E-02	1.10E+00
MEK	6.00E-03	127.584	1.16E-03	5.00E-03	127.584	9.67E-04	9.00E-03	127.584	1.74E-03	1.29E-03	1.35E+00
Phenols	7.00E-04	127.584	1.35E-04	8.00E-04	127.584	1.55E-04	5.00E-04	127.584	9.67E-05	1.29E-04	1.20E+00

				Max	Average	
Pollutant	lb/hr	mbf/cycle	lb/mbf	lb/hr	lb/mbf	max/avg
THC	4.46E+00	127.584	8.62E-01	1.35E+01	8.62E-01	3.03E+00
THC w/ Cond.	4.04E+00	127.584	7.82E-01	1.50E+01	7.82E-01	3.71E+00

Test Methods
PM = Particulate, Method 5
Cond. PM = Cond. Particulate, Method 202
Formaldehyde = Method T05
Phenol = Method T08
THC = Total Hydrocarbon, Method 25A
THC w/ cond. = Total Hydrocarbon with Precondenser

EL DORADO, ARKANSAS
EMISSION FACTORS
Test Dates: 7/26 - 8/2 1994

INDIRECT-FIRED DRYING KILN EMISSIONS

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content 44% average
- Dry moisture content 12%
- Rough input total 131,265 board feet
- Kiln Cycle Time - 26.57 hours
- Average Dry Bulb Temperature - 196 F
- Average Wet Bulb Temperature - 181 F

DRY KILN #1 TEST 1

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)			Average lb/mbf	max/ave
THC	2.67E+02	131.265	0.00E+00	6.87E+01		2.03E+00	6.84E+00
THC w/cond	2.57E+02	131.265	n/a	n/a		1.96E+00	n/a

TEST METHODS
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser

EL DORADO, ARKANSAS
EMISSION FACTORS
Test Dates: 7/26 - 8/2 1994

DIRECT-FIRED DRYING KILN EMISSIONS

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content 38% average
- Dry moisture content 15.5%
- Rough input total 138,225 board feet
- Kiln Cycle Time - 95.87 hours
- Average Dry Bulb Temperature - 119 F
- Average Wet Bulb Temperature - 168 F

DRY KILN #9

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)			Average lb/mbf	max/ave
THC	5.06E+01	138.225	n/a	n/a		3.66E-01	n/a
THC w/cond	3.90E+01	138.225	n/a	n/a		2.82E-01	n/a
NOx	0.00E+00	138.225	n/a	n/a		0.00E+00	n/a
CO	0.00E+00	138.225	n/a	n/a		0.00E+00	n/a

TEST METHODS
- PM = Particulate Matter, Method 5
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

EL DORADO, ARKANSAS
EMISSION FACTORS
Test Dates: 7/26 - 8/2 1994

INDIRECT-FIRED DRYING KILN EMISSIONS

TEST OPERATING PARAMETERS:
- Green moisture content 37% average
- Dry moisture content 12%
- Rough input total 128,454 board feet
- Kiln Cycle Time - 25.4

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

DRY KILN #1 TEST 2

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)			Average lb/mbf	max/ave
THC	1.81E+02	128.454	0.00E+00	4.53E+01		1.41E+00	6.36E+00

TEST METHODS
THC = Total Hydrocarbons, Method 25A

COLUMBIA, MISSISSIPPI
EMISSION FACTORS
Test Dates: 2/7 & 2/8 1994

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

DIRECT-FIRED DRYING KILN EMISSIONS (SUSPENSION BURNER)

TEST OPERATING PARAMETERS:
- Green moisture content 41% average
- Dry moisture content 12%
- Rough input total 106,720 board feet
- Kiln Cycle time 20.25 hours

	Run 1			Run 2			Run 3			Average	
Pollutant	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/mbf	max/ave
Cond. PM	1.88E-01	106.72	3.57E-02	9.60E-02	106.72	1.82E-02	1.57E-01	106.72	2.98E-02	2.79E-02	1.28E+00
PM	3.06E+00	106.72	5.80E-01	4.32E+00	106.72	8.20E-01	3.38E+00	106.72	6.41E-01	6.80E-01	1.21E+00

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)		Average lb/hr	Average lb/mbf	max/ave
VOCs	4.95E+02	106.72	7.93E+00	4.57E+01	2.45E+01	4.64E+00	1.87E+00
NOx	4.50E+01	106.72	1.09E+00	3.69E+00	2.24E+00	4.22E-01	1.65E+00
CO	2.43E+02	106.72	5.61E+00	2.51E+01	1.20E+01	2.28E+00	2.09E+00

TEST METHODS
- PM = Particulate Matter, Method 5
- Cond. PM = Condensible Particulate Matter, Method 202
- VOCs = Volatile Organic Compounds, Method 25A
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

CROSS CITY, FLORIDA
EMISSION FACTORS
Test Dates: 8/30 - 9/3 1994

DIRECT-FIRED DRYING KILN EMISSIONS (PILE BURNER)

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content - n/a
- Dry moisture content 16%
- Rough input total 104,448 board feet
- Kiln Cycle Time - 17.25 hours
- Average Dry Bulb Temperature - 223 F
- Average Wet Bulb Temperature - 171 F

DRY KILN #2 TEST 1

Pollutant	Run 1			Run 2			Run 3			Average	max/ave
	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/mbf	
PM	1.47E+00	104.448	2.43E-01	1.93E+00	104.448	3.19E-01	1.90E+00	104.448	3.13E-01	2.91E-01	1.09E+00

DRY KILN #2 TEST 1

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)		Average lb/mbf	max/ave
THC	3.30E+02	104.448	6.06E+00	3.55E+01	3.16E+00	1.86E+00
THC w/cond	2.16E+02	104.448	4.98E+00	1.94E+01	2.07E+00	1.55E+00
NOx	1.05E-01	104.448	4.00E-02	3.78E-01	1.01E-03	6.21E+01
CO	9.65E-01	104.448	3.00E-01	1.49E+00	9.24E-03	2.66E+01

- Gas in recycle/return line was tested to determine pollutant concentrations in kiln exhaust. Concentrations were then applied to exit vent exhaust flow rates to establish lb/hr emissions.

TEST METHODS
- PM = Particulate Matter, Method 5
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

CROSS CITY, FLORIDA
EMISSION FACTORS
Test Dates: 8/30 & 9/3 1994

DIRECT-FIRED DRYING KILN EMISSIONS (PILE BURNER)

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content 51%
- Dry moisture content 18%
- Rough input total 104,448 board feet
- Kiln Cycle Time 17.75 hours
- Average Dry Bulb Temperature - 206 F
- Average Wet Bulb Temperature - 166 F

DRY KILN #2 TEST 2

Pollutant	lb/cycle	mbf/cycle	Range (lb/hr)			Average lb/mbf	max/ave
THC	3.02E+02	104.448	1.78E+00	3.33E+01		2.89E+00	1.95E+00
THC w/cond	1.68E+02	104.448	1.21E+00	2.73E+01		1.61E+00	2.89E+00
NOx	1.39E-01	104.448	1.06E-01	4.26E-01		1.33E-03	5.44E+01
CO	1.01E+00	104.448	2.20E-01	4.26E-01		9.67E-03	7.49E+00

- Gas in recycle/return line was tested to determine pollutant concentrations in kiln exhaust. Concentrations were then applied to exit vent exhaust flow rates to establish lb/hr emissions.

TEST METHODS
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

PROSPERITY, SOUTH CAROLINA
EMISSION FACTORS
Test Dates: 9/22 - 9/23 1994

INDIRECT-FIRED DRYING KILN EMISSIONS

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content 44% average
- Dry moisture content 10.4%
- Rough input total 88,500 board feet
- Kiln Cycle Time - 22 hours
- Average Dry Bulb Temperature - 219 F
- Average Wet Bulb Temperature - 163 F

DRY KILN #3

Pollutant	lb/cycle	mbf/cycle		Average lb/mbf	max/ave
THC	1.71E+02	88.5		1.93E+00	n/a
THC w/cond	1.22E+02	88.5		1.38E+00	n/a

TEST METHODS
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser

WAKEFIELD, VIRGINIA
EMISSION FACTOR DATA
Test Dates: 9/28 - 9/30 1994

DIRECT-FIRED DRYING KILN (SUSPENSION BURNER)

TEST OPERATING PARAMETERS:
- Green moisture content - 40%
- Dry moisture content - 12.5%
- Rough input total 124,287 board feet
- Kiln Cycle Time - 22.47 hours
- Average Dry Bulb Temperature - 189 F
- Average Wet Bulb Temperature - 164 F

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

DRY KILN TEST 1

	Run 1			Run 2			Run 3			Average	
Pollutant	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/hr	mbf/cycle	lb/mbf	lb/mbf	max/ave
Filterable PM	6.73E-01	124.287	1.22E-01	1.36E-01	124.287	2.46E-02	4.47E-01	124.287	8.08E-02	7.57E-02	1.61E+00
Condensable PM	4.80E-01	124.287	8.68E-02	3.91E-01	124.287	7.07E-02	3.41E-01	124.287	6.16E-02	7.30E-02	1.19E+00
PM	1.15E+00	124.287	2.08E-01	5.27E-01	124.287	9.53E-02	7.88E-01	124.287	1.42E-01	1.49E-01	1.40E+00
Formaldehyde	1.32E-01	124.287	2.39E-02	1.22E-01	124.287	2.21E-02	5.60E-02	124.287	1.01E-02	1.87E-02	1.28E+00
Acetaldehyde	9.70E-02	124.287	1.75E-02	9.40E-02	124.287	1.70E-02	5.40E-02	124.287	9.76E-03	1.48E-02	1.19E+00
Hexaldehyde	7.00E-04	124.287	1.22E-04	4.80E-02	124.287	8.68E-03	7.00E-04	124.287	1.27E-04	2.98E-03	2.91E+00
Acetone	4.30E-02	124.287	7.77E-03	1.90E-02	124.287	3.44E-03	4.00E-03	124.287	7.23E-04	3.98E-03	1.95E+00
MEK	7.00E-04	124.287	1.27E-04	7.00E-04	124.287	1.27E-04	7.00E-04	124.287	1.27E-04	ND	ND

DRY KILN TEST 1

Pollutant	lb/cycle	mbf/cycle	Average lb/mbf	max/ave
THC	1.15E+02	124.287	9.24E-01	n/a
THC w/cond	8.90E+01	124.287	7.16E-01	n/a
NOx	1.10E+01	124.287	8.86E-02	n/a
CO	2.94E+01	124.287	2.37E-01	n/a

NOTE
1) Gas in recycle/return line was tested to determine pollutant concentrations in kiln exhaust. Concentrations were then applied to exit vent exhaust flow rates to establish lb/hr emissions.
2) Actual cycle times recorded at test differ from those used in the source test report. Field measurement of 22.47 hours is used to develop emission factors for test 1.

TEST METHODS
- PM = Particulate Matter, Method 5
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser,
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

WAKEFIELD, VIRGINIA
EMISSION FACTOR DATA
Test Dates: 9/28 - 9/30 1994

DIRECT-FIRED DRYING KILN (SUSPENSION BURNER)

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content 41%
- Dry moisture content 22%
- Rough input total 133,824 board feet
- Kiln Cycle Time 25.5 hours
- Average Dry Bulb Temperature - 222 F
- Average Wet Bulb Temperature - 171 F

DRY KILN TEST 2

Pollutant	lb/cycle	mbf/cycle		Average lb/mbf	max/ave
THC	8.11E+01	133.824		6.06E-01	n/a
THC w/cond	5.84E+01	133.824		4.36E-01	n/a
NOx	7.91E+00	133.824		5.91E-02	n/a
CO	1.91E+01	133.824		1.43E-01	n/a

NOTE
1) Gas in recycle/return line was tested to determine pollutant concentrations in kiln exhaust. Concentrations were then applied to exit vent exhaust flow rates to establish lb/hr emissions.
2) Actual cycle times recorded at test differ from those used in the source test report. Field measurement of 25.5 hours is used to develop emission factors for test 2.

TEST METHODS
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser,
- NOx = Nitrogen Oxides, Method 7E
- CO = Carbon Monoxide, Method 10

WOODLAND, MAINE
EMISSION FACTORS
Test Dates: 10/11 - 10/14 1994

INDIRECT-FIRED DRYING KILN

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

TEST OPERATING PARAMETERS:
- Green moisture content - 25.4%
- Dry moisture content - 11.6%
- Rough input total - 178,560 board feet
- Kiln Cycle Time - 24 hours
- Average Dry Bulb Temperature - 203 F
- Average Wet Bulb Temperature - 161 F
- Wood species - Spruce

DRY KILN #2 TEST 1

Pollutant	lb/cycle	mbf/cycle		Average lb/mbf	max/ave
THC	6.94E+02	178.56		3.88E+00	n/a
THC w/cond	6.11E+02	178.56		3.42E+00	n/a

* Emissions based on tracer gas dilution flowrate.

DRY KILN #2 TEST 1

Pollutant	lb/cycle	mbf/cycle		Average lb/mbf	max/ave
THC	3.17E+01	178.56		1.78E-01	n/a
THC w/cond	2.79E+01	178.56		1.56E-01	n/a

** Emissions based on vent flowrate.

TEST METHODS
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser

WOODLAND, MAINE
EMISSION FACTORS
Test Dates: 10/11 - 10/14 1994

INDIRECT-FIRED DRYING KILN

TEST OPERATING PARAMETERS:
- Green moisture content - 37.5%
- Dry moisture content - 13.7%
- Rough input total - 178,560 board feet
- Kiln Cycle Time - 54 hours
- Average Dry Bulb Temperature - 207 F
- Average Wet Bulb Temperature - 160 F
- Wood species - Fir

CONTACT G-P CORPORATE ENVIRONMENTAL ENGINEERING BEFORE USING ANY EMISSION FACTOR PRESENTED. EMISSIONS WILL VARY SIGNIFICANTLY FOR VARIOUS UNITS OF THIS TYPE. THE FACTORS PRESENTED REPRESENT EMISSIONS FROM A UNIQUE SOURCE AND OPERATING CONDITIONS BASED ON THE TESTING METHODOLOGIES USED.

DRY KILN #2 TEST 2

Pollutant	lb/cycle	mbf/cycle		Average lb/mbf	max/ave
THC	4.19E+02	178.56		2.35E+00	n/a
THC w/cond	2.09E+02	178.56		1.17E+00	n/a

* Emissions based on tracer gas dilution flowrate.

DRY KILN #2 TEST 2

Pollutant	lb/cycle	mbf/cycle		Average lb/mbf	max/ave
THC	4.38E+01	178.56		2.45E-01	n/a
THC w/cond	2.21E+01	178.56		1.24E-01	n/a

** Emissions based on vent flowrate.

TEST METHODS
- THC = Total Hydrocarbons, Method 25A
- THC w/cond = Total Hydrocarbons with condenser, Method 25A with precondenser

INTERNATIONAL PAPER

6600 LBJ FREEWAY
DALLAS TX 75240
PO BOX 809024
DALLAS TX 75380-9024
PHONE 214 934 6000

December 8, 1994

Mr. Dallas Safriet
Emissions Inventory Branch (MD-14)
Office of Air Quality Planning And Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Dr. Mr. Safriet:

Enclosed for your review are summary and emissions data for four of International Paper's Wood Products Division facilities. This data is intended for use in your preparation of emission factor documentation in AP-42, Section 10.1, *Lumber and Wood Products Manufacturing and Woodworking Operations.*

Sincerely,

Thomas F. Duckert
Regulatory Manager

CC: Art McGowen, International Paper, Dallas, TX w/o
Thad McCoy, International Paper, Memphis, TN w/o
Tom Sauer, International Paper, Memphis, TN w/o
Dr. David Word, NCASI, Southern Regional Center, Gainesville, Florida

TFD:ws

International Paper Company
lumber kiln emissions test data summary
Southern Yellow Pine
for AP42 use

Test mill Kiln type	Henderson, Tx direct fire	Moundville, Al direct fire	Maplesville, Al steam	Morton, Ms steam
Test date from	2/2/94	9/27/94	4/19/94	9/13/94
Test date to	2/4/94	9/29/94	4/21/94	9/15/94
Drying time (HRS)	17.4	18.2	19.71	18.26
Drying capacity (MBF)	105	133	116	149
THC emission as carbon (lb/MBF)	2.8	2.8	4.8	5.3
Total fuel usage (TONS)	18.4	19.4	NA	NA
CO (lb/TON fuel)	3.1	7.0	NA	NA
NOX (lb/MMBTU)	0.20	0.22	NA	NA
PM (lb/TON fuel)	2.61	3.20	NA	NA
Lumber avg (% MC)	13.5	16.0	16.0	16.0

PC
12/08/94

Lumber kiln THC emission test method
by International Paper Company
date: Dec. 5, 1994

Method: EPA Method 25A determination of Total Hydro Carbon from both direct and indirect wood drying kilns

Description: The method measures the THC accurately without the fugitive air problem by the other testing methods in the industry. The fugitive air was estimated about less than 2 % for all the test runs conducted for IP.

Procedure:

1. Build/erect two stacks over two single vents, one from each vent row. The stack must be covered and sealed around vents, yet allow the vents to function normally.

2. Conduct all the instrument calibrations during the last period of the last cycle before the voc sampling actually started. This allows to capture the critical emission data at the early stage in the cycle, without losing the accuracy due to the interruption in the early instruments calibration.

3. Measure the relative air flow (FPM) for each vents of the kiln. It quantifies the emission proportionally accounting for each vent. The test result revealed that the emission did not flow through vents equally.

   Procedure (measure the relative air flows):
   a. measured the flow at the beginning of the cycle when the kilns were not hot (less than 130 deg. F).
   b. close the all intake vents and 100 % open all the exhaust vents, this is a simulation of the actual sampling operation.

4. Record the venting times for each vent row, this improves accuracy of calculation of the air flow.

Sampling operation:

5. Close the intake vents and 100 % open the exhaust vents in the entire test cycle, this creates a negative air pressure inside the

kiln, eliminating / minimizing fugitive air escaped through the leaks.

5. Measure the residual voc after the drying cycle ended. The voc exits inside the kiln, even after the charge was shut down and heat cut off. The accuracy of projection of the total THC emission may be further improved by properly estimate the residual voc.

   Procedure:
   a. open both the intake and the exhaust vents to speed up cooling, and to accelerate releasing the residual voc to the stack for measurement.

PC

Air flows distribution through the kiln vents
Henderson lumber mill

1. There are total six vents on each north and south side of roof
2. vent dimension: 21"x21"
   Test date: 6/1/94
   Test condition: green kiln before starup
   air flow meter brand: VelociCheck 8330, 25 - 4,000 fpm

3. Measurements of air flow

   A. North vents:

	(blocked)	VOC test				
vent ID:	No.1	No.2	No.3	No.4	No.5	No.6
(fpm):	-	1950	1360	1480	1720	1710
(deg F):	-	93	94	93	93	94

   average air flow thru. north vents: 1644 fpm

   B. South vents:

	(blocked)	VOC test				
vent ID:	No.1	No.2	No.3	No.4	No.5	No.6
(fpm):	-	1950	1650	1650	2230	1760
(deg F):	-	93	92	93	92	93

   average air flow thru. south vents: 1848 fpm

4. Calcualtions:
   venting time (hrs): north vents - 9 hrs (52.9 %)
   south vents - 8 hrs (47.1 %)
   calculate the number of vents based on the size of vent tested for VOC for both north and south
   north side: (1,644 x 5)/1950 = 4.21 vents
   south side: (1,848 x 5)/1950 = 4.74 vents

   combination of north and south vents:
   (4.21 x 52.9%) + (4.74 x 47.1%) = 4.46 vents = 4.5 vents

PC
6/2/94

attached 1

Henderson kiln VOC emissions test summary
tested kiln: No.1

		CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4
VOC emissions as propane per the tested vent (lbs/hr)	:		4.1	4.5	4.6
VOC emissions as carbon per the tested vent (lbs/hr)	:		3.1	3.4	3.5
Total drying time in cycle (hrs)	:		17.1	17.4	16.9
Lumber moisture contents (%)	:			11.8	13.5
Kiln capacity (mbf)	:	105	105	105	105
******************************					
Projected VOC as propane:					
Projected VOC emissions (lbs/MBF)	:		3.0	3.4	3.3
Projected VOC emission plus the 10 % uncertainty (lbs/MBF)	:		3.3	3.7	3.7
Total VOC emissions in 1993 based on 83 MM BF lumber prod. (tons)	:		137	153	152
******************************					
Projected VOC as carbon:					
Projected VOC emissions (lbs/MBF)	:		2.3	2.6	2.5
Projected VOC emission plus the 10 % uncertainty (lbs/MBF)	:		2.5	2.8	2.7
Total VOC emissions in 1993 based on 83 MM BF lumber prod. (tons)	:		103	115	114

Note
Total air flow: 4.5 x air flow measured at the sampled vent

PC
7/29/94

attached 2

Henderson kiln CO, NOX, SO2 emissions test summary
tested kiln: No.1

		CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4
CO emissions per vent (lbs//hr)	:		0.6	0.7	0.8
NOX emissions per vent (lbs/HR)	:		0.4	0.4	0.4
SO2 emissions per vent (lbs/HR)	:		0.0	0.0	0.0
Total drying time in cycle (hrs)	:		17.1	17.4	16.9
Kiln capacity (mbf)	:	105	105	105	105
Total fuel used in the cycle (lbs)	:		40,480	36.887	39,600
CO emissions factor (lbs/ton)	:		2.3	3.0	3.1
NOX emissions factor (lbs/ton)	:		1.5	1.7	1.5
NOX emissions factor (lbs/mmbtu)	:		0.2	0.2	0.2
SO2 emissions factor (lbs/ton)	:		0.0	0.0	0.0
CO max. hourly emissions of both kilns combined (lbs/hr)	:		5.4	6.3	7.2
NOX max. hourly emissions of both kilns combined (lbs/hr)	:		3.6	3.6	3.6
Total CO emissions in 1993 based on 83MM bf lumber prod. (tons)	:		19	22	24

Note:
Total air flow: 4.5 x the air flow measured at the sampled vent

EC
6/3/94

attached 3

Henderson kiln particulate matter emissions test summary
Kiln no. 1

Test No. :	CYCLE 1 No.1	CYCLE 1 No.2	CYCLE 2 No.3	CYCLE 3 No.4	CYCLE 4 No.5
PM emissions per vent (lbs//hr) :	0.6	0.46	0.65	0.69	0.55
Total drying time in cycle (hrs) :			17.1	17.4	16.9
Kiln capacity (mbf) :	105	105	105	105	105
Fuel used during the PM test (lbs):			2.312	2.249	2.198
Total fuel used in the cycle (lbs):			40.480	36.887	39.600
PM emissions factor (lbs/ton) :			2.46	2.71	2.46
Max. hourly emissions for each of the two kilns (lbs/hr) :			2.9	3.1	2.9
Max. hourly emissions of both kilns combined (lbs/hr) :			5.9	6.2	5.9
Total PM emissions in 1993 based on 83MM bf lumber prod. (tons) :			20	21	20
Fuel required to dry 1 MBF lumber (tons/MBF) :			0.19	0.18	0.19

Note:
Total air flow: 4.5 x air flow measured at the sampled vent

PC
6/3/94

IP Moundville / Tuskalusa

Tuskalusa No.2 kiln - relative air flows of vents

Measurement instruments:

1. by Peter: TSI hot wire air flow meter
2. by METCO: Pitot tube, using EPA mentods 1,2,3,4

Measuring condition:

the vent air flows were measured when the exhaust side vent 100 % open and the intake side vent closed

north vents air flows:

	N1	N2	N3	smplng vent N4	N5	avg	% time operat
1. by Peter	610	520	570	540	360	520	52.6 %
2. by METCO	570	601	543	599	316	526	

south vents air flows:

	S1	S2	S3	smplng vent S4	S5	avg	% time operat
1. by Peter	630	630	610	600	400	574	
2. by METCO	719	733	696	630	516	659	47.3 %

calculation for vent multiplier:

1. by Peter:

North - (520 x 5/ 540) x 52.6% = 2.53
South - (574 x 5/ 600) x 47.4% = 2.27
total vents = 2.53 + 2.27 = 4.8 vents

2. by METCO:

North - (539 x 5/ 599) x 52.6% = 2.31
South - (659 x 5/ 630) x 47.4% = 2.47
total vents = 2.31 + 2.47 = 4.78 vents

11/21/94
PC

Table 1

Tuskalusa Lumber Mill kiln emissions summary:
Kiln No. 2

		CYCLE 1 2x6	CYCLE 2 2x6	CYCLE 3 2x6
A.				
VOC emissions thru the tested vents (lbs/hr) as propane	:	4.7	4.6	5.2
CO emissions thru the tested vents (lbs/hr)	:	1.3	1.4	1.4
NOX emissions thru the tested vents (lbs/hr)	:	0.4	0.4	0.5
B.				
Total drying time in cycle (hrs)	:	20.3	19.95	18.2
Lumber moisture contents (%)	:	12.0	16.2	-
Kiln capacity (MBF)	:	133.0	131.0	133.1
Total fuel usage for the cycle (tons)	:	18.85	19.14	19.38
C. Results:				
VOC:				
Projected VOC emissions as propane (lbs/MBF)	:	3.4	3.3	3.4
Projected VOC emissions as carbon (lbs/MBF)	:	2.8	2.7	2.8
Total VOC emissions as carbon in 1993 based on 113 MM BF lumber production annually (tons)	:	159	155	157
CO:				
Projected CO emissions (lbs/ton fuel)	:	6.7	7.0	6.[illegible]
Total CO emissions in 1993 based on 113 MM BF lumber production annually (YPT)	:	54	58	51
NOX:				
Projected NOX emissions (lbs/ton fuel)	:	2.1	2.0	2.2
Projected NOX emissions (lbs/mmbtu)	:	0.21	0.20	0.22
Total NOX emissions in 1993 based on 113 MM BF lumber production annually (TPY)	:	16.5	16.5	18.5

Note:
Total air flow: 4.78 x air flow measured at the sampled vent...

PC
11/21/94

Table 2

Tuskalusa kiln particulate matter emissions test summary
Kiln No.2

Run time (hrs)		CYCL 1 10.8	CYCL 1 13.8	CYCL 2 6.4	CYCL 2 9.4	CYCL 2 12.5
PM emissions thru the tested vent (lbs/hr)	:	0.57	0.47	0.65	0.58	0.49
Total drying time in cycle (hrs)	:	20.3	20.3	19.95	19.95	19.95
Kiln capacity (mbf)	:	133	133	131	131	131
Total fuel usage for the cycle (tons)	:	18.85	18.85	19.14	19.14	19.14
Projected PM emissions (lbs/ton fuel)	:	2.9	2.4	3.2	2.8	2.4
Total PM emissions in 1993 based on 113 MM bf lumber prod. (tons)	:	23.5	19.4	26.7	23.0	20.2
Fuel required to dry 1 MBF lumber (tons/MBF)	:	0.14	0.14	0.15	0.15	0.15

Note:
Total air flow: 4.78 x air flow measured at the sampled vent

PC
11/21/94

To: Brent Horne
From: Peter Chen, IP

Maplesville kiln VOC emissions test summary
tested kiln: No.3

		CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4
Type of products		2x4, 2x6		2x8.2x10	[illegible]
VOC emissions thru the tested vents (lbs/hr) as propane	:	6.8		7.5	[illegible]
VOC emissions thru the tested vents (lbs/hr) as pinenes	:	6.3		7.0	[illegible]
Total drying time in cycle (hrs)	:	19.8		18.8	19.71
Lumber moisture contents (%)	:	16.6		14.0	[illegible]
Kiln capacity (mbf)	:	115.0		107.6	[illegible]
Projected VOC emissions as propane (lbs/MBF)	:	4.7		5.2	[illegible]
Projected VOC emissions as carbon (lbs/MBF)	:	3.8		4.3	[illegible]
Projected VOC emissions as pinenes (C10H16) (lbs/MBF)	:	4.3		4.9	[illegible]
Total VOC emissions as carbon in 1993 based on 97 MM BF lumber production annually (tons)	:	178		199	[illegible]
Total VOC emissions as propane in 1993 based on 97 MM BF lumber production annually (tons)	:	218		244	[illegible]
Total VOC emissions as pinenes in 1993 based on 97 MM BF lumber production annually (tons)	:	202		226	[illegible]

Total VOC = sample voc x4

PC
7/29/94

Air flows distribution through the kiln vents
Maplesville lumber mill

1. There are total five vents on each north and south side of roof
2. vent dimension: 28"x28"
   Test date: 4/24/94
   Test condition: kiln was down, DB: 144 deg. F. WB: 90 deg.
   air flow meter brand: Alnor Velometer Jr.. 0 -1600 fpm

3. Measurements of air flow

   A. South vents:

vent ID:	No.1	VOC test No.2	No.3	No.4	No.5
(fpm):	500	450	450	350	150

   average air flow thru. south vents: 380 fpm

   B. North vents:

vent ID:	No.1	No.2	VOC test No.3	No.4	No.5
(fpm):	260	320	450	450	180

   average air flow thru. south vents: 332 fpm

4. Calcualtions:
   venting time (hrs): south vents - 10.2 hrs (53.8 %)
   nouth vents - 9 hrs (46.9 %)
   calculate the number of vents based on the size of vent tested for VOC for both north and south
   south side: (380 x 5)/450 = 4.22 vents
   north side: (332 x 5)/450 = 3.68 vents

   combination of north and south vents:
   (4.22 x 53.8%) + (3.68 x 46.9%) = 4.0 vents

PC
4/26/94

Morton No.3 kiln - relative air flows of vents

Measurement instruments:

1. by Peter: TSI hot wire air flow meter
2. by METCO: Pitot tube, using EPA mentods 1,2,3,4

Measuring condition:

1. by Peter: the vent air flows were measured when the exhaust side vent 100 % open and the intake side vent closed. This is a simulation as in the actual sampling test.
2. by METCO: the exhaust side was 100 % open, the intake side was 70 % open. The intake vent was partially open to boost the air flow to be measurable by the Pitot tube.

A. East vents air flows:

	E1	E2 (saplng vent)	E3	E4	E5	avg	% time operat
1. by Peter	290	180	290	350	390	237	49.2 %
2. by METCO	726	955	370	974	849	875	

B. West vents air flows:

	W1	W2 (saplng vent)	W3	W4	W5	avg	% time operat
1. by Peter	195	275	320	320	045	231	50.8 %
2. by METCO	848	845	888	865	759	843	

calculation for vent multiplier:

1. by Peter:
   - East - (237 x 5/ 180) x 49.2 % = 3.24
   - West - (231 x 5/ 275) x 50.8 % = 2.13
   - total vents = 3.24 + 2.13 = 5.37 vents

2. by METCO:
   - East - (875 x 5/ 955) x 49.2 % = 2.25
   - West - (843 x 5/ 845) x 50.8 % = 2.53
   - total vents = 2.25 + 2.53 = 4.78 vents

comments:

The multilplier calculated based on Peter's method will be applied for voc emissions computations.

10/19/94
PC

attached 4

Morton kile kiln VOC emissions test summary
Kiln No. 3

		CYCLE 1	CYCLE 2	CYCLE 3
Type of products		2x6	2x6	2x4
VOC emissions thru the tested vents (lbs/hr) as propane	:	9.9	10.0	9.2
Total drying time in cycle (hrs)	:	18.26	17.55	18.93
Lumber moisture contents (%)	:	16.0	14.6	15.9
Kiln capacity (MBF)	:	149.6	148.6	151.6
Projected VOC emissions as propane (lbs/MBF)	:	6.5	6.4	6.2
Projected VOC emissions as carbon (lbs/MBF)	:	5.3	5.2	5.1
Total VOC emissions as carbon in 1993 based on 140 MM BF lumber production annually (tons)	:	372	364	354

Total VOC = sample voc x 5.37

11/05/94
PC

ncasi

SOUTHERN REGIONAL CENTER
P.O. Box 141020
Gainesville, FL 32614-1020
(904) 377-4708
FAX: (904) 371-6557

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

September 12, 1994

Original sent to MRI on 9-15-94

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

Re: August 1994 Revised Draft AP-42 Section 10.1, "Lumber and Wood Products Manufacturing and Woodworking Operation"

Dear Dallas:

The purpose of this letter is to request three months of additional time to comment on the above cited document. In your letter of August 22, 1994 you requested comments by the end of September.

The lumber industry is in the process of developing kiln testing protocols, and numerous VOC emission tests have been conducted over the last six months. Meetings were held on September 6 and 7, 1994 to share information concerning methods that are currently being used. Several companies have kiln testing programs and are refining their methods as they learn from their experiences. Thus, new data will soon be available from tests that were more carefully conducted than some that have been conducted in the past (and from which the AP-42 emission factors have been derived).

Several companies have agreed to submit their test reports to EPA when they are completed. Many of the recent tests have not reached the final report stage. It is estimated that 4 to 12 additional test reports can be supplied before the end of the year (several tests are scheduled for September and October).

Regarding the revised draft AP-42 Section 10.1, we have not had time to make a thorough review, but a cursory review has revealed a miscalculation and an omission that we would like to comment on at this time.

The steam heated kiln data from reference 17 (page 26) have apparently been misinterpreted. By letter of March 18, 1994 we transferred this report (Kiln Test 4) and summarized the information. Our calculations provided a value of 3.15 pounds of VOC as carbon per thousand board feet of lumber dried. This value of 3.15 represented all the kiln's vents (two rows with four vents per row) and provided a total emissions factor for the entire kiln. If you multiply this value by four and change it from a carbon to a methane basis, you obtain the 16.8 pounds of VOC per thousand board feet represented in the AP-42 draft (page 26). Thus, the VOC obtained from one vent (per row) was multiplied by four twice to obtain the value of 16.8. This value of 16.8 was then averaged with other test data to provide an inaccurate emission factor.

The omission is in regards to the discussion of "Emission Testing Issues" as included in the recent draft AP-42 sections for Oriented Strandboard and Medium Density Fiberboard. These same issues exist in regards to the sampling of emissions from lumber drying, and we believe this discussion should also be included in Section 10.1.

Thanks in advance for your consideration relative to including additional lumber kiln emission testing data in AP-42. If you have questions regarding these comments, feel free to contact me at (904) 377-4708 x241.

Sincerely,

David H. Word, Ph.D.
Research Engineer

cc: Rob Kaufmann
John Pinkerton
Larson Harsey
Mike Rast
Don Hejna
Tom Duckert
Peter Chen
Bill Swofford
Chuck Vaught
Rich Barrett
Karl Brohammer
Jerry Ethridge

SOUTHERN REGIONAL CENTER
P.O. Box 141020
Gainesville, FL 32614-1020
(904) 377-4708
FAX: (904) 371-6557

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

March 18, 1994

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

Re: December, 1993 Draft AP-42 Section 10.1, "Lumber and Wood Products Manufacturing and Woodworking Operation"

Dear Dallas:

Thank you for the opportunity to comment on the above cited AP-42 section. Our comments are provided below under **bold** headings that match the headings in the draft document. General comments on the overall quality of Section 10.1 are also provided.

I would also like to thank you for extending our deadline for comment on this section. As a result, we have been able to solicit and receive additional information pertinent to this section. That information is being mailed under separate cover.

GENERAL COMMENTS

This entire AP-42 section is based on two reports referred to within the document as References 5 and 12. The applicable section of reference 5 is based on "field observation" and is completely lacking any test data. Reference 12 is a single stack test on a lumber kiln in which an unconventional source sampling method was used. This lack of data has resulted in tables that are mostly void of emission factors, and in factors that are all suspect and have little scientific basis.

EMISSION FACTOR DOCUMENTATION

2. INDUSTRY DESCRIPTION - First paragraph

Sawdust and shavings are described as useful by-products of lumber production. This statement is correct in that virtually all wood residue is used, and very little, if any, should be considered waste. However, the term "waste" has been incorrectly applied to wood residue or wood by-products in other sections of the document. These references are discussed, in order, in subsequent sections of this letter.

2.2 PROCESS DESCRIPTION - Debarking

In the second sentence, "One" should be substituted for "The major" in the second sentence (since logs are not chipped or pulped in lumber manufacturing).

2.2 PROCESS DESCRIPTION - Wood Waste Handling

As stated above, and consistent with the first paragraph under the heading *INDUSTRY DESCRIPTION*, references to wood waste should be deleted since sawdust, sanderdust, planer shavings, etc. are rarely disposed of, or treated, as a waste. The section heading should read "Wood Residue Handling". In the first sentence, "wood waste" should be changed to "wood residue." The second sentence should be rewritten as follows: "These systems are a convenient means of transporting the wood residue to common collection points where it may be used immediately or stored for future use." In the third sentence, "used primarily" should be replaced with "often used" since sawdust use will vary greatly from mill to mill. A similar change should be made in the fifth sentence with respect to use of planer shavings.

2.3 EMISSIONS - First paragraph

The movement of trucks and loading equipment in the storage pile area should not be described as a "substantial" source of dust. The relative importance of this source has not been adequately assessed and would vary considerably from one location to another.

2.4 CONTROLS - First paragraph

In the first sentence, the words "waste material" should be replaced by wood residue.

4.2.1.1 Reference 5

The emission factors discussed in this section appear to be subjective estimates only. On page 2-333 of "Reference 5," the authors explain the method by which they developed their lumber and furniture industry emission factors. They state, "The fugitive emission factors are based solely on best engineering judgement and material balance information obtained during plant visits. Thus, listed emission factors are at best order of magnitude estimates." (Although not specifically stated, the Acknowledgement section of Reference 5 indicates that two furniture manufacturing facilities were visited.)

The fact that these emission factors were used previously is provided as a reason for their continued inclusion. This reasoning is invalid. We recommend that the factors based on this reference not be included in AP-42.

4.2.1.2 Reference 12 - Second paragraph

The "basis" for the initial moisture content should be stated. From the test report, it appears that the 50 percent moisture figure was reported on a wet or "as is" basis which would be equivalent to 100 percent moisture on a dry basis. The final moisture should be stated on the same basis.

4.2.1.2 Reference 12 - Third paragraph

The sampling train was unconventional and was not a Method 5H train. (The condensible particulate matter lab analysis may have been conducted according to Method 5H.) It should be mentioned that the impingers were maintained at a temperature of approximately 45°F, since impinger temperature will affect the amount of material condensed.

4.2.1.2 Reference 12 - Fourth paragraph

The VOC emissions should be based on a molecular weight of 12 (rather than 16) and expressed as lb C/TBF (pounds of carbon per thousand board feet). Note that propane was the calibration gas used, and Method 25A specifies that results should be expressed as propane (or some other calibration gas) or in terms of carbon. Additionally, expressing the results as carbon would be consistent with Method 25.

4.2.1.2 Reference 12 - Fifth paragraph

If temperature information is available on the probe, sample line and the impinger train outlet, that information should be provided. Since a front filter was not used, some of the material measured as condensible particulate matter may have been solid particulate matter and not condensible gaseous material.

4.2.1.2 Reference 12 - Sixth paragraph

The VOC emission data are rated C. This conclusion is based, in part, on the use of a "sound methodology." While the sampling method used may be appropriate for wood products drying operations, it is unconventional and would likely provide different results than a Method 25 or 25A sample train. If this single run is to be the basis for the lumber kiln VOC emission factor, then a footnote in the appropriate AP-42 tables should be included to explain the unconventional manner in which the sample was obtained.

Table 4-3

The table should specify if the emission factor is for wet or dry debarking.

Table 4-6

For footnote "a," the moisture basis should be provided (i.e., wet or dry). For footnote "d," as discussed previously, a molecular weight of 12 would be more appropriate.

Tables 4-7 and 4-8

Since these two tables differ only in the units used, the comments are combined below.

The emission factors for debarking should specify if they are for wet or dry debarking. The emission factors for lumber drying should specify that they are for a steam heated kiln.

Footnote "c" should read "....Method 202 (or equivalent)." Footnote "g" should provide the moisture basis for the percent moisture (e.g., wet or dry). Footnote "h" refers to a molecular weight of 16. A molecular weight of 12 would be more appropriate, as previously discussed.

In both tables conversions are made directly from "mass of pollutant/mass of logs" to "mass of pollutant/volume of lumber" by assuming a density for wood. This cannot be done since 100 percent of the log is not converted into lumber. Emissions from lumber drying should be expressed on a "mass of pollutant/volume of lumber dried" basis (e.g., 2 lb VOC/TBF). Emissions from log handling operations are best expressed as "mass of pollutant/mass of logs" basis (e.g., 0.05 lb PM/ton of logs). The moisture basis for the logs should be specified (i.e., wet (green) or dry).

5. DRAFT AP-42 SECTION 10.1

10.1.1 General - First Paragraph

In the first sentence, "processing" should be substituted for "breakdown."

10.1.2 Debarking

In the second sentence, "One" should be substituted for "The major," since lumber is neither chipped nor pulped.

10.1.2 Wood Waste Handling

As previously discussed wood residue is seldom a "waste." The paragraph title should be Wood Residue Handling. In the first sentence, "wood waste" should be replaced with "wood residue." The second sentence should be deleted. The third sentence should be rewritten as follows: "These systems are a convenient means of transporting the wood residue to common collection points where it may be used immediately or stored for future use." In the fourth sentence, "used primarily" should be replaced with "often used" since sawdust use will vary greatly from mill to mill. A similar change should be made in the sixth sentence with respect to use of planer shavings.

10.1.3 Emissions and Controls - First paragraph

In the fifth sentence, the movement of trucks and loading equipment in the storage pile area should not be described as a "substantial" source of dust. The relative importance of this source has not been adequately assessed and would vary considerably from one location to another.

10.1.3 Emissions and Controls - Fourth paragraph

In the first and sixth sentences, "waste material" should be replaced by "wood residue." In the seventh, eighth and ninth sentences, the words "wastes" and "waste" should be replaced by "wood residue."

10.1.3 Emissions and Controls - Sixth paragraph

This entire paragraph should be deleted. Since wet suppression systems were not observed and are not in general use in the industry, they may not be a feasible control system. Most solid wood products facilities do not treat or discharge wastewater and would not have the capability to manage wastewater from a spray system.

Tables 10.1-1 and 10.1-2

Since these two tables differ only in the units used, the comments are combined below.

The emission factors for debarking should specify if they are for wet or dry debarking. The emission factors for lumber drying should specify that they are for a steam heated kiln.

Footnote "c" should read "....Method 202 (or equivalent)." Footnote "g" should provide the moisture basis for the percent moisture (e.g., wet or dry). Footnote "h" refers to a molecular weight of 16. A molecular weight of 12 would be more appropriate, as previously discussed.

In both tables conversions are made directly from "mass of pollutant/mass of logs" to "mass of pollutant/volume of lumber" by assuming a density for wood. This cannot be done since 100 percent of the log is not converted into lumber. Emissions from lumber drying should be expressed on a "mass of pollutant/volume of lumber dried" basis (e.g., 2 lb VOC/TBF). Emissions from log handling operations are best expressed as "mass of pollutant/mass of logs" basis (e.g., 0.05 lb PM/ton of logs). The moisture basis for the logs should be specified (i.e., wet (green) or dry).

If you have questions regarding these comments, feel free to contact me at (904) 377-4708 x241.

Sincerely,

David H. Word, Ph.D.
Research Engineer

cc: V. Dallons
D. Mumper
T. Sauer
A. Caron
J. Pinkerton

Building Board Mfg.
- Lumber

3/94

SOUTHERN REGIONAL CENTER
P.O. Box 141020
Gainesville, FL 32614-1020
(904) 377-4708
FAX: (904) 371-6557

File

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

March 18, 1994

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

Re: Lumber Kiln Test Reports

Dear Dallas:

By copy of this letter I am transmitting test reports that include information on five source samples on lumber kilns. The results of the testing have been summarized in attachments labeled Kiln Test 1 through Kiln Test 5.

A brief explanation of the data available for each test is provided below. I hope that the information, thus provided, will satisfy the criteria for inclusion of this information in the AP-42 Section 10.1, "Lumber and Wood Products Manufacturing and Woodworking Operation."

Kiln Test 1

The test report dated September 2, 1992 includes data on two direct fired kilns and a steam fired kiln. Kiln Test 1 is the summary of the report on the direct fired kilns. In this test, a Method 25A probe was inserted directly into the kilns, for a one-hour sample on kiln 2 and two one-hour samples on kiln 1. The results were then averaged since the kiln charges and species dried were the same.

Since the kilns were direct fired, F factors could be used to estimate flow rates. I have shown the calculation based on an F factor for carbon dioxide, although an oxygen F factor can also be used. The fuel usage and production data can be found in the final section of the test report.

Kiln Test 2

The information on this test is relatively straightforward and included in the September 2, 1992 test report. I found a couple of errors in the report. Tables 3 and 4 of that report incorrectly calculate the ppm of THC for the four vents (this does not affect the final results). The production data at the end of the report provide a kiln cycle time of 19.3 hours. The kiln did not vent during the first two hours of this cycle (personal correspondence) and the emissions should be calculated for a 17.3 hour period.

Kiln Test 3

This test information is derived from the test report dated June 18, 1993. Calculations for this test are straightforward, but the test report is a draft which includes no production data. My understanding in talking to the company is that no data changes were made from the draft to the final report, and the only changes were those penciled onto the draft report. I have attached the pertinent production data for that test as Attachment A. These data are from an internal company memo dated July 7, 1993.

Kiln Test 4 and 5

All the information needed to evaluate these tests and convert emissions to a production basis is included in the test reports. (Although it may take you some time to match up the data.) I did not copy the test information on the units other than kilns that were tested.

The test report dated October 29, 1992 contains the summary sheets and other information for Kiln Test 5. The field data, calibration information, etc. can be found in one of the two documents entitled "Volume 2 - Appendices." The production data for Kiln Test 4 and 5 can be found in either copy of "Volume 2 - Appendices" in Appendix O.

The test report for Kiln Test 4 has, as its cover, a letter dated December 28, 1992. The field data, calibration information, production data, etc. can be found in one of the two documents entitled "Volume 2 - Appendices."

I hope the above information will help you sort out the information that you need. If you need further information on these test reports, don't hesitate to call me. I can be reached at (904) 377-4708.

Sincerely,

David H. Word, Ph.D.
Research Engineer

Attachments

cc: V. Dallons
D. Mumper
A. Caron
J. Pinkerton

KILN TEST 1

Weyerhaeuser Direct Fired Kilns 1 & 2
Bruce, Mississippi
July 16, 1992
Southern Yellow Pine Lumber
Clean Air Engineering Report Dated September 2, 1992

RUN NO.	1	2	3	Average
LOCATION	Kiln 2	Kiln 1	Kiln 1	
SAMPLE TIME (min)	60	60	60	
CO_2 (%)	3.3	4.6	4.2	4.0
THC, ppm (as propane)	342	150	967	486.3
WOOD CHARGE	71.4 MBF (thousand board feet)			
WOOD FUEL RATE	15 lb/min			

Assumptions:

(1) Grab samples are representative of full 17 hour kiln cycle.

(2) Flow rates estimated by fuel factors. One pound wood fuel produces 15.6 dry standard cubic feet of carbon dioxide.

Calculations:

$$\left(\frac{15\ \text{lb wood fuel}}{\text{minute}}\right)\left(\frac{15.6\ \text{dscf}\ CO_2}{\text{lb wood fuel}}\right)\left(\frac{100\%}{4\%\ CO_2}\right)$$

= 5850 dscfm total gas flow

$$\left(\frac{486\ \text{propane}}{1{,}000{,}000}\right)\left(\frac{44\ \text{lb propane}}{\text{lb mole}}\right)\left(\frac{\text{lb mole}}{385.3\ \text{dscf}}\right)\left(\frac{5850\ \text{dscf}}{\text{minute}}\right)\left(\frac{60\ \text{minutes}}{\text{hour}}\right)$$

= 19.48 lb VOC as propane/hour

19.48 x 36/44 = 15.94 lb VOC as C/hour

$$\left(\frac{15.94\ \text{lb VOC as C}}{\text{hour}}\right)\left(\frac{17\ \text{hours}}{71.4\ \text{MBF}}\right) = 3.8\ \text{lb VOC as C/MBF}$$

KILN TEST 2

Weyerhaeuser Steam Heated Kiln
Bruce, Mississippi
July 17 and 18, 1992
Southern Yellow Pine Lumber
Clean Air Engineering Report Dated September 2, 1992

Assumptions & Notes:

(1) One vent is representative of the four vents on each side.

(2) Total drying time was 19.3 hours, but venting did not occur during the first two hours.

Calculations:

East Stack VOC Average = 5.45 lb/hr (as propane)
West Stack VOC Average = 5.34 lb/hr (as propane)
Average = 5.40 lb/hr

$$\left(\frac{5.40 \text{ lb VOC}}{\text{hour}}\right)\left(\frac{17.3 \text{ hours}}{143 \text{ MBF}}\right)\left(\frac{4 \text{ stacks}}{1 \text{ stack}}\right) = 2.61 \text{ lb VOC as propane/MBF}$$

2.61 x 36/44 = 2.14 lb VOC as C/MBF

KILN TEST 3

Weyerhaeuser Steam Heated Kiln
Bruce, Mississippi
May 5 and 6, 1992
Southern Yellow Pine Lumber
Clean Air Engineering Report Dated June 18, 1993

Assumptions & Notes:

(1) One vent is representative of the four vents on each side.

Calculations:

East Side Stack VOC Average = 13.2 lb/hr (as carbon)
West Side Stack VOC Average = 15.2 lb/hr (as carbon)
Average = 14.2 lb/hr

$$\left(\frac{14.2 \text{ lb VOC as C}}{\text{hour}}\right)\left(\frac{17.96 \text{ hours}}{157.5 \text{ MBF}}\right) = 1.62 \text{ lb C/MBF}$$

KILN TEST 4

Weyerhaeuser Steam Heated Kiln
Mountain Pine, Arkansas
August 12, 1992
Southern Yellow Pine Lumber
Radian Corporation Report Dated December 28, 1992,
Plus Appendices

Assumptions & Notes:

(1) Assume one vent is representative of the four vents on each side.

Calculations:

$$\left(\frac{21.80 \text{ lb VOC as carbon}}{\text{hour}}\right)\left(\frac{17.18 \text{ hours}}{119 \text{ MBF lumber}}\right) = 3.15 \text{ lb VOC as C/MBF}$$

KILN TEST 5

Weyerhaeuser Steam Heated Kiln
Mountain Pine, Arkansas
August 17, 1992
Southern Yellow Pine Lumber
Radian Corporation Volume I Report, Plus Appendices

Assumptions & Notes:

(1) Assume one vent is representative of the four vents on each side.

Calculations:

$$\left(\frac{19.2 \text{ lb VOC}}{\text{hour}}\right)\left(\frac{18.17 \text{ hours}}{119.25 \text{ MBF}}\right) = 2.93 \text{ lb VOC as C/MBF}$$

Similarly,

CO = 0.027 lb/MBF
Formaldehyde = 0.007 lb/MBF
"Front-Half" PM = 0.067 lb/MBF
"Back-Half" CPM = 0.134 lb/MBF
Total PM = 0.201 lb/MBF

ATTACHMENT A

BRUCE LUMBER MILL PARTICULATE AND GASEOUS EMISSION INVENTORY

DISTRIBUTION

Jerry Avenell[3]	WTC 2H2
Mike Branson[3]	Hot Springs
Jack Cain[3]	Hot Springs
Victor Dallons[2]	WTC 2F2
Steve Hindrix[2]	Bruce
Glen Lenard[1]	Bruce
Dave Mumper[3]	CH 1L28
Ken Nichols[2]	WTC 2F2
Wally Permenter[2]	Bruce
Dan Sjolseth[3]	WTC 2H2
Mike Rast[1]	Columbus, MS
Chuck Vaught[2]	New Bern
File Center[1]	WTC 2F2
TIC[1]	WTC TIC
Lee DeHihns[2]	Alston & Bird One Atlantic Center 1201 West Peachtree Street Atlanta GA 30309-3424
Jim Little[2]	Dames & Moore, Inc Six Piedmont Center, Suite 500 3525 Piedmont Road Atlanta, Georgia 30305

1 Full Report With Attachments
2 Full Report
3 Exucative Summary

TITLE: BRUCE LUMBER MILL PARTICULATE AND GASEOUS EMISSION INVENTORY: May, 1993

OBJECTIVE:

Emissions were sampled at the Weyerhaeuser Lumber Mill in Bruce, Mississippi to determine the current particulate and gaseous (PM, CO, NOx, and VOC) emissions from the boilers and lumber kilns. Sampling took place in May, 1993. Particulate matter from the cyclones was also sampled for the same purpose; those results are contained in a separate report from Clean Air Engineering.

INTRODUCTION

Environmental Sciences and Technology (ES&T) along with Clean Air Engineering (CAE) were retained to conduct a comprehensive emissions inventory of the Bruce Lumber Mill Facility. CAE conducted particulate and gaseous tests while ES&T collected the applicable production data.

The emissions inventory was compiled by measuring emissions from the testable sources and estimating emissions from those sources that were not tested. Tested emission sources were boilers 1 and 2 and kiln #2. Emissions from Kilns 1, 3, and 4 were estimated from an emission factor developed from emission tests of kiln #2.

Emission testing results reported by Clean Air Engineering are attached. This report contains information on production rates during the testing and a summarization of testing results along with emission factors calculated. Production information was recorded by ES&T and mill Personnel. The production information is presented as an appendix to this report.

CAE staff included Tony Dawson (Field Manager), John "Jack" Piontek and Tony Patrick. ES&T personnel present during the testing were Victor Dallons and Karl Schumacher. Glen Leonard and numerous mill personnel provided their expertise and support during the tests.

DISTRIBUTION TO TECHNICAL INFORMATION CENTER	LOCATION TIC	AUTHOR'S SIGNATURE	DATE
		[signature]	07/07/93
		AUTHOR'S NAME (Typed) Karl Schumacher	
PROJECT NO. 044-9334		APPROVED BY (Signature) [signature]	DATE 7/12

TESTED SOURCE DESCRIPTIONS

Boiler #1 "Old Boiler"

The Old Boiler is a spreader/stoker hog fuel boiler which receives fuel generated from the debarker and chip and saw. The combustion gases pass through two multiclones before exiting out the stack. The boiler was operated near its rated capacity of 40,000 lb/hr steam production during the emission tests. Fly-ash re-injection was used during the testing.

Boiler #2 "New Boiler"

The New Boiler is a 3 cell pile burner manufactured by Wellons. It receives hogged wood fuel generated from the debarker and chipping saw. The combustion gases pass through a multiclone and an electrostatic precipitator (ESP) before exiting out the stack. The boiler was operated near its rated capacity of 60,000 lb/hr steam production during the emission tests.

#2 Lumber Kiln

The double track steam heated kiln accommodates lumber on rail cars stacked two packs high and two packs wide with varying lengths and widths. During the emission test the Kiln contained 151.1 MBF of 2 X 4s and 6.45 MBF of 2 X 6s for a total of 157.5 MBF.

EMISSION TEST RESULTS

Boiler #1 "Old Boiler"

Table 1 summarizes the boiler operating conditions during emission testing. During emission testing, the steam production averaged between 93 and 100 percent of the boilers rated capacity. The boiler #1 operation data sheets for each emission test are shown in **Appendix B.**

TABLE 5 BOILER #2 GASEOUS EMISSION TEST RESULTS

	NOx				CO				VOCs as Carbon			
Test	ppm	lb/hr	lb/ MMBtu	lb/Mlb steam	ppm	lb/hr	lb/ MMBtu	lb/Mlb steam	ppm	lb/hr	lb/ MMBtu	lb/Mlb steam
B21	128	20	0.19	0.33	317	30	0.29	0.50	<4	<0.16	<0.00	<0.00
B22	137	22	0.22	0.37	148	14	0.14	0.24	<4	<0.17	<0.00	<0.00
B23	133	21	0.21	0.35	130	12	0.12	0.21	<4	<0.16	<0.00	<0.00
Avg.	133	21	0.21	0.35	198	19	0.19	0.32	<4	<0.16	<0.00	<0.00

TABLE 6 BOILER #2 PARTICULATE EMISSION TEST RESULTS

Test	Filterable gr/DSCF	lb/hr	lb/ MMBtu	lb/Mlb steam
B21	0.003	0.51	0.0086	0.0051
B22	0.000	0.02	0.0003	0.0002
B23	0.000	0.01	0.0002	0.0001
Avg.	0.001	0.18	0.0030	0.0018

Hourly emission rates were calculated from the pollutant concentration and the average dry gas flow rate. The emissions in terms of lb/MMBtu were calculated using EPA Method 19, Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide and Nitrogen Oxides Emission Rates. The Carbon Dioxide-Based F Factor was used for the calculations. The Fc was calculated form the ultimate analysis of the fuel as shown in **Appendix B**. Emissions rates in terms of lb/Mlb steam produced was calculated by dividing the hourly emission rate by the steam production rate.

Lumber Kiln #2

Table 7 summarizes the production and VOC emission data during the emission test conducted on the Lumber Kiln on May 6-7, 1993. The emission test results were summarized from the attached Clean Air Engineering emission test report. The Kiln operation data sheets for each emission test are shown in **Appendix D.**

The average VOC emission rate was 15 lbC/hr, which corresponded to 1.71 lb/MBF.

The emissions measured may be lower than typical because the lumber in the kiln at the time of testing was cut from logs that had been stored on the wet deck for about a month. The truck unloading crane was broken prior to testing and the mill was unable to cut fresh logs.

A water balance shows that 59 percent of the water entering the kiln with the lumber was accounted for in the emissions. This unaccounted for water implies that the sampling measured about 50 percent of the emissions. The unaccounted for water loss possibly resulted from an imbalance in flows from the kiln vents. Two of the 8 kiln vents were sampled. These 2 vents had stack extensions attached to them. The stack extensions may have increased the resistance to flow from these two vents, causing emission venting to be higher in the remaining 6 vents. The gas flows were assumed to be the same from all vents.

TABLE 7 KILN #2 GASEOUS EMISSION TEST RESULTS

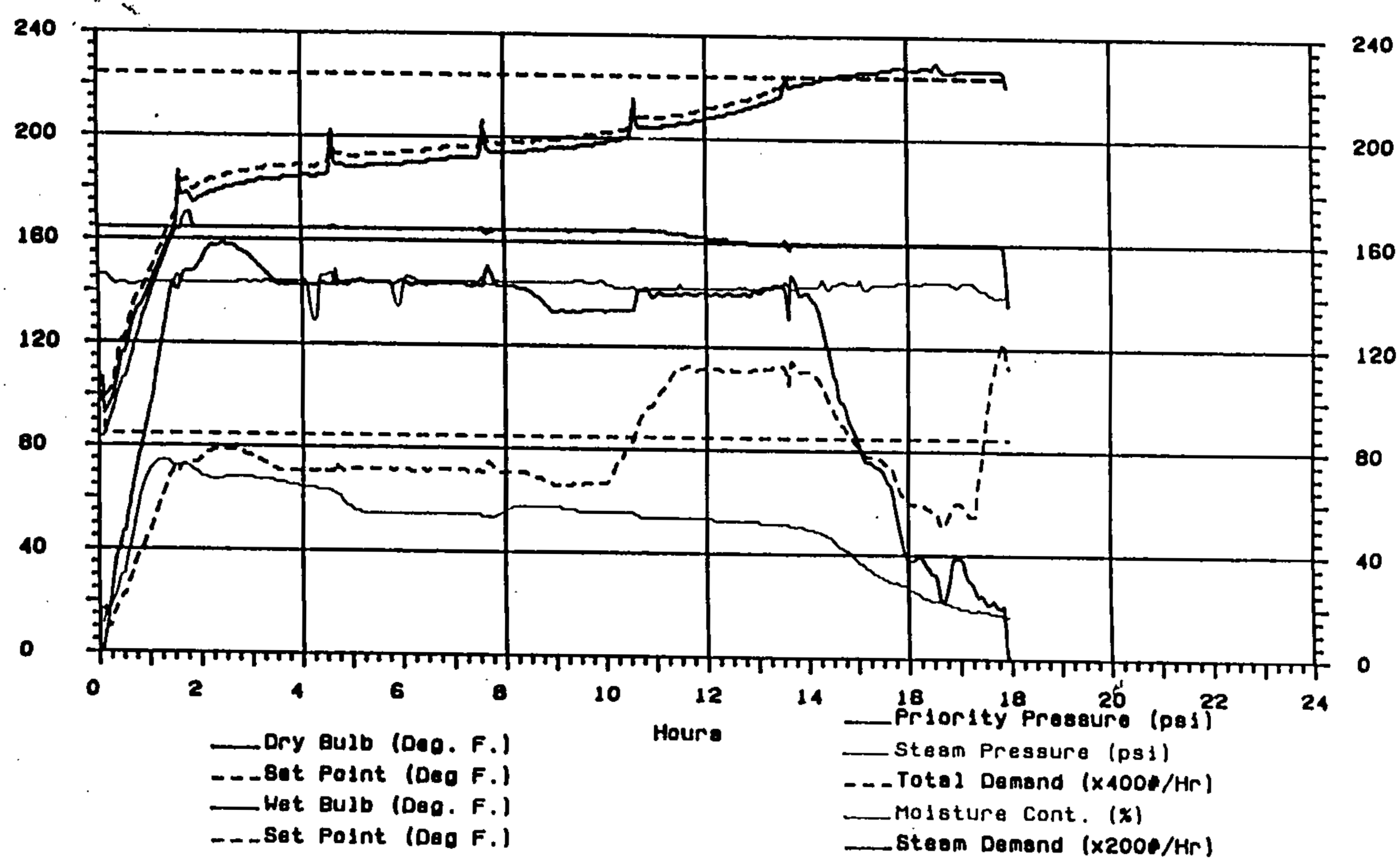
2 X 4 Lumber in Kiln:	151.1 MBF
2 X 6 Lumber in Kiln:	6.4 MBF
Total Lumber in Kiln:	157.5 MBF
Green lumber moisture content:	104 % dry basis
Dry lumber moisture content:	13 % dry basis
Drying time:	17.96 hrs
Average gas flow:	7278 DSCFM
Average gas water content:	35 Percent Vol.
Avg. VOC concentration:	1175 ppm as C
Avg. VOC emission rate:	15 lb C/hr
Avg. VOC emission rate:	1.71 lb C/MBF

APPENDIX D

KILN #2 OPERATING DATA

Weyerhaeuser Company Bruce

Kiln No. 2 Sch: 19 LOW WB/AUTO DB 2X4 * 05/05/93 * (BOB) # 21:05
Start Time: Wed May 05 21:05:26 1993 Finish Time: Thu May 06 15:03:08 1993
Auto Shutdown: MC 17.44 Mult 1.53 TDAL 11.40 Stm Usage 428,880



ROUGH-DRY LUMBER			AREA	
INVENTORY DATE			TAKEN BY	

DIM.	LGTH.		TOTAL LOADS	FACTOR
1X4	8			1408
	12			2112
	16			2816
2X4	8	1 - 4 - 2	7	1820
	10	1 -	1	2480
	12	4 - 3	7	2976
	14	3	3	3472
	16	4 - 4 - 2 - 3	13	3968
	18	3	3	4464
	20	4 - 4	8	4960
2X6	8			1820
	10			2480
	12	1	1	2976
	14	1	1	3472
	16			3968
	18			4464
	20			4960
2X8	8			1984
	10			2480
	12			2976
	14	Total MBF - 157.6.		3472
	16	157,572 Bdft		3968
	18			4464
	20			4960
2X10	8			2067
	10			2583
	12			3100
	14			3617
	16			4133
	18			4650
	20			5167
2X12	8			1984
	10			2480
	12			2976
	14			3472
	16			3968
	18			4464
	20			4960
JAGS				
TOTAL				

Weyerhaeuser Company
Wood Products
Industrial Engineering/Quality Control
Tacoma, Washington

MOISTURE CONTENT TALLY

Kiln No.	Date
Species	Grade
Length	Size

West Track

~~North end~~

% M.C.	Tally: East side of Pack					West side of pack					Number of Pieces	M.C. # of P
Under 4												
4												
5												
6												
7		~~[illegible]~~ South end										
8						⊕	South end					
9		//		/								
10	//	/	/	/	//							
11	//	/	/	/	///				/	//		
12		/	//	//			/	/		/		
13		/			/			/		//		
14	//		//	//	/	/	//	//	//	//		
15						///	/		/			
16							//	/	/			
17	/					/			/			
18	⊕							/				
19						/						
20	North end							/				
21												
22							North end					
23												
24												
25												
26												
27												
28												
29												
30												
Over 30												
Total												

Kiln Schedule

Hours	Dry Bulb, °F	Wet Bulb, °F

Average M.C. ________
% Overdry ________
% Wet ________

FORM LQC110 2/89 Printing Services [illegible]

Weyerhaeuser Company
Wood Products
Industrial Engineering/Quality Control
Tacoma, Washington

MOISTURE CONTENT TALLY

Kiln No. 2	Date
Species	Grade
Length	Size

EAST TRACK

East Side

West Side of Duct

% M.C.	Tally (~~Northend~~)					Tally (South end)					Number of Pieces	M.C. # of P
Under 4												
4												
5												
6												
7												
8								///	/	/		
9							/	/	//	//		
10						/		/	//	//		
11						/	//	/	/	/		
12				//		///	//					
13	/						/					
14	//		/		//	//				/		
15	//	/	///	//	//							
16			//		/							
17	//	///		//	/							
18		/	/									
19		/										
20												
21	North end											
22												
23												
24												
25												
26												
27												
28												
29												
30												
Over 30												
Total												

Kiln Schedule

Hours	Dry Bulb, °F	Wet Bulb, °F

Average M.C. ________
% Overdry ________
% Wet ________

FORM LOC110 2/89 Printing Services

SOUTHERN REGIONAL CENTER
P.O. Box 141020
Gainesville, FL 32614-1020
(904) 377-4708
FAX: (904) 371-6557

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

Original sent to MRI 1-17-95

January 6, 1995

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

Dear Dallas:

The purpose of this letter is to submit comments on the Revised Draft AP-42 Section 10.1 for Lumber and Wood Products Manufacturing and Woodworking Operations.

First, I would like to thank you for considering our comments submitted on March 18, 1994 and incorporating many of those comments into the revised draft. Additionally, you granted the extension we requested by letter of September 12, 1994, and we appreciate the extension. Because of the extension we have received 15 additional lumber kiln test reports, with the understanding that these 15 reports were also submitted to you individually by three different companies.

Our review of these lumber kiln test reports should coincide with your review. If we can help you or your contractor during the review period, please let us know.

Our comments on the revised draft are provided below under bold headings that match the headings in the draft document. General comments are also provided. All referenced letters are attached.

GENERAL COMMENTS

The recent draft AP-42 sections for oriented strandboard and medium density fiberboard have a section on "Emission Testing Issues." These same issues exist in regard to the sampling of emissions from lumber drying, and we believe this discussion should also be included in Section 10.1.

It appears that some of the information contained in the five test reports submitted by letter of March 18, 1994 has been misinterpreted. In one case I have been able to determine how the mistake was made and pointed this out by letter of September 12, 1994. For the other cases in which there is a discrepancy in my calculations and those of your contractor, I have not been able to determine a reason for the discrepancy. It appears that some of the problems may relate to conversion of VOC expressed as propane to VOC expressed as methane.

Below, under comments for Table 4-5, I have shown the differences in my calculations and those of the contractor. I am willing to do whatever is necessary to resolve these discrepancies. I would be glad to review your contractor's calculations or discuss them over the phone. Please let me know if I can help in this regard.

I have attached a recent article authored by R. W. Rice et al. regarding lumber kilns. The article was published in the *Forest Products Journal*, Volume 44, No. 7/8. I thought it might be of interest.

4. AP-42 SECTION DEVELOPMENT TABLE 4-5

As mentioned earlier, discrepancies exist in the calculations that I have made and those that provided the emission factors for this table. The table below provides the discrepancies.

REFERENCE	TYPE KILN	POLLUTANT	TABLE 4-5 FACTOR	NCASI CALCULATION
15	DF	TOC	1.71	5.07
15	SH	TOC	1.01	2.85
16	SH	TOC	2.91	3.91
17	SH	TOC	16.8	4.2
18	SH	TOC	2.35	2.16
17	SH	CO	0.109	0.027

Mistakes made in this table carry over to Tables 4-6, 4-7, 4-8 and the final Section 10.1 tables. Thus, all tables must be corrected.

Table 10.1-1 (Metric Units)

Factors are presented in this table in units of kg/Mg of lumber dried. An assumed wood density is used to convert from MBF to Mg. Rather than use an assumed wood density, it would be better to convert from the English unit of MBF to the metric unit of M^3, both of which have the dimension L^3. In doing this, an unnecessary (and probably controversial) assumption can be avoided.

As mentioned, the lumber drying emission factor for TOC is incorrect.

Table 10.1-2 (English Units)

The explanation in footnote "a" regarding units is confusing. It should be rewritten to clearly state which units are denoted by parentheses and which are not.

As with Table 10.1-1, an assumed density is used to convert from one unit to another. This creates confusion and introduces unnecessary error. A single emission factor for each category, in units of lb/MSF, would eliminate confusion, conform to the industry standard and avoid the use of an assumed density.

Footnote "j" should be amended to state "Emission concentration in units of lb per thousand cubic feet of air" to avoid confusion with lb/Mft^3 of material handled.

As mentioned, the lumber drying emission factor for TOC is incorrect.

Table 10.1-3 (Metric Units)

Factors are presented in this table in units of kg/Mg of lumber dried. An assumed wood density is used to convert from MBF to Mg. Rather than use an assumed wood density, it would be better to convert from the English unit of MBF to the metric unit of M^3, both of which have the dimension L^3. In doing this, an unnecessary (and probably controversial) assumption can be avoided.

The carbon monoxide emission factor for steam heated kilns appears to be incorrect (see the table on page 2).

Table 10.1-4 (English Units)

The explanation in footnote "a" regarding units is confusing. It should be rewritten to clearly state which units are denoted by parentheses and which are not.

As with Table 10.1-3, an assumed density is used to convert from one unit to another. This creates confusion and introduces unnecessary error. A single emission factor for each category, in units of lb/MSF, would eliminate confusion, conform to the industry standard and avoid the use of an assumed density.

The carbon monoxide emission factor for steam heated kilns appears to be incorrect (see the table on page 2).

Thanks for providing us the opportunity to comment on this revised draft. I again offer any assistance that I can in terms of resolving discrepancies or reviewing the new data. Please don't hesitate to call.

Sincerely,

David H. Word, Ph.D.
Research Engineer

DHW/sck

Attachments

cc: Rob Kaufmann
John Pinkerton
Larson Harsey
Mike Rast
Don Hejna
Tom Duckert
Peter Chen
Bill Swofford
Chuck Vaught
Rich Barrett
Karl Brohammer
Jerry Ethridge
Jim Boswell
Jim Evensen

SOUTHERN REGIONAL CENTER
P.O. Box 141020
Gainesville, FL 32614-1020
(904) 377-4708
FAX: (904) 371-6557

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

April 21, 1995

Mr. Richard J. Marinshaw
Senior Environmental Engineer
Midwest Research Institute
401 Harrison Oaks Boulevard, Suite 350
Cary, North Carolina 27513-2412

Dear Mr. Marinshaw:

Attached to this letter are: (1) a draft lumber kiln database, (2) a hastily edited set of instructions for the database, and (3) an attachment labeled "Comments" concerning the data you submitted.

Yesterday we mailed out a set of questions to each company that submitted data. We found several apparent calculation errors (as you did), and in some cases needed additional data or clarification. It will probably be at least a month before some of the data can be reconciled.

As we reviewed the reports, we also reviewed your Enclosure 3. The attachment labeled "Comments" discusses discrepancies in "our" results and "yours." I have made only a cursory review of the other two enclosures. I do plan on working through these more thoroughly and will provide additional comment in the near future.

I appreciate you sending me these data to review. Sorry it has taken so long. Please call if you have questions or comments. I can be reached at (904) 377-4708 x241.

Sincerely,

David H. Word, Ph.D.
Research Engineer

DHW/sck

Attachments

cc: Dallas Safriet
John Pinkerton

COMMENTS

(1) General

(a) Although not stated in the reports, lumber moisture contents in the 40-60% range are wet basis moisture contents. They can be converted to a dry basis by the following formula

$$\% MC_{dry} = \frac{\% MC_{wet} / 100}{1 - \left(\frac{\% MC_{wet}}{100} \right)}$$

(b) Assigning an emission data rating to these varied kiln tests is a somewhat formidable task. In general, the nicknamed "octopus" method received A ratings while representative vent sampling and F-factor calculated flow tests were rated B.

In my opinion, use of an F-factor is probably the best means of "measuring" flow from a direct-fired kiln. The accuracy of flow estimation is then related to the fuel rate measurement accuracy and perhaps the fuel Btu analysis. In most of these kilns, the return duct provides a very good location to measure gaseous pollutant concentration and CO_2 or O_2 (diluent). F-factors provide total flow and fugitive estimates are eliminated.

References 22-25 were rated B because only two vents (one per side) were tested. These kilns were tested very carefully with a lot of effort to eliminate fugitives and measure the total kiln flow. The kilns were sealed with sandbags and other measures until virtually all leaks were "plugged." Special measures were taken to insure that kiln vents were open only on the side being tested. Additionally, all vents were tested for relative flow rates. Two assumptions were made: (1) the kiln is well mixed and thus the concentrations are equal at all vents in a vent row, and (2) the relative flow, vent to vent, remains constant throughout the kiln cycle. In my opinion, these were very good kiln tests because the question of fugitive "quantity" was moot.

The "octopus" method measured kiln data were rated A because all stacks were tested. It is good that all stacks were measured, and assumption 1 mentioned in the above paragraph need not be made. But, total kiln flow was not measured (only what you refer to as process flow), and fugitives were estimated by an unproven technique (for this industry).

In my opinion, the "octopus" method is an innovative and good means of tackling a difficult problem, but just because all stacks are measured, it may not yield better results than the two previous methods discussed.

(2) Reference No. 4/25 - The TOC concentrations (ppm) are not as carbon but as propane. These should be multiplied by three or the footnote should be changed to reflect ppm as propane.

(3) Reference No. 4/22 - The TOC concentrations given are for TOC as propane.

The TOC lb/hr and lb/TBF data are as carbon.

(4) Reference No. 4/24 - The TOC concentrations (ppm) are not as carbon but as propane. These should be multiplied by three or the footnote should be changed to reflect ppm as propane.

(5) Reference No. 4/23 - The TOC concentrations (ppm) are not as carbon but as propane. These should be multiplied by three or the footnote should be changed to reflect ppm as propane.

(6) Reference No. 4/35 - Emission factors have been split into process and fugitive. I have used the F-factor flow rate on all emissions from this facility, thus none of the emissions data match.

(7) Reference No. 4/36 - NO_x and CO data do not match. It appears that the company contractor made some calculation errors. The NO_x and CO should be calculated from sampling report Table 1.1.

(8) Reference No. 4/38 - Our data match except fugitive emissions are not accounted for in database values.

(9) Reference No. 4/31 - Using flow rates and ppm values as provided in Table 1.1 of the report, we could not obtain the same final values as reported by the company (and MRI). Additionally, we did not include fugitives even though they were 90% or greater. We have written the company a letter requesting additional information and may eventually use fugitive plus process values since the process values are so low.

(10) Reference No. 4/30 - For the first cycle our calculations did not match those of the contractor for all continuously monitored pollutants. Our values were:

HTHC as Carbon	0.755 lb/MBF
CTHC as Carbon	0.618 lb/MBF
NO_x	0.191 lb/MBF
CO	0.084 lb/MBF.

We have written the company a letter and are requesting clarification.

(11) Reference No. 4/42 - The TOC value of 2.7 lb/TBF does not reconcile with concentration and flow data and appears to be in error. Additionally, flow and concentration data for the particulate matter components and acetone also provide different results from those given. We have written the company a letter requesting additional information and clarification.

(12) Reference No. 4/28 - Our data for this mill agree with yours except for the THC data. We were unable to calculate the same values found in the report for this pollutant. We have written the company a letter requesting additional information and clarification.

(13) Reference No. 4/27 - This is a draft report with insufficient data for a quality check. Should not be given an A rating since it is in draft form.

[redacted] Intended for "full" database. Modified to help you with the Draft Lumber Kiln Database. Please see hand editing.

NCASI WOOD PRODUCTS DATABASE -PRINTED VERSION

I DATABASE STRUCTURE

A. Introduction

It is important that the user understand the overall structure, table headings, codes, and purpose of each table, etc. of the database and how the various tables are related. A general overview will first be provided followed by a more detailed explanation of the individual tables.

Codes or abbreviations are explained in Appendix A. A glossary, which includes an explanation of column (field) headings, is in Appendix B. ~~Appendix C contains a table that provides file names and full table names as used in this text~~.

B. Overview of Structure and Table Links

The structure for the Wood Products Database is provided in Figure 1. Tables are grouped according to type or function and are joined or linked according to common codes.

The Reports Table, which contains stack gas parameters and other information, can be thought of as the heart of the database. It contains one record (row) for every sample run in the database. Each sample run has been assigned a run number, test code and unit code, the combination of which is (and must be) unique to the Reports Table. Each record (row) in the Reports Table has a corresponding record in one of the "B Tables." The two records are linked through common Test Code/Unit Code/Run Number combinations. The "B Tables" provide process information specific to the individual test run.

Similarly, each record in one of the Pollutant Tables can be linked to either the Reports Table or a "B Table" through its identifying Test Code/Unit Code/Run Number. However, there is not a one-to-one relationship between the records in the Reports Table and the records in the Pollutants Tables. There are two reasons for this: (1) multiple pollutants can be tested for in the same sample run; and (2) multiple methods can be used for the same pollutant in the same sample run. Thus, the Test Code/Unit Code/Run Number combination that represents a single sample run in the Reports Table can occur in more than one pollutant table and more than once in an individual pollutant table. Kiln-B Table

The "A Tables" contain information about the equipment being tested. Each individual unit (or combination of units) has a unique Unit Code. Since the equipment generally does not change from test to test, neither does the unit code. Thus, a single record in one of the "A Tables" describes the equipment for multiple records in the Reports Table, "B" Tables and Pollutant Tables (see Unit Codes below). Kiln-A Table

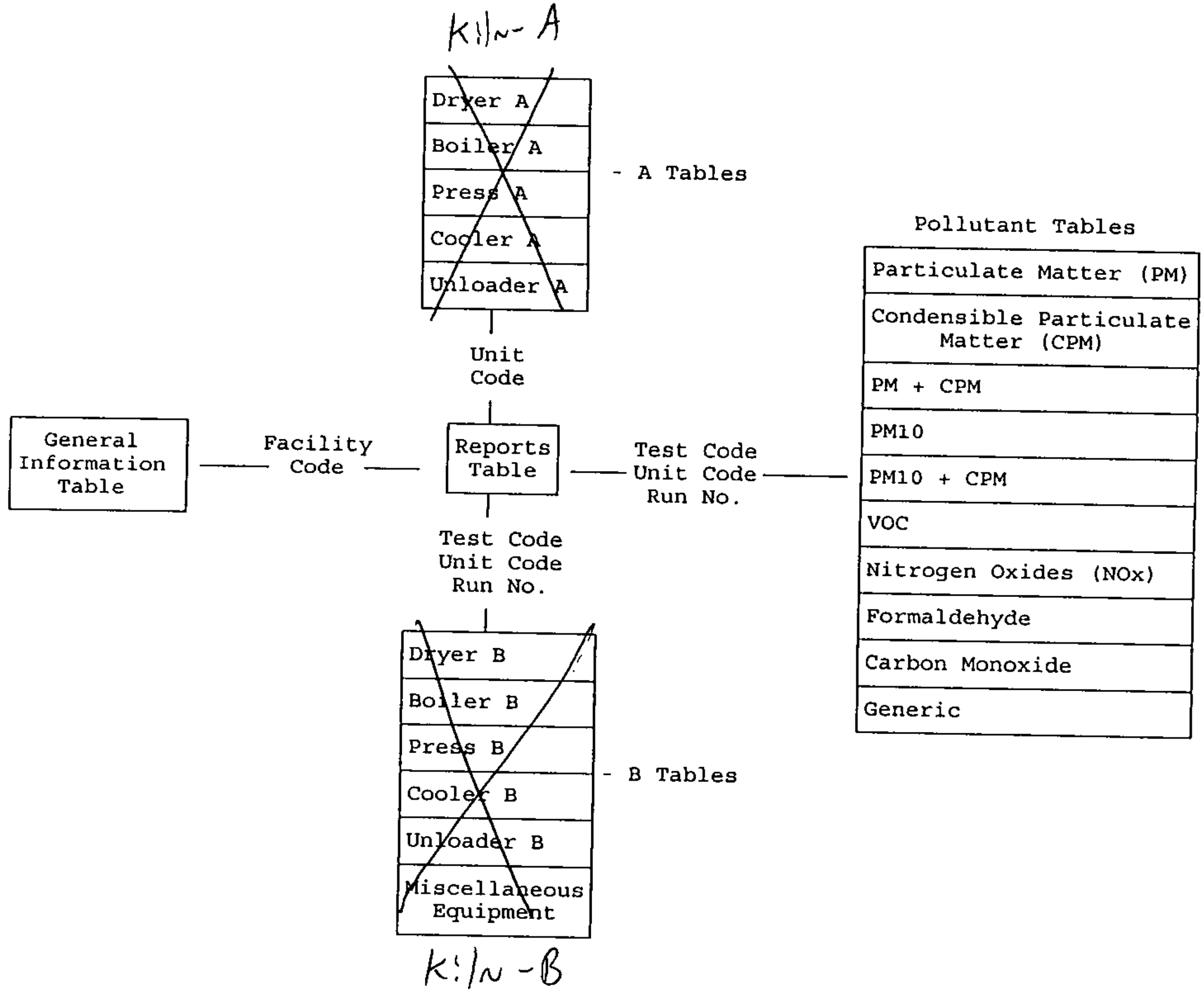


FIGURE 1 DATABASE STRUCTURE

The General Information Table contains information about the facility or mill such as product produced and tree species generally used. The General Information Table and the Reports Table are linked by a Facility Code. These two tables are the only tables containing this particular code. The major purpose of the General Information Table is to provide a means for sorting the database information by panel or product type.

C. Unit Codes, Test Codes and Facility Codes

(1) Facility Codes - Each mill that supplied information was assigned a Facility Code. The Facility Code is a three digit number that appears in the General Information Table and the Reports Table. The facility code also is part of each assigned Unit Code and Test Code.

(2) Unit Codes - Unit codes consist of an arbitrary first digit followed by a letter indicating a type of unit and a three digit facility code. If multiple units have a common stack, the first digit is replaced with an X, Y or Z. For example, a press might be assigned a unit code of 1P888 and two dryers venting to a common stack might have a unit code of XD888. The unit code letters and corresponding equipment types are provided in Table 1.

TABLE 1 IDENTIFYING LETTERS USED IN UNIT CODES

D	Dryer	A	Planer
P	Press	E	Screening
B	Boiler	F	Former
C	Cooler	I	Dust Bin or Silo
U	Unloader	M	Mill (hammermill)
K	Kiln	N	Pneumatic Conveyor
		R	Refiner
		S	Sander
		W	Saw
		Z	Miscellaneous

The assignment and use of Unit Codes can best be explained through an example:

> In 1988 facility 999 had two single pass dryers each with its own product cyclone and stack. It also had three new triple pass dryers that all vented to a common WESP and stack. In a 1993 modification, the two single pass dryers were connected to a single WESP. Stack test reports for this mill were submitted for 1989 and 1994. All dryers were tested.
>
> For the 1989 test report the two single pass dryers would be coded 1D999 and 2D999. The three triple pass dryers with the common stack would be given the single code XD999. For the 1994 test report the three triple pass dryers did not change and would keep their same unit code (XD999); but the two single pass dryers did change and therefore would be recoded as YD999 for the 1994 report. The old codes (1D999 and 2D999) would remain in the database (Dryer A table) since they are necessary to describe those dryers during the 1989 tests.

(3) Test Codes - Test codes consist of a three digit facility code followed by a six digit number representing the test date and a final letter used to separate test codes with similar dates.

To illustrate, the above example will be expanded. Dryer 1D999 and Dryers XD999 were tested for particulate matter on October 31, 1989. Furthermore, Dryers XD999 were also simultaneously tested for VOC and were simultaneously tested at both the inlet and the outlet of the WESP. Table 2 shows how this information would be coded for the Reports Table.

TABLE 2 EXAMPLE OF TEST CODE ASSIGNMENT

TEST CODE	UNIT CODE	RUN NO.	SAMPLE LOCATION	FLOW (dscfm)	POLL 1	POLL 2
999-103189A	1D999	1	OUT	31,000	PM	
999-103189A	1D999	2	OUT	31,500	PM	
999-103189B	XD999	1	IN	101,000	PM	VOC
999-103189B	XD999	2	IN	110,000	PM	VOC
999-103189C	XD999	1	OUT	102,000	PM	VOC
999-103189C	XD999	2	OUT	109,000	PM	VOC

Note that there are three different test codes - one for Dryer 1D999's test and one each for the inlet and outlet test on Dryers XD999. Note also that PM and VOC samples were given the same test code since these pollutants were sampled for simultaneously.

D. Tables

(1) Introduction - The master database contains 23 tables, 21 of which are in three functional groups: "A" Tables, "B" Tables and Pollutant Tables. An overview of the function of each group, and the two other tables, was provided in Section III B. In this section the purpose and use of each table or group of tables will be discussed in more detail.

(a) General Information Table - This table provides information on tree species generally used and the form in which the wood is received. The product column (field) is used to sort the database by panel type. The facility code provides a link to the Reports Table.

(b) Reports Table - This table is central to the database and contains all Test Code/Unit Code/Run Number combinations. The table contains basic stack gas parameters and a list of pollutants sampled for in each sample run. The Test Code/UnitCode/Run Number combination of this table will be the link to the "B" Tables and Pollutant Tables.

(c) Dryer A Table - This table provides a description of the dryers that were tested. Fields (columns) such as Firing Type and Pollution Control Device contain information (criteria) that can be used to sort the database. In this table the Type Fuel field refers to fuels the dryer is capable of using or the fuel typically used. To sort records by type of fuel burned during the emission tests, the Type Fuel field in the Dryer B Table should be used.

(d) Dryer B Table - This table provides information about dryer operation and other process parameters during the testing period. Criteria such as wood species, type fuel, wood moisture content and dryer temperature can be used to segregate the data.

(e) Press A Table - This table provides general information on the presses that were tested. None of the presses in the database had pollution control devices (PCD) installed, thus PCD information is not included.

(f) Press B Table - This table provides information about the operation of the presses during the testing period. Numerous criteria are available for sorting the data, but data are scarce in some of the fields.

(g) Cooler A/Cooler B Tables - These tables serve the same purpose as the Press A/Press B Tables but describe cooler, rather than press, operations.

(h) Miscellaneous Equipment Table - This table provides information on units other than presses, dryers, boilers, coolers and unloaders. Codes for the types of miscellaneous equipment are provided in Section III C (1). Pollution control devices and general parameters such as wood species and temperature are provided.

(i) Unloader A/Unloader B Tables - These tables serve the same purpose as the Press A/Press B tables but describe unloader rather than press operations. Note that generally the unloader was considered part of the press, and unloader emissions were not separated. In some cases, however, the unloader emissions were considered separate in the stack test report. In this case, the emissions were kept separate in the database and comments were provided to alert the user.

(j) Pollutant Tables - These tables provide pollutant emission rates generally in several different units. All pollutant tables are identical in structure so that they can be combined or segregated as needed (by computer). Nine of the ten pollutant tables are pollutant specific. One, the Generic Table, contains information on all other pollutants. VOC data were converted to a carbon basis if provided otherwise. Nitrogen oxide data are provided on a NO_2 basis. In a very few cases, insufficient information was provided to determine the basis, and a NO_2 basis was assumed.

APPENDIX A

CODE OR CRITERIA TABLES

APPENDIX A

CODE OR CRITERIA TABLES

The tables in this appendix provide codes or criteria for information contained in the database table fields (columns). These tables also provide explanations for the abbreviations used in the database tables. Field (column) headings are described in Appendix B.

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Wood Species Codes	A12

~~DRYER~~ Kiln FIRING TYPE CODES

CODE	DEFINITION
BOTH	Both Direct Fired and Indirect Heat
DFIRE	Direct Fired; Includes Suspension Burners, Gas Burners, Fuel Cells and Other Combustion Sources Whose Combustion Gases Directly Contact the Wood Furnish
IHEAT	Indirect Heat; Usually from Steam or Thermal Oil

~~DRYER HEAT~~ Hot Air SOURCE CODES

CODE	DEFINITION
BOTH	Both Direct Fired and Indirect Heat
DFIRE	Direct Fired; Includes Suspension Burners, Gas Burners, Fuel Cells and Other Combustion Sources Whose Combustion Gases Directly Contact the Wood Furnish
FLUE GAS	Combustion Unit Gases Directly Contact Furnish; Usually from a Fuel Cell
GAS B	Gas Burner
IHEAT	Indirect Heat; Usually from Steam or Thermal Oil
RFREQ	Radio Frequency
SUSP BU	Suspension Burner

DRYER TYPE CODES

CODE	DEFINITION
JET	Jet
LFLOW	Longitudinal Flow
PANEL	Panel
PLAT	Platen
RFREQ	Radio Frequency
RSP	Rotary Single Pass
RTP	Rotary Triple Pass
RU	Rotary Unspecified
TUBE	Tube Type

FUEL TYPE CODES

CODE	DEFINITION
MDF	MDF Scraps
DFINE	Dry Fines, Unspecified. May or May Not Contain Resin.
STEAM	Steam
TRIM	Trim
SDUST	Sanderdust
NGAS	Natural Gas
WREF	Wood Refuse or Wood Waste, Unspecified. May or May Not Contain Resin.
BARK	Bark
OIL	Oil
SAWD	Sawdust
FINES	Fines, Unspecified. May or May Not Contain Resin.
WDUST	Wood Dust, Unspecified. May or May Not Contain Resin.
BSG	Boiler Stack Gas

POLLUTANT CODES

CODE	DEFINITION
111-T-CH-E	1,1,1-Trichloroethane
124TMBENZ	1,2,4-Trimethyl Benzene
2-5-DMBENZ	2,5 Dimethyl Benzaldehyde
4-M-2-PENT	4-Methyl-2-Pentanone
44METDIAN	4,4 Methylene Dianiline
A-PINENE	Alpha Pinene
A-TERPENE	Alpha Terpeneol
ACETALD	Acetaldehyde
ACETONE	Acetone
ACETPH	Acetophenone
ACROLEIN	Acrolein
ACRYLNIT	Acrylonitrile
ALD/KET	Aldehydes/Ketones (Generally from Method 0011)
B-PINENE	Beta Pinene
BENZALD	Benzaldehyde
BENZENE	Benzene
BIPHENYL	Biphenyl
BIS-2EH-PH	Bis-(2-Ethylhexyl Phthalate)
BROMOMET	Bromomethane
BUTBENPHTH	Butylbenzyl Phthalate
BUTYLALDEH	Butylaldehyde
CARBDIS	Carbon Disulfide
CARBTETCHL	Carbon Tetrachloride
CHLOROFORM	Chloroform
CHLOROMET	Chloromethane
CO	Carbon Monoxide

POLLUTANT CODES (Cont'd)

CODE	DEFINITION
CO2	Carbon Dioxide
CPM	Condensible Particulate Matter, Back Half Only
CROTONALDE	Crotonaldehyde
D-N-BUT-PH	Di-N-Butyl Phthalate
DBM	Dibromomethane
DMS	Dimethyl Sulfide
ETYLBENZ	Ethyl Benzene
FOR	Formaldehyde
HAPS	"Catch All" Category, Generally Involves Testing for "Hazardous Air Pollutants"
HEXALD	Hexaldehyde
HYDROQUIN	Hydroquinone
ISOOCTANE	Isooctane
ISOVALALD	Isovaleraldehyde
M-P-XYLENE	m,p Xylene
M-TOLALD	m-Tolualdehyde
MDI	Methylene Bisphenyl Isocyanate
MEK	Methyl Ethyl Ketone
METH	Methane
METHENECHL	Methylene Chloride
N-BUTYRALD	N-Butyraldehyde
N-HEXANE	N-Hexane
NAPHTHALENE	Naphthalene
NITROBENZ	Nitrobenzene
NOX	Nitrogen Oxides
O-TOLALD	o-Tolualdehyde

POLLUTANT CODES (Cont'd)

CODE	DEFINITION
O-XYLENE	o-Xylene
P-CYMEME	p-Cymene
P-TOLALD	p-Tolualdehyde
PHENOL	Phenol
PM	Particulate Matter, Filterable Particulate, Front Half Only
PM10	PM1O, Particulate Matter less than 10 Microns
PM10&CPM	Particulate Matter less than 10 Microns, Includes Condensible Particulate Matter (Back Half)
PROPIONALD	Propionaldehyde
SO2	Sulfur Dioxide
STYRENE	Styrene
T-FL-METH	Trichlorofluoromethane
T1-4-DCBUT	Trans 1,4 Dichlorobutene
TOLUENE	Toluene
VALALD	Valeraldehyde
VINYLACET	Vinyl Acetate
VOC	Volatile Organic Compounds, Sometimes Called TOC or THC

POLLUTION CONTROL DEVICE CODES

CODE	DEFINITION
BIO	Biofilter
CYC	Cyclone
EFB	Electrified Filter Bed, Electrified Gravel Bed
ESP	Electrostatic Precipitator
FFIL	Fabric Filter or Baghouse
INC	Incinerator
MCLO	Multiclone
NONE	None, No Pollution Control Device
PBA	Packed Bed Absorber
RTO	Regenerative Thermal Oxidizer
SCRB	Scrubber
SF	Sand Filter
VSC	Venturi Scrubber
WESP	Wet Electrostatic Precipitator
WSCR	Wet Scrubber

PRODUCT CODES

CODE	DEFINITION
FS	Fiberboard Sheathing
HB	Hardboard
LU	Lumber
MDF	Medium Density Fiberboard
OSB	Oriented Strandboard (for Database, Includes Waferboard
PB	Particleboard
PLY-H	Hardwood Plywood
PLY-S	Softwood Plywood
RIB	Roof Insulation Board

RESIN TYPE CODES

CODE	DEFINITION
LIQUID PF	Liquid Phenol-Formaldehyde
MDI	MDI
PF	Phenol-Formaldehyde
SEE COMM	Used to Refer User to Comments Section of Table
UF	Urea-Formaldehyde

STACK TEST METHOD CODES

CODE	DEFINITION
?	Unknown, Method Not Provided in Submittal
G5T	Georgia 5T (Similar to ODEQ-7)
M0010	SW-846 Method 0010, Often Termed Semi-VOST or MM5
M0011	BIF Method 0011, for Aldehydes and Ketones, 40 CFR 266 Appendix IX
M0030	SW-846 Method 0030, Termed VOST, Volatile Organic Sampling Train
M1	EPA Method 1
M10	EPA Method 10
M10B	EPA Method 10B
M18	EPA Method 18
M2	EPA Method 2
M201/201A	Modification of Method 201A
M201/202	EPA Methods 201 and 202, PM10 Front and Back Half
M201A	EPA Method 201A
M201A/202	EPA Methods 201A and 202, PM 10 Front and Back Half
M201A/OD7	EPA Method 201A with ODEQ 7 Back Half
M202	EPA Method 202
M25	EPA Method 25
M25A	EPA Method 25A
M25M	Modification of Method 25A
M3	EPA Method 3
M4	EPA Method 4
M5	EPA Method 5
M5/202	EPA Methods 5 and 202, Front and Back Half

STACK TEST METHOD CODES (Cont'd)

CODE	DEFINITION
M5/OD7	EPA Method 5 with ODEQ Method 7 Back Half
M5A	EPA Method 5A - Back Half
M5X	EPA Method 5 Type Train with NaOH in the Impingers
M6	EPA Method 6
M604	Method 604 (Phenol)
M7C	EPA Method 7C
M7E	EPA Method 7E
MGC	A Gas Chromatographic Method, Unspecified
MM0011	Modified BIF Method 0011
MM5	A Modification of Method 5
MN3500	Modified NIOSH 3500
N347	NIOSH P&CAM 347
N3500	NIOSH Method 3500
NM1501	NIOSH Method 1501
OD5	ODEQ 5
OD7	ODEQ 7
OD8	ODEQ 8
P&CAM125	P&CAM 125
TO-11	TO-11 (Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air)
TO-5	TO-5 (Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air)
TO-8	TO-8 (Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air)

WOOD MATERIALS FORM CODES

CODE	DEFINITION
CHP	Chips
DCHP	Debarked Chips
FIBR	Fiber
LOG	Logs
LUMB	Lumber
PSHAV	Planar Shavings
SAWD	Sawdust
SF	Strands or Flakes
SHAV	Shavings
SKERF	Saw Kerf
TRIM	Trim
VENE	Veneer
WTC	Whole Tree Chips

WOOD SPECIES CODES

CODE	DEFINITION
ASPEN	Aspen
DFIR	Douglas Fir
GUM	Gum
HWOOD	Unspecified Hardwood
LARCH	Larch
LOB P	Loblolly Pine
LODGE P	Lodgepole Pine
MAPLE	Maple
OAK	Oak
PINE SP	Unknown Pine Species (Specific Information Not Provided)
POND P	Ponderosa Pine
POPLAR	Poplar
REDW	Redwood
SPRUCE	Spruce
SWOOD	Unspecified Softwood
SY PINE	Southern Yellow Pine (Mixed or Unspecified Southern Pines)
UFIR	Unspecified Fir
UWOOD	Wood from Urban Recycling Plant
WFIR	White Fir
HEM	Hemlock

APPENDIX B

GLOSSARY AND COLUMN HEADINGS

APPENDIX B

GLOSSARY AND COLUMN HEADINGS

This appendix provides explanations for field (column) headings. Since separate headings had to be made for dBase versions of the database, dual heading names are shown for some definitions. A few definitions are also included.

APPENDIX B

GLOSSARY AND COLUMN HEADINGS

% Free Formaldehyde [X_Free For] - Best defined as percent free formaldehyde as determined by Wood Adhesives Manufacturers Technical Association (WAMTA) Methods 10.1 and 11.1.

% Fuel [X_Fuel] - Provides information on the percentage of total heat input supplied by the fuel (specified in the column to the left).

% HAS [X_HAS] - The percentage of heat input supplied by the source specified in the column to the left.

% Heat Input Fuel (1-3) [X_Heat_I] - Provides the percentage of the total heat input supplied by the specific fuel (specified in the column to the left).

% Species (% Sp.1-3) [X_Species] - The approximate percentage of each wood species referred to in the previous column.

Air Flows - Provides a "Y" or "N" answer to the question, "Is information available from the survey forms on typical air flows from the vents?"

Allow Sup. Testing [Allow_Sup] - A "Y" or "N" answer is provided to the question, "Would the company allow supplemental testing at this facility?"

Amount Fuel - Provides information on the amount of fuel (specified in the column to the left) that was combusted. Units are not consistent and are specified within the column.

Any Air Emis. Burned? [Air_Em_Brn] - A "Y" or "N" answer is provided to the question, "Are any air emissions from any process burned in this unit?"

Any Catalyst or Scavenger? [Any_Cat_Sc] - A "Y" or "N" answer is provided to answer the question, "Are any catalysts or scavengers used?"

Application Rate [Applc_Rat] - The rate at which the adhesive (specified in the column to the left) is applied. Units are inconsistent and specified within the column.

Attached Sketch [Attach_Skt] - provides a "Y" or "N" answer to the question, "Is a sketch provided in the report to illustrate (normally the unit and control device configuration)?"

Board Density [Bd Density] (lb/ft^3) - The density of the panel being pressed during the testing period.

Board Exit Temperature [Bd_Ext_Tem] - Temperature of board coming out of the unloader.

Boiler Type - General type or configuration of combustion unit or boiler. Code definitions are provided in Appendix A.

Burner Capacity [Burner_Cap] - Capacity of the dryer burner in MMBtu/hr.

CO2 (%) - The percent carbon dioxide present in the stack gas at the sampling point.

Core and Surface Different? [Cor_Sur_Df] - A "Y" or "N" answer is provided to answer the question, "Is the resin type and application rate different for the core and surface layers?"

Core, Surface, or Both [Core_Sur_B] - A "C", "S", or "B" answer is provided to the question, "Is the dryer producing material for the core of the panel, the surface of the panel, or both?"

Dryer Capacity - Information is shown as provided in mixed units. In some cases units were not provided. A strict definition of capacity was not given in the survey, therefore the basis for the given capacities is unknown (nameplate, maximum, etc.).

Dryer Type - General type or configuration of the dryer. Code definitions are provided in Appendix A.

Fac Code - Facility Code. Three digit code assigned to each mill. The facility code is part of all test codes and unit codes associated with the specific mill.

Field - Database lingo for a column in a table.

Final PCD - Final Pollution Control Device. If only one control device exists, it is coded as a Final PCD. If two exist, they are coded as Initial and Final PCDs. If a series of three PCDs exists; Initial, Intermediate, and Final PCD columns are all used. Code definitions are provided in Appendix A.

Firing Rate - The rate at which the specific fuel (specified in the column to the left) was fired during the testing period. Units are inconsistent and provided within the column.

Firing Type - Provides broad categories for the means by which a dryer is heated. Code definitions are provided in Appendix A.

Form - Wood Material Form as it enters the dryer (see Appendix A for codes).

Form FP - Form of wood material as used to make the final product (see Appendix A for codes).

Formaldehyde Mole Ratio [Form_ML_RT] - The mole ratio of formaldehyde to urea or phenol.

gr/dscf - grains per dry standard cubic feet.

Heat Input Capacity - Capacity as rated in Million Btu/hr heat input. A strict definition of capacity was not given in the survey, therefore the basis for the given capacities is unknown (nameplate, maximum, etc.).

Heat Value - The amount of heat available per unit weight of the fuel (specified in the column to the left).

Hold Time (min) - Provides information on the number of minutes a board was in the cooler.

Hot Air Source [Hot_Air] - Similar to Firing Type column in the Dryer A Table, but with more detail. For most purposes, the Firing Type column in Table A will provide a more convenient means of segregating the data. The codes for this column (field) can be used when more detail is needed. Code definitions are provided in Appendix A.

Initial PCD - Initial Pollution Control Device. If only one control device exists, it is coded as a Final PCD. If two exist, they are coded as Initial and Final PCDs. If a series of three PCDs exists; Initial, Intermediate, and Final PCD columns are all used. Code definitions are provided in Appendix A.

Inlet Moisture (% OD) - Provides information on the percent moisture of the wood feed at the process unit inlet, on an oven dry basis.

Inlet Temperature (F) - Provides information on the temperature, in Fahrenheit, at the inlet of the dryer.

Intermediate PCD - Intermediate Pollution Control Device. If only one control device exists, it is coded as a Final PCD. If two exist, they are coded as Initial and Final PCDs. If a series of three PCDs exists; Initial, Intermediate, and Final PCD columns are all used. Code definitions are provided in Appendix A.

lb/hr - pounds per hour.

lb/MMBtu - pounds of pollutant per million Btus of heat input.

lb/MSF ¾ - pounds of pollutant per thousand square feet of panel produced at a nominal thickness of 3/4 inch.

lb/MSF ⅜ - pounds of pollutant per thousand square feet of panel produced at a nominal thickness of 3/8 inch.

lb/ODT - pounds of pollutant per oven dry ton of wood material processed through the unit.

Method - Measurement method, stack test method or source sampling method. Code definitions are provided in Appendix A.

MMBtu/hr - Million Btus per hour heat input.

Modelling? - Provides a "Y" or "N" answer to the question, "Has computer modelling been conducted at the facility?"

Moisture (%) - The percent of moisture in the fuel at which the heat value was rated. Moisture basis unspecified.

Moisture Content [Mois_Cont] (%) - The moisture content of the wood material prior to entering the press. Moisture basis unspecified.

Nominal Thickness [Nmnal_Thck] (inches) - Provides information on the thickness of panel pressed during the testing period.

Number of Decks - For veneer dryers, provides information on the number of decks in the dryer.

Number of (Press) Vents [No_Vents] - Provides information on the number of vents or stacks through which the press, cooler, or unloader releases emissions to the atmosphere.

Number of Sectors - For veneer dryers, provides information on the number of sectors in the dryer.

Number of Zones - For veneer dryers, provides information on the number of zones in the dryer.

O2 (%) - The percent oxygen present in the stack gas at the sampling point.

ODTH - Oven dry tons per hour.

One to One? - A "Y" or "N" answer is provided to the question, "Is there one unit and one stack?" If the column contains a "Y" (for yes), conversion from a pollutant-mass-rate to a production-based-pollutant-rate was generally straightforward. If the column contains an "N," the conversion <u>may</u> not have been straightforward and assumptions <u>may</u> have been made. The user should check the comments column for information on assumptions.

Other Additives? [Othr_Addit] - A "Y" or "N" answer is provided to the question, "Are additives other than wax, catalysts, and scavengers used?"

Outlet Moisture (% OD) - Provides information on the percent moisture of the wood material at the process unit outlet, on an oven dry basis.

Outlet Temperature (F) - Provides information on the temperature, in Fahrenheit, at the outlet of the dryer.

PCD Parameters - Provides a "Y" or "N" answer to the question, "Is information supplied in the report on pollution control device parameters?"

Planned Pollutant [Plan_Poll] - Provides information on the pollutants for which that facility intends to conduct testing.

Pollutant - Compound or group of compounds for which the test(s) were conducted. Code definitions are provided in Appendix A.

ppm - parts per million.

PR_MSF_3_4 - Production rate in thousands of board square feet at 3/4 inch per hour basis.

PR_MSF_3_8 - Production rate in thousands of board square feet at 3/8 inch per hour basis.

PR_ODTH - Production rate in oven dried tons per hour.

PR_Other - Production rate defined in the column.

Press Cycle Time [Pr_Cyc_Tme] (min.) - Provides the time, in minutes, for which the panels were pressed during the testing period.

Press Temperature (F) - Press operating temperature, in Fahrenheit, during the testing period.

Product - Panel type produced. Code definitions are provided in Appendix A.

Production Rate - The production rate of the tested equipment as provided in report, on survey forms or as calculated. If (Units) are shown, the data provided in the column have inconsistent units and the unit is provided. Otherwise the units are specified. Unit explanations are included in this glossary.

Prop. Line - Provides a "Y" or "N" answer to the question, "Has property line sampling been conducted at the facility?"

Q/C? [Q_C] - A "Y" or "N" answer is provided to the question, "Is there a quench or cooling section for the dryer exhaust?"

Query - Database lingo for a structured question to be "answered" by the database.

Ques 5-9? - Provides a "Y" or "N" answer to the question, "Were question 5-9 answered on the survey form?"

Ques. 6,7,8,9,10 - Provides a "Y" or "N" answer to the question, "Were questions 6-10 answered on the survey form?"

Raw Wood Mat'l - Raw Wood Material. The form in which the mill receives its wood. Code definitions are provided in Appendix A.

Record - Database lingo for a row of information in a table.

Recycled? - A "Y" or "N" answer is provided to the question, "Is any of the exhaust from the dryer recycled back into the burner or dryer?"

Run - The assigned sample run number.

Sam. Loc. - Sample Location. Provides information on the sample location relative to a control device. IN indicates inlet to the control device. OUT indicates outlet from a control device as well as outlet to the atmosphere (for those cases in which a control device does not exist).

Size and Openings (Size) - Provides a description of the press area in feet and information on the number of openings. For example, 10 x 25 5 openings describes a press that is 10 feet wide, 25 feet long and has 5 openings.

Sur and Core DIFF [Sur_Cor_DI] - A "Y" or "N" answer is provided to the question, "Is the wood species mix different for the surface and core panel layers?"

Source Heated (1-4) [Srce_Heat] - Provides information on the process equipment that is heated by the boiler or combustion unit.

Stack Flow (dscfm) - The air flow rate at the sampling point, provided in the unit of dry standard cubic feet per minute.

Stack Moisture (%) - The percent moisture (by volume) at the sample point.

Stack Temperature (F) - The temperature in Fahrenheit at the sample point.

Steam Capacity (lb/hr) - For boilers, their capacity as rated in steam production. A strict definition of capacity was not given in the survey, therefore the basis for the given capacities is unknown (nameplate, maximum, etc.).

Steam Pressure - Provides information on the boilers steam pressure. Units provided within the column.

Steam Temperature - Provides information on the boilers steam temperature. Units provided within the column.

Test Code - Please see Section III C. (3).

Time? - Provides information on the amount of time the wood materials were stored prior to drying.

Type Adhesive [Type_Adhs] - The type of resin or adhesive used during the testing period. Code definitions are provided in Appendix A.

Type Board - Same as product. See codes in Appendix A.

Type Fuel - Type of fuel burned by the particular unit. "A" Tables provide capabilities and general usage, "B" Tables provide specific run-by-run fuel information. Code definitions are provided in Appendix A.

Unit Code - Please see Section III C. (2).

Wax Application Rate [Wax_App_Rt] - The rate at which wax was applied. Units are inconsistent and specified within the column.

Wood Species - The type of wood used. The General Information table indicates wood type generally used at the mill. Run-by-run specific wood use is provided in the "B" tables. Code definitions are provided in Appendix A.

Zone Temperature (F) - For veneer dryers, the temperature in Fahrenheit of the specific dryer zone.

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LUMBER KILN DATABASE

General Information Table

Facility Code	Product	Wood Species 1	Wood Species 2	Comments?
23	LUMBER	SY PINE		
25	LUMBER	SY PINE		
26	LUMBER	SY PINE		Assume SY PINE.
31	LUMBER	SY PINE		Assume SY PINE.
33	LUMBER	SY PINE		Assume SY PINE.
35	LUMBER	SY PINE		
36	LUMBER	SY PINE		Assume SY PINE.
37	LUMBER	SY PINE		
40	LUMBER	SY PINE		Assume SY PINE.
46	LUMBER	SY PINE		Assume SY PINE.
47	LUMBER	JPINE	REDPINE	
50	LUMBER	SY PINE		
51	LUMBER	SY PINE		Assume SY PINE.
98	LUMBER	SY PINE		
129	LUMBER	SY PINE		
164	LUMBER	SY PINE		
180	LUMBER	SY PINE		Assume SY PINE.
181	LUMBER	SY PINE		
190	LUMBER	UFIR	SPRUCE	
193	LUMBER	SY PINE		Assume SY PINE.

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Reports Table - see below for heading explanations

Test Code	Unit Code	Run	Facility Code	One to One?	Stack Flow (dscfm)	Stack Temp. (F)	Stack Moisture (%)	Pollutant 1	Pollutant 2	Pollutant 3	Pollutant 4	Pollutant 5	Pollutant 6	Pollutant 7	Pollutant 8	Comments
023-091494A	1K023	1	23	N	7787	208	45	VOC								Representative vent method of measuring flow; very little fugitives.
023-091594A	1K023	1	23	N	7110	207	49	VOC								Representative vent method of measuring flow; very little fugitives.
023-091694A	1K023	1	23	N	7228	205	46	VOC								Representative vent method of measuring flow; very little fugitives.
025-011995A	1K025	1	25	N	5550		41	VOC	NOX	CO						F factor method of calculating flow.
026-091494A	1K026	1	26	N	10672	197	30	PM								Assume had 1 stack per vent row.
026-091494A	1K026	2	26	N	10862	216	29	PM								Assume had 1 stack per vent row.
026-091494A	1K026	3	26	N	4510	216	29	PM								Assume had 1 stack per vent row.
026-091594A	1K026	1	26	N	8471	205	32	VOC								Flow estimated, not time weighed but simple average.
031-071494A	1K031	1	31	N	3830			CO	NOX	VOC	PM	CPM	PM&CPM	METHANO	ALD/KET	Report confusing. No process data. Inconsistent calculations. Four flow methods used. Flow reported is F factor flow.
033-102694A	1K033	1	33	N	7820	215	37	PM	VOC	ALD/KET	CPM	PM&CPM	FOR	METHANO		Octopus Method with F factor comparison. F factor approximately 13% lower. Fugitives not estimated.
035-051794A	1K035	1	35	Y	18229	161	9	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051794A	1K035	2	35	Y	17379	138	16	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051794A	1K035	3	35	Y	16579	120	26	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051894A	1K035	1	35	Y	14245	166	32	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051894A	1K035	2	35	Y	17641	151	24	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051894A	1K035	3	35	Y	14834	163	29	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051994A	1K035	1	35	Y	16604	146	22	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051994A	1K035	2	35	Y	15637	158	26	PM	CPM	PM&CPM	VOC					Only 1 stack.
035-051994A	1K035	3	35	Y	14801	166	31	PM	CPM	PM&CPM	VOC					Only 1 stack.
036-020294A	1K036	1	36	N	7585	212	30	VOC	NOX	CO						Representative vent method of measuring flow; very little fugitives. Particle size data available in report. SO2 below detection limits.
036-020294B	1K036	1	36	N	7439	224	29	PM	CPM	PM&CPM						Representative vent method of measuring flow; very little fugitives. Particle size data available in report. SO2 below detection limits.
036-020394A	1K036	1	36	N	7960	212	30	VOC	NOX	CO						Representative vent method of measuring flow; very little fugitives. Particle size data available in report. SO2 below detection limits.
036-020394B	1K036	1	36	N	7394	226	28	PM	CPM	PM&CPM						Representative vent method of measuring flow; very little fugitives. Particle size data available in report. SO2 below detection limits.
036-020494A	1K036	1	36	N	7500	212	30	VOC	NOX	CO						Representative vent method of measuring flow; very little fugitives. Particle size data available in report. SO2 below detection limits.
036-020494B	1K036	1	36	N	7524	220	29	PM	CPM	PM&CPM						Representative vent method of measuring flow; very little fugitives. Particle size data available in report. SO2 below detection limits.
037-060894A	2K037	1	37	N	6000		20	VOC								F-factor method.
037-061094A	1K037	1	37	N				VOC								No flow measured. Flow estimated by water loss for lumber and moisture measurements.
040-031694A	1K040	1	40		1467	169	48	PM	CPM	PM&CPM	FOR	ALD/KEY	PHENOL	VOC	VOC	Hexald and Phenol below detection limits.
040-031694A	1K040	2	40		1800	182	38	PM	CPM	PM&CPM	FOR	ALD/KEY	PHENOL	VOC	VOC	
040-031694A	1K040	3	40		1377	167	38	PM	CPM	PM&CPM	FOR	ALD/KEY	PHENOL	VOC	VOC	
040-031694B	1K040	1	40					VOC	VOC							Do not have, total Kiln flow, average moisture and average temp data.
046-072294A	1K046	1	46	N				VOC								DSCFM moisture and temperature not provided. Cannot check emissions calculations. Octopus method compared to representative vent method. Not enough data provided. No Kiln charge provided..Draft report. No fugitive emissions estimate.
047-081294A	1K047	1	47	Y	6300	131	17	VOC								Flow is best estimate from a straight average, not time weighted average. Vent-X-Changer Kiln.
047-081294B	2K047	1	47	Y	8400	140	22	VOC								Flow is best estimate from a straight average, not time weighted average. Vent-X-Changer Kiln.
050-042094A	1K050	1	50	N	7040	203	40	VOC								Representative vent method of measuring flow; very little fugitives.
050-042194A	1K050	1	50	N	7280	218	37	VOC								Representative vent method of measuring flow; very little fugitives.
050-042394A	1K050	1	50	N	7600	212	39	VOC								Representative vent method of measuring flow; very little fugitives.
051-020794A	1K051	1	51	N	7115	198		VOC	NOX	CO	PM	CPM	PM&CPM			F factor flow rate.
051-020794A	1K051	2	51	N	7023	208		VOC	NOX	CO	PM	CPM	PM&CPM			F factor flow rate.
051-020794A	1K051	3	51	N	5700	220		VOC	NOX	CO	PM	CPM	PM&CPM			F factor flow rate.
051-020794B	1K051	1	51	N	6613			VOC	NOX	CO						F-factor method for flow rate.
098-022394A	1K098	1	98	N		232		VOC	VOC	NOX	CO					Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; representative vent test method; fugitives not accounted for; dry bulb set point: 240 F.

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One to One? - If "Y" a one-to-one relationship exist between the stack and the kiln (one kiln, one stack)
Stack Flow (dscfm) - For kilns, this generally is total kiln flow rate in dry standard cubic feet per minute
Stack Temp. and Moisture - If possible, the temperature and moisture at a vent outlet or stack for single stack kilns.

Reports Table - see below for heading explanations

Test Code	Unit Code	Run	Facility Code	One to One?	Stack Flow (dscfm)	Stack Temp. (F)	Stack Moisture (%)	Pollutant 1	Pollutant 2	Pollutant 3	Pollutant 4	Pollutant 5	Pollutant 6	Pollutant 7	Pollutant 8	Comments
098-022394B	1K098	1	98	N	9000	224	36	PM	CPM	PM&CPM	FOR	PHENOL				Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022394B	1K098	2	98	N	9000	222	30	PM	CPM	PM&CPM	FOR	PHENOL				Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022394B	1K098	3	98	N	9000	251	21	PM	CPM	PM&CPM	FOR	PHENOL				Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494A	2K098	1	98	N		215		VOC	VOC	NOX	CO					Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; representative vent test method; Fugitives not accounted for; dry bulb set point: 240 F.
098-022494B	2K098	1	98	N	7650	205	39	PM	CPM	PM&CPM						Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494B	2K098	2	98	N	7650	208	40	PM	CPM	PM&CPM						Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494B	2K098	3	98	N	7650	221	28	PM	CPM	PM&CPM						Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494C	2K098	1	98	N	8370	206	40	FOR	PHENOL							Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494C	2K098	2	98	N	8370	222	28	FOR	PHENOL							Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494C	2K098	3	98	N	8370	216	28	FOR	PHENOL							Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494D	2K098	1	98	N		215		VOC	NOX	CO						Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; representative vent test method; Fugitives not accounted for; dry bulb set point: 240 F.
098-090194A	2K098	1	98	N	3120			VOC	VOC	CO	NOX					
098-090194B	2K098	1	98	N	3120			VOC	VOC	CO	NOX					Data for gasifier only; does not represent kiln.
098-090294A	2K098	1	98	N	2987			VOC	VOC	CO	NOX					
098-090294B	2K098	1	98	N	2987			VOC	VOC	CO	NOX					Data for gasifier only; does not represent kiln.
098-090294C	2K098	1	98		3118	222.2	50	PM	CPM	PM&CPM						
098-090294C	2K098	2	98		3127	216.6	49	PM	CPM	PM&CPM						
098-090294C	2K098	3	98		2908	237.3	38	PM	CPM	PM&CPM						
098-090294D	2K098	1	98	N	7867	1032	22	PM	CPM	PM&CPM						This test code is for gasifier or burner data. Not for kiln data. See 098-090294C for kiln data.
098-090294D	2K098	2	98	N	8648	903	19	PM	CPM	PM&CPM						This test code is for gasifier or burner data. Not for kiln data. See 098-090294C for kiln data.
098-090294D	2K098	3	98	N	8599	964	21	PM	CPM	PM&CPM						This test code is for gasifier or burner data. Not for kiln data. See 098-090294C for kiln data.
129-092294A	1K129	1	129	N	1587	207	37	VOC	VOC							
164-062894A	1K164	1	164	Y	3101	140	9	VOC	VOC	FOR	ALD/KEY	CPM	PM&CPM			Vent-X-Changer Kiln with one stack. VOC data associated with this test code do not represent full Kiln cycle but are provided because the data are concurrent with the other pollutants. Full cycle VOC data can be found in Test Code 164-062894B.
164-062894A	1K164	2	164	Y	2329	142	25	VOC	VOC	FOR	ALD/KEY	CPM	PM&CPM			Vent-X-Changer Kiln with one stack. VOC data associated with this test code do not represent full Kiln cycle but are provided because the data are concurrent with the other pollutants. Full cycle VOC data can be found in Test Code 164-062894B.
164-062894A	1K164	3	164	Y	2134	151	30	VOC	VOC	FOR	ALD/KEY	CPM	PM&CPM			Vent-X-Changer Kiln with one stack. VOC data associated with this test code do not represent full Kiln cycle but are provided because the data are concurrent with the other pollutants. Full cycle VOC data can be found in Test Code 164-062894B.
164-062894B	1K164	1	164	Y	2538	150	26	VOC	VOC							Data represents VOC from full 23 hour Kiln cycle. Vent-X-Changer Kiln with one stack.
180-072694A	1K180	1	180	N	1780		37	VOC	VOC							Tracer gas indicates 8% Fugitives (not accounted for).
180-072894A	2K180	1	180	N	852		12	VOC	CO	NOX						Tracer gas indicates 79.5% Fugitives (not accounted for). Preliminary data indicates traces does not work on direct fired sources.
180-080194A	1K180	1	180	N	1235			VOC								Tracer gas indicates 52% Fugitives (not accounted for).
181-092794A	1K181	1	181	N	7262	214	33	VOC	NOX	CO						
181-092794B	1K181	1	181	N	6974	223	44	PM								
181-092794B	1K181	2	181	N	7200	220	40	PM								
181-092894A	1K181	1	181	N	7291	213	35	VOC	NOX	CO						
181-092894B	1K181	1	181	N	7109	224	45	PM								
181-092894B	1K181	2	181	N	7522	221	42	PM								
181-092894B	1K181	3	181	N	7157	225	39	PM								
181-092994A	1K181	1	181	N	7478	210	34	VOC	NOX	CO						
190-101194A	1K190	1	190	N	954		34	VOC	VOC							Tracer gas indicates 95% fugitives (not accounted for); emissions values are as given in report. Values do not check. Appears to be error in reported emission levels.
190-101294A	1K190	1	190	N	1043		33	VOC	VOC							Tracer gas indicates 89.5% fugitives (not acounted for); emissions values are as given in report. Values do not check. Appears to be error in reported emission levels.
193-092894A	1K193	1	193	N	1225	249.4	42	PM	CPM	PM&CPM	FOR	ACETALD	HEXALD	ACETONE	MEK	
193-092894A	1K193	2	193	N	1225	218.4	32	PM	CPM	PM&CPM	FOR	ACETALD	HEXALD	ACETONE	MEK	
193-092894A	1K193	3	193	N	1225	183.5	24	PM	CPM	PM&CPM	FOR	ACETALD	HEXALD	ACETONE	MEK	
193-092894B	1K193	1	193	N	1225			VOC	VOC	CO	NOX					Reported values do not match NCASI calculations.
193-092994A	1K193	1	193	N	993			VOC	VOC	CO	NOX					

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One to One? - If "Y" a one-to-one relationship exist between the stack and the kiln (one kiln, one stack)
Stack Flow (dscfm) - For kilns, this generally is total kiln flow rate in dry standard cubic feet per minute
Stack Temp. and Moisture - If possible, the temperature and moisture at a vent outlet or stack for single stack kilns.

Kiln-A Table (describes kilns) - see below for code definitions and some heading explanations

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Unit Code	Kiln Manufacturer	Kiln Type	Typical Product	Capacity (MBF/Chg)	Firing Type	Burner Manufacturer	Burner Capacity (MMBtu/hr)	Fuel Capability 1	Fuel Capability 2	Fuel Capability 3	Emissions Recycled? (Y or N)	Initial PCD	Final PCD	No. Vents	Comments
1K023		IHEAT	LUMBER	150	IHEAT							NONE	NONE	10	
1K025		DFIRE	LUMBER	116	DFIRE			WREF				NONE	NONE		No information on Kiln vents, tested in January 1995 by F factor method.
1K026			LUMBER	135								NONE	NONE		No information on Kiln type or number of vents.
1K031		DFIRE	LUMBER		DFIRE			WREF	SAWD		N	NONE	NONE	8	
1K033		DFIRE	LUMBER	170	DFIRE			SAWD			N	NONE	NONE	16	
1K035		IHEAT	LUMBER	300	IHEAT						N	NONE	NONE	1	2 KILNS
1K036		DFIRE	LUMBER	105	DFIRE			WREF				NONE	NONE	12	
1K037		IHEAT	LUMBER		IHEAT										
1K040		IHEAT	LUMBER		IHEAT							NONE	NONE	18	
1K046		IHEAT	LUMBER		IHEAT									10	
1K047		IHEAT	LUMBER	164	IHEAT						Y	NONE	NONE		Vent-X-Changer Kiln.
1K050		IHEAT	LUMBER	120	IHEAT							NONE	NONE	10	
1K051		DFIRE	LUMBER	125	DFIRE			WREF						12	
1K098		DFIRE	LUMBER		DFIRE			SAWD			Y	NONE	NONE	16	Kiln burner is a gasifier; emissions recycled to blend chamber not to burner.
1K129		IHEAT	LUMBER		IHEAT									14	
1K164		IHEAT	LUMBER	125	IHEAT						Y	NONE	NONE		Vent-X-Changer Kiln. One stack.
1K180		IHEAT	LUMBER		IHEAT						N	NONE	NONE	16	
1K181		DFIRE	LUMBER		DFIRE			WREF			N	NONE	NONE		
1K190		IHEAT	LUMBER		IHEAT							NONE	NONE	12	
1K193		DFIRE	LUMBER		DFIRE									14	
2K037		DFIRE	LUMBER		DFIRE										
2K047		IHEAT	LUMBER	164	IHEAT						Y	NONE	NONE		Vent-X-Changer Kiln.
2K098		DFIRE	LUMBER		DFIRE			SAWD			Y	NONE	NONE	16	Kiln burner is a gasifier; emissions recycled to blend chamber not to burner.
2K180		DFIRE	LUMBER		DFIRE			NGAS			?	NONE	NONE	16	Gas fired Kiln; unknown if blend chamber and recirculation duct exist.

Kiln Types - IHEAT (indirect heat, normally steam) DFIRE (direct fired)

Firing Types - STEAM, DFIRE (direct fired)

Fuel Capability - WREF (wood refuse), SAWD (sawdust)

MBF = Thousand Board Feet

MMBtu/hr = Million Btu per hour of heat input

Emissions Recycled ? - A "Y" indicates that gasses are recirculated back to a burner or blend chamber; If "Y" comments should be read.

" Kiln-B Table: Describes kiln operation during the testing period. See below for some column heading explanations.

Test Code	Unit Code	Run	Production (MBF/Charge)	Cycle Time (hr)	Wood Species 1	Percent Wood Species 1	Wood Species 2	Percent Wood Species 2	Lumber Dimensions	Inlet Moisture (%OD)	Outlet Moisture (%OD)	Hot Air Source 1	% Hot Air Source 1	Type Fuel 1	Amount Fuel 1	Type Fuel 2	Percent Fuel 1	Amount Fuel 2	Percent Fuel 2	Initial Wet Bulb (F)	Final Wet Bulb (F)	Initial Dry Bulb (F)	Final Dry Bulb (F)
023-091494A	1K023	1	149.6	17.75	SY PINE	100			2x6		16	IHEAT	100	STEAM									
023-091594A	1K023	1	148.6	17.5	SY PINE	100			2X6		14.6	IHEAT	100	STEAM									
023-091694A	1K023	1	151.6	19	SY PINE	100			2x4		15.9	IHEAT	100	STEAM									
025-011995A	1K025	1	116	20.5	SY PINE	100						DFIRE	100	WREF			100						
026-091494A	1K026	1	133.5		SY PINE	100			2x10,2x12	67	16												
026-091494A	1K026	2	133.5		SY PINE	100			2x10,2x12	67	16												
026-091494A	1K026	3	133.5		SY PINE	100			2x10,2x12	67	16												
026-091594A	1K026	1	126.7	20.8	SY PINE	100			mixed 2 in	61	18									159	160	197	226
031-071494A	1K031	1		13	SY PINE	100						DFIRE	100	SAWD			100						
033-102694A	1K033	1	169	24	SY PINE	100				61	10.6	DFIRE	100	SAWD	1.02 tons/hr		100				148		230
035-051794A	1K035	1	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051794A	1K035	2	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051794A	1K035	3	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051894A	1K035	1	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051894A	1K035	2	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051894A	1K035	3	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051994A	1K035	1	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051994A	1K035	2	300	24	SY PINE	100						IHEAT	100	STEAM									
035-051994A	1K035	3	300	24	SY PINE	100						IHEAT	100	STEAM									
036-020294A	1K036	1	105	17.1	SY PINE	100						DFIRE	100	WREF			100						
036-020294B	1K036	1	105	17.1	SY PINE	100						DFIRE	100	WREF			100						
036-020394A	1K036	1	105	17.4	SY PINE	100					11.3	DFIRE	100	WREF			100						
036-020394B	1K036	1	105	17.4	SY PINE	100					11.3	DFIRE	100	WREF			100						
036-020494A	1K036	1	105	16.9	SY PINE	100					13.5	DFIRE	100	WREF			100						
036-020494B	1K036	1	105	16.9	SY PINE	100					13.5	DFIRE	100	WREF			100						
037-060894A	2K037	1	197.64	72					2x6			GAS B		NGAS									
037-061094A	1K037	1	87.48	17					2x6			IHEAT	100	STEAM									
040-031694A	1K040	1	127.584	24.67	SY PINE	100			17%2x6; 83			IHEAT	100	STEAM									
040-031694A	1K040	2	127.584	24.67	SY PINE	100			17%2x6; 83			IHEAT	100	STEAM									
040-031694A	1K040	3	127.584	24.67	SY PINE	100			17%2x6; 83			IHEAT	100	STEAM									
040-031694B	1K040	1	127.584	24.67	SY PINE	100			17%2x6; 83			IHEAT	100	STEAM									
046-072294A	1K046	1		14								IHEAT	100	STEAM									
047-081294A	1K047	1	164	28	JPINE	100			2x4			IHEAT	100	STEAM						134	151	133	178
047-081294B	2K047	1	164	31	REDPINE	100			2x4			IHEAT	100	STEAM						170	139	179	182
050-042094A	1K050	1	115	19.8	SY PINE	100			2x4;2x6		16.6	IHEAT	100	STEAM									
050-042194A	1K050	1	107.6	18.8	SY PINE	100			2x8,2x10		14.6	IHEAT	100	STEAM									
050-042394A	1K050	1	116.2	19.71	SY PINE	100			2x4,2x6		16.6	IHEAT	100	STEAM									
051-020794A	1K051	1	106.7	20.25	SY PINE	100				69.5	13.6	DFIRE	100	PSHAV	1975 lb/hr		100						
051-020794A	1K051	2	106.7	20.25	SY PINE	100				69.5	13.6	DFIRE	100	PSHAV	1975 lb/hr		100						
051-020794A	1K051	3	106.7	20.25	SY PINE	100				69.5	13.6	DFIRE	100	PSHAV	1975 lb/hr		100						
051-020794B	1K051	1	106.7	20.25	SY PINE	100				69.5	13.6	DFIRE	100	PSHAV	1975 lb/hr		100			183	168	205	244

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Inlet and Outlet Moistures are Oven Dry moistures for lumber prior to (inlet) and after (outlet) drying.
Initial Wet and Dry Bulb temperatures are those temperatures that exist 4 hours after the cycle started.
Final Wet and Dry Bulb temperatures are those temperatures that exist 2 hours prior to the cycle finish.

Kiln-B Table

Test Code	Unit Code	Run	Number of Vents Total	Number of Vents Tested	O2 (%)	CO2 (%)	Comments
023-091494A	1K023	1	10	2			Wet/Dry bulb and wood moisture data unavailable.
023-091594A	1K023	1	10	2			Wet/Dry bulb and wood moisture data unavailable.
023-091694A	1K023	1	10	2			Wet/Dry bulb and wood moisture data unavailable.
025-011995A	1K025	1		0	12		Kiln tested by F factor method. Unknown position of M25A probe.
026-091494A	1K026	1					Assume 100% SY PINE. Kiln type and number of vents unknown. Flow calculation method unknown. Sample does not represent kiln cycle.
026-091494A	1K026	2					Assume 100% SY PINE. Kiln type and number of vents unknown. Flow calculation method unknown. Sample does not represent kiln cycle.
026-091494A	1K026	3					Assume 100% SY PINE. Kiln type and number of vents unknown. Flow calculation method unknown. Sample does not represent entire kiln cycle.
026-091594A	1K026	1					Kiln type unknown. Number of vents unknown. How flow determined unknown. Fugitives unknown. Assume 100% SY PINE.
031-071494A	1K031	1	10	10	14.3		Report not well understood. Could not arrive at many of some answers. No process data in report. EPA reported 14.2 hour cycle and 63.5 MBF charge.
033-102694A	1K033	1	16	16	11.1	5.2	Did not get all of 11/16/94 memo transmitting process data. Mill recorded dimensions as 6x14, 6x12, 6x10 etc; what does this mean?
035-051794A	1K035	1	1	1	20.9	0	No bulb temperatures given.
035-051794A	1K035	2	1	1	20.9	0	No bulb temperatures given.
035-051794A	1K035	3	1	1	20.9	0	No bulb temperatures given.
035-051894A	1K035	1	1	1	20.9	0	No bulb temperatures given.
035-051894A	1K035	2	1	1	20.9	0	No bulb temperatures given.
035-051894A	1K035	3	1	1	20.9	0	No bulb temperatures given.
035-051994A	1K035	1	1	1	20.9	0	No bulb temperatures given.
035-051994A	1K035	2	1	1	20.9	0	No bulb temperatures given.
035-051994A	1K035	3	1	1	20.9	0	No bulb temperatures given.
036-020294A	1K036	1	12	2	16.1		Assume SY PINE; unknown lumber size; particle size data available in report. SO2 below detection limits.
036-020294B	1K036	1	12	2	15.6		Assume SY PINE; unknown lumber size; particle size data available in report. SO2 below detection limits.
036-020394A	1K036	1	12	2	16		Assume SY PINE; unknown lumber size; particle size data available in report. SO2 below detection limits.
036-020394B	1K036	1	12	2	16.4		Assume SY PINE; unknown lumber size; particle size data available in report. SO2 below detection limits.
036-020494A	1K036	1	12	2	15.9		Assume SY PINE; unknown lumber size; particle size data available in report. SO2 below detection limits.
036-020494B	1K036	1	12	2	16.2		Assume SY PINE; unknown lumber size; particle size data available in report. SO2 below detection limits.
037-060894A	2K037	1		0	16.8	1.2	No bulb temperatures given.
037-061094A	1K037	1		0			No bulb temperatures given.
040-031694A	1K040	1	18	18	20.9	0	Dry bulb set pt: 245 F; and assumed SYPINE
040-031694A	1K040	2	18	18	20.9	0	Dry bulb set pt: 245 F; and assumed SYPINE
040-031694A	1K040	3	18	18	20.9	0	Dry bulb set pt: 245 F; and assumed SYPINE
040-031694B	1K040	1	18	18			Do not have total Kiln flow, average moisture and average temp. data.
046-072294A	1K046	1	10	10			No bulb temp given.
047-081294A	1K047	1	1	1			Kiln with Vent-X-Changer.
047-081294B	2K047	1	1	1			Kiln with Vent-X-Changer.
050-042094A	1K050	1	10	2			Wet/Dry bulb and wood moisture data unavailable.
050-042194A	1K050	1	10	2			Wet/Dry bulb and wood moisture data unavailable.
050-042394A	1K050	1	10	2			Wet/Dry bulb and wood moisture data unavailable.
051-020794A	1K051	1	12	1	9.6	8.8	Assume SY PINE.
051-020794A	1K051	2	12	1	10	8.3	Assume SY PINE.
051-020794A	1K051	3	12	1	9.4	8.8	Assume SY PINE.
051-020794B	1K051	1	12	1	11.7	8.6	Assume SY PINE.

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Kiln-B Table: Describes kiln operation during the testing period. See below for some column heading explanations.

Test Code	Unit Code	Run	Production (MBF/Charge)	Cycle Time (hr)	Wood Species 1	Percent Wood Species 1	Wood Species 2	Percent Wood Species 2	Lumber Dimensions	Inlet Moisture (%OD)	Outlet Moisture (%OD)	Hot Air Source 1	% Hot Air Source 1	Type Fuel 1	Amount Fuel 1	Type Fuel 2	Percent Fuel 1	Amount Fuel 2	Percent Fuel 2	Initial Wet Bulb (F)	Final Wet Bulb (F)	Initial Dry Bulb (F)	Final Dry Bulb (F)
098-022394A	1K098	1	130	26.45	SY PINE	100			4x4	79	22	DFIRE	100	SAWD			100			173	176	186	243
098-022394B	1K098	1	130	26.45	SY PINE	100			4x4	79	22	DFIRE	100	SAWD			100						
098-022394B	1K098	2	130	26.45	SY PINE	100			4x4	79	22	DFIRE	100	SAWD			100						
098-022394B	1K098	3	130	26.45	SY PINE	100			4x4	79	22	DFIRE	100	SAWD			100						
098-022494A	2K098	1	128	17.52	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100			165	177	190	241
098-022494B	2K098	1	128	17.52	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100						
098-022494B	2K098	2	128	17.52	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100						
098-022494B	2K098	3	128	17.52	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100						
098-022494C	2K098	1	128	17.52	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100						
098-022494C	2K098	2	128	17.52	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100						
098-022494C	2K098	3	128	17.52	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100						
098-022494D	2K098	1	128	15.03	SY PINE	100			2x4	100	16	DFIRE	100	SAWD			100						
098-090194A	2K098	1	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100			176	171	213	242
098-090194B	2K098	1	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100			176	171	213	242
098-090294A	2K098	1	104.5	17.75	SY PINE	100			2x4	104	22	DFIRE	100	SAWD			100			174	204	179	234
098-090294B	2K098	1	104.5	17.75	SY PINE	100			2x4	104	22	DFIRE	100	SAWD			100			174	204	179	234
098-090294C	2K098	1	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100						
098-090294C	2K098	2	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100						
098-090294C	2K098	3	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100						
098-090294D	2K098	1	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100						
098-090294D	2K098	2	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100						
098-090294D	2K098	3	104.5	17.25	SY PINE	100			2x4		19	DFIRE	100	SAWD			100						
129-092294A	1K129	1	88.5	22	SY PINE	100			2x4			IHEAT	100	STEAM						180	152	229	224
164-062894A	1K164	1	156.1	23	SY PINE	100			2x4	79	15	IHEAT	100	STEAM			100						
164-062894A	1K164	2	156.1	23	SY PINE	100			2x4	79	15	IHEAT	100	STEAM			100						
164-062894A	1K164	3	156.1	23	SY PINE	100			2x4	79	15	IHEAT	100	STEAM			100						
164-062894B	1K164	1	156.1	23	SY PINE	100			2x4	79	15	IHEAT	100	STEAM			100						
180-072694A	1K180	1	131.3	26.57	SY PINE	100			mixed 2 in	79	14	IHEAT	100	STEAM						180	190	155	224
180-072894A	2K180	1	138.2	95.87	SY PINE	100			mixed 2 in	61	18	DFIRE	100	NGAS			100			104	110	132	204
180-080194A	1K180	1	128.5	25.4	SY PINE	100			mixed 2 in	59	14	IHEAT	100	STEAM									
181-092794A	1K181	1	133	20.3	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
181-092794B	1K181	1	133	20.3	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
181-092794B	1K181	2	133	20.3	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
181-092894A	1K181	1	131	20	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
181-092894B	1K181	1	131	20	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
181-092894B	1K181	2	131	20	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
181-092894B	1K181	3	131	20	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
181-092994A	1K181	1	133.1	18.2	SY PINE	100			2 in mixed			DFIRE	100	WREF			100						
190-101194A	1K190	1	178.56	24	SPRUCE	100						IHEAT	100	STEAM						162	162	200	213
190-101294A	1K190	1	178.56	54	UFIR	100						IHEAT	100	STEAM						156	153	195	213
193-092894A	1K193	1	124.3	22.47	SY PINE	100			2x4	67	14.3	DFIRE	100	SAWD			100						
193-092894A	1K193	2	124.3	22.47	SY PINE	100			2x4	67	14.3	DFIRE	100.	SAWD			100						
193-092894A	1K193	3	124.3	22.47	SY PINE	100			2x4	67	14.3	DFIRE	100	SAWD			100						
193-092894B	1K193	1	124.3	22.47	SY PINE	100			2x4	67	14.3	DFIRE	100	SAWD			100			147	170	154	230
193-092994A	1K193	1	133.8	25	SY PINE	100			4x4	70	28	DFIRE	100	SAWD			100			185	164	225	231

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Inlet and Outlet Moistures are Oven Dry moistures for lumber prior to (inlet) and after (outlet) drying.
Initial Wet and Dry Bulb temperatures are those temperatures that exist 4 hours after the cycle started.
Final Wet and Dry Bulb temperatures are those temperatures that exist 2 hours prior to the cycle finish.

Test Code	Unit Code	Run	Number of Vents Total	Number of Vents Tested	O2 (%)	CO2 (%)	Comments
098-022394A	1K098	1	16	2	16.4	4.43	Unable to determine total flow rate used in calculations; unable to determine if VOC is reported as carbon; representative vent method; Fugitives not accounted for; dry bulb set point: 240 F.
098-022394B	1K098	1	16	2	14.7	6	Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022394B	1K098	2	16	2	16.5	4.4	Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022394B	1K098	3	16	2	18.3	3	Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494A	2K098	1	16	2	15.5	5.27	Unable to determine total flow rate used in calculations; unable to determine if VOC is reported as carbon; representative vent method; Fugitives not accounted for; dry bulb set point: 240 F.
098-022494B	2K098	1	16	2	14.9	5.9	Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494B	2K098	2	16	2	14.9	5.9	Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494B	2K098	3	16	2	16.8	4	Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494C	2K098	1	16	2			Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494C	2K098	2	16	2			Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494C	2K098	3	16	2			Representative vent test method; Fugitives not accounted for; dry bulb temperature set point: 240 F.
098-022494D	2K098	1	16	2			Unable to determine total flow rate used in calculations; unable to determine if VOC is reported as carbon; representative vent method; Fugitives not accounted for; dry bulb set point: 240 F.
098-090194A	2K098	1	16	16	13.7	7.2	
098-090194B	2K098	1	16	16	14	5.3	Gasifier duct. Data for gasifier; does not represent kiln emissions.
098-090294A	2K098	1	16	16	12.1	7.8	
098-090294B	2K098	1	16	16	11.3	6.8	Gasifier duct. Data for gasifier; does not represent kiln emissions.
098-090294C	2K098	1	16	16			Flow tested all 16 vents; pollutant concentrations tested at recirculation duct; Fugitives not accounted for; PM samples taken at 6 hrs, 9 hrs, 12 hrs into 17 hr cycle.
098-090294C	2K098	2	16	16			Flow tested all 16 vents; pollutant concentrations tested at recirculation duct; Fugitives not accounted for; PM samples taken at 6 hrs, 9 hrs, 12 hrs into 17 hr cycle.
098-090294C	2K098	3	16	16			Flow tested all 16 vents; pollutant concentrations tested at recirculation duct; Fugitives not accounted for; PM samples taken at 6 hrs, 9 hrs, 12 hrs into 17 hr cycle.
098-090294D	2K098	1	16	16			Gasifier data. This is test at burner outlet.
098-090294D	2K098	2	16	16			Gasifier data. This is test at burner outlet.
098-090294D	2K098	3	16	16			Gasifier data. This is test at burner outlet.
129-092294A	1K129	1	14	14			
164-062894A	1K164	1	1	1			
164-062894A	1K164	2	1	1			
164-062894A	1K164	3	1	1			
164-062894B	1K164	1	1	1			
180-072694A	1K180	1	16	16			Assume SY PINE. Stack temperatures not provided. See Reports Table concerning Fugitive emisisons. Octopus method.
180-072894A	2K180	1	16	16	18.4	1.5	Assume SY PINE. Stack temperature not provided. See Reports Table concerning Fugitive emissions. Octopus method.
180-080194A	1K180	1	16	16			Assume SY PINE. Stack moistures and temperatures not provided. See Reports Table concerning Fugitive emissions. Octopus method.
181-092794A	1K181	1		2	13.3	7.2	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
181-092794B	1K181	1		2	13	7.5	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
181-092794B	1K181	2		2	13.2	7.3	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
181-092894A	1K181	1		2	12.7	7.7	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
181-092894B	1K181	1		2	13	7.6	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
181-092894B	1K181	2		2	13	7.6	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
181-092894B	1K181	3		2	12.8	7.7	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
181-092994A	1K181	1		2	13.7	7	Representative vent method, one stack each vent row measured; other stacks flow checked at least once. Almost no fugitive emissions.
190-101194A	1K190	1	12	12			Emissions values are as given in report. Values do not check. Appears to be error in reported emission levels.
190-101294A	1K190	1	12	12			Emissions values are as given in report. Values do not check. Appears to be error in reported emission levels.
193-092894A	1K193	1	14	14	15	5	
193-092894A	1K193	2	14	14	15	5	
193-092894A	1K193	3	14	14	15	5	
193-092894B	1K193	1	14	14	15	5	Reported emission levels do not match NCASI calculations.
193-092994A	1K193	1	14	14			

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Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
023-091494A	1K023	1	VOC	M25A	IHEAT	149.6	17.8	SY PINE	3015		43.8	5.35 lb/MBF	Representative vent method. EPA ppm as propane, not carbon.
023-091594A	1K023	1	VOC	M25A	IHEAT	148.6	17.5	SY PINE	3354		44.6	5.25 lb/MBF	Representative vent method. EPA ppm as propane, not carbon.
023-091694A	1K023	1	VOC	M25A	IHEAT	151.6	19.0	SY PINE			39	4.89 lb/MBF	Representative vent method. EPA ppm as propane, not carbon.
025-011995A	1K025	1	VOC	M25A	DFIRE	116.0	20.5	SY PINE	1921			3.66 lb/MBF	F factor method.
026-091594A	1K026	1	VOC	M25A		126.7	20.8	SY PINE	1343		21.26	3.49 lb/MBF	PPM calculated from report data. Lb/hr value from report.
031-071494A	1K031	1	VOC		DFIRE		13.0	SY PINE					All data questionable until it can be checked further. Could not obtain same answer as report using flow and concentration as provided.
033-102694A	1K033	1	VOC	M25A	DFIRE	169.0	24.0	SY PINE					Flow and concentration yield different results from test report.
035-051794A	1K035	1	VOC	M25A	IHEAT	300.0	24.0	SY PINE	1099		49.84	3.987 lb/MBF	Individual run; does not represent entire kiln cycle; approximately one hour runs.
035-051794A	1K035	2	VOC	M25A	IHEAT	300.0	24.0	SY PINE	948.6		41.01	3.281 lb/MBF	Individual run; does not represent entire kiln cycle; approximately one hour runs.
035-051794A	1K035	3	VOC	M25A	IHEAT	300.0	24.0	SY PINE	958.1		39.52	3.162 lb/MBF	Individual run; does not represent entire kiln cycle; approximately one hour runs.
035-051894A	1K035	1	VOC	M25A	IHEAT	300.0	24.0	SY PINE	1087		38.53	3.082 lb/MBF	Individual run; does not represent entire kiln cycle; approximately three hour runs.
035-051894A	1K035	2	VOC	M25A	IHEAT	300.0	24.0	SY PINE	559.2		24.54	1.963 lb/MBF	Individual run; does not represent entire kiln cycle; approximately three hour runs.
035-051894A	1K035	3	VOC	M25A	IHEAT	300.0	24.0	SY PINE	1686		62.22	4.978 lb/MBF	Individual run; does not represent entire kiln cycle; approximately three hour runs.
035-051994A	1K035	1	VOC	M25A	IHEAT	300.0	24.0	SY PINE	1028		42.48	3.398 lb/MBF	Individual run; does not represent entire kiln cycle; approximately one hour runs.
035-051994A	1K035	2	VOC	M25A	IHEAT	300.0	24.0	SY PINE	885.2		34.44	2.755 lb/MBF	Individual run; does not represent entire kiln cycle; approximately one hour runs.
035-051994A	1K035	3	VOC	M25A	IHEAT	300.0	24.0	SY PINE	992		36.53	2.922 lb/MBF	Individual run; does not represent entire kiln cycle; approximately one hour runs.
036-020294A	1K036	1	VOC	M25A	DFIRE	105.0	17.1	SY PINE	1065		15.1	2.46 lb/MBF	Representative vent method.
036-020394A	1K036	1	VOC	M25A	DFIRE	105.0	17.4	SY PINE	1113		16.6	2.75 lb/MBF	Representative vent method.
036-020494A	1K036	1	VOC	M25A	DFIRE	105.0	16.9	SY PINE	1209		16.9	2.72 lb/MBF	Representative vent method.
037-060894A	2K037	1	VOC	M25A	DFIRE	197.6	72.0	SY PINE	331		3.71	1.40 lb/MBF	
037-061094A	1K037	1	VOC	M25A	IHEAT	87.5	17.0	SY PINE			8.59	1.67 lb/MBF	No moisture given; ppm gives in wet basis. Unusual test method.
040-031694B	1K040	1	VOC	M25A	IHEAT	127.6	24.7	SY PINE			4.459	0.862 lb/MBF	Do not have total Kiln flow, average moisture and average temperature data.
040-031694B	1K040	1	VOC	M25AC	IHEAT	127.6	24.7	SY PINE			4.044	0.782 lb/MBF	Do not have total Kiln flow, average moisture and average temperature data.
046-072294A	1K046	1	VOC	M25A	IHEAT	64.0	14.0				14.8	3.26 lb/MBF	VOC given as ppm as carbon (wet basis) but no moisture given to convert data from draft report.
047-081294A	1K047	1	VOC	M25A.	IHEAT	164.0	28.0	JPINE	466		5.65	0.97 lb/MBF	PPM back calculated. Lb/hr value from report.
047-081294B	2K047	1	VOC	M25A	IHEAT	164.0	31.0	REDPINE	697		11	2.08 lb/MBF	PPM back calculated. Lb/hr value from report.
050-042094A	1K050	1	VOC	M25A	IHEAT	115.0	19.8	SY PINE	1689		22.3	3.8 lb/MBF	Representative vent method. EPA ppm as propane, not carbon.
050-042194A	1K050	1	VOC	M25A	IHEAT	107.6	18.8	SY PINE	1800		24.5	4.3 lb/MBF	Representative vent method. EPA ppm as propane, not carbon.
050-042394A	1K050	1	VOC	M25A	IHEAT	116.2	19.7	SY PINE	1974		28.1	4.8 lb/MBF	Representative vent method. EPA ppm as propane, not carbon.
051-020794A	1K051	1	VOC	M25A	DFIRE	106.7	20.3	SY PINE	2677		35.64	6.76 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794A	1K051	2	VOC	M25A	DFIRE	106.7	20.3	SY PINE	2962		38.93	7.39 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794A	1K051	3	VOC	M25A	DFIRE	106.7	20.3	SY PINE	2533		27.02	5.13 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794B	1K051	1	VOC	M25A	DFIRE	106.7	20.3	SY PINE	2129		26.3	4.99 lb/MBF	F factor flow rate used. Results do not match company results or EPA results.
098-022394A	1K098	1	VOC	M25A	DFIRE	130.0	26.5	SY PINE			23.14	4.7 lb/MBF	Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; unable to determine dry concentration of VOC.
098-022394A	1K098	1	VOC	M25AC	DFIRE	130.0	26.5	SY PINE			18.2	3.7 lb/MBF	Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; unable to determine dry concentration of VOC.
098-022494A	2K098	1	VOC	M25A	DFIRE	128.0	17.5	SY PINE			21	2.87 lb/MBF	Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; unable to determine dry concentration of VOC.
098-022494A	2K098	1	VOC	M25AC	DFIRE	128.0	17.5	SY PINE			17.7	2.42 lb/MBF	Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; unable to determine dry concentration of VOC.
098-022494D	2K098	1	VOC	M25A	DFIRE	128.0	15.0	SY PINE			24.1	2.83 lb/MBF	Unable to determine total flow rate used in calculations; unable to determine if VOC reported as carbon; unable to determine dry concentration of VOC.

VOC POLLUTANT TABLE; Page 2

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Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
098-090194A	2K098	1	VOC	M25A	DFIRE	104.5	17.3	SY PINE	3327		19.4	3.16 lb/MBF	
098-090194A	2K098	1	VOC	M25AC	DFIRE	104.5	17.3	SY PINE	2178		12.7	2.07 lb/MBF	
098-090194B	2K098	1	VOC	M25A	DFIRE	104.5	17.3	SY PINE	996.5		5.81	0.946 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090194A for kiln emissions.
098-090194B	2K098	1	VOC	M25AC	DFIRE	104.5	17.3	SY PINE	358.5		2.09	0.340 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090194A for kiln emissions.
098-090294A	2K098	1	VOC	M25A	DFIRE	104.5	17.8	SY PINE	3046		17	2.89 lb/MBF	
098-090294A	2K098	1	VOC	M25AC	DFIRE	104.5	17.8	SY PINE	1700		9.49	1.61 lb/MBF	
098-090294B	2K098	1	VOC	M25A	DFIRE	104.5	17.8	SY PINE	111.4		0.622	0.106 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090294A for kiln emissions.
098-090294B	2K098	1	VOC	M25AC	DFIRE	104.5	17.8	SY PINE	85.46		0.477	0.081 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090294A for kiln emissions.
129-092294A	1K129	1	VOC	M25A	IHEAT	88.5	22.0	SY PINE	2617		7.76	1.93 lb/MBF	
129-092294A	1K129	1	VOC	M25AC	IHEAT	88.5	22.0	SY PINE	1875		5.56	1.33 lb/MBF	
164-062894A	1K164	1	VOC	M25A	IHEAT	156.1	23.0	SY PINE	412		2.39		These VOC values are for three discrete 1 hour intervals; they do not represent the full Kiln cycle. See Test Code 164-062894B for full cycle results.
164-062894A	1K164	1	VOC	M25AC	IHEAT	156.1	23.0	SY PINE	393		2.28		These VOC values are for three discrete 1 hour intervals; they do not represent the full Kiln cycle. See Test Code 164-062894B for full cycle results.
164-062894A	1K164	2	VOC	M25A	IHEAT	156.1	23.0	SY PINE	1118		4.87		These VOC values are for three discrete 1 hour intervals; they do not represent the full Kiln cycle. See Test Code 164-062894B for full cycle results.
164-062894A	1K164	2	VOC	M25AC	IHEAT	156.1	23.0	SY PINE	966		4.21		These VOC values are for three discrete 1 hour intervals; they do not represent the full Kiln cycle. See Test Code 164-062894B for full cycle results.
164-062894A	1K164	3	VOC	M25A	IHEAT	156.1	23.0	SY PINE	1290		5.15		These VOC values are for three discrete 1 hour intervals; they do not represent the full Kiln cycle. See Test Code 164-062894B for full cycle results.
164-062894A	1K164	3	VOC	M25AC	IHEAT	156.1	23.0	SY PINE	1209		4.82		These VOC values are for three discrete 1 hour intervals; they do not represent the full Kiln cycle. See Test Code 164-062894B for full cycle results.
164-062894B	1K164	1	VOC	M25A	IHEAT	156.1	23.0	SY PINE			4.26	0.628 lb/MBF	
164-062894B	1K164	1	VOC	M25AC	IHEAT	156.1	23.0	SY PINE	868		4.06	0.598 lb/MBF	Condenser preceeding FID.
180-072694A	1K180	1	VOC	M25A	IHEAT	131.3	26.6	SY PINE	3150		10.05	2.03 lb/MBF	Tracer gas indicated 8% fugitives. Fugitives not included in emission values.
180-072694A	1K180	1	VOC	M25AC	IHEAT	131.3	26.6	SY PINE	2790		9.67	1.96 lb/MBF	Tracer gas indicated 8% fugitives. Fugitives not included in emission values.
180-072894A	2K180	1	VOC	M25A	DFIRE	138.2	95.9	SY PINE	333		0.53	0.366 lb/MBF	Fugitives not included.
180-080194A	1K180	1	VOC	M25A	IHEAT	128.5	25.4	SY PINE	3090		7.13	1.41 lb/MBF	Tracer gas indicated 52% fugitives. Fugitives not included in emission values.
181-092794A	1K181	1	VOC	M25A	DFIRE	133.0	20.3	SY PINE	1374		18.65	2.85 lb/MBF	
181-092894A	1K181	1	VOC	M25A	DFIRE	131.0	20.0	SY PINE	1335		18.19	2.78 lb/MBF	
181-092994A	1K181	1	VOC	M25A	DFIRE	133.1	18.2	SY PINE	1476		20.63	2.82 lb/MBF	
190-101194A	1K190	1	VOC	M25A	IHEAT	178.6	24.0	SPRUCE	193.2		1.32	0.18 lb/MBF	Emissions values are as given in report. Values do not check. Appears to be error in reported emissions levels.
190-101194A	1K190	1	VOC	M25AC	IHEAT	178.6	24.0	SPRUCE	166.9		1.16	0.16 lb/MBF	Emissions values are as given in report. Values do not check. Appears to be error in reported emisisons levels.
190-101294A	1K190	1	VOC	M25A	IHEAT	178.6	54.0	UFIR	90.8		0.81	0.25 lb/MBF	Emissions values are as given in report. Values do not check. Appears to be error in reported emisisons levels.
190-101294A	1K190	1	VOC	M25AC	IHEAT	178.6	54.0	UFIR	47.5		0.41	0.12 lb/MBF	Emissions values are as given in report. Values do not check. Appears to be error in reported emissions levels.
193-092894B	1K193	1	VOC	M25A	DFIRE	124.3	22.5		1850		5.11	0.91 lb/MBF	Reported values do not match NCASI calculations.
193-092894B	1K193	1	VOC	M25AC	DFIRE	124.3	22.5		1515		3.96	0.71 lb/MBF	Reported values do not match NCASI calculations.
193-092994A	1K193	1	VOC	M25A	DFIRE	133.8	25.0		1800		3.18	0.59 lb/MBF	
193-092994A	1K193	1	VOC	M25AC	DFIRE	133.8	25.0		1331		2.29	0.43 lb/MBF	

PM+CPM TABLE (TOTAL PARTICULATE, front- and back-half)

Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
031-071494A	1K031	1	PM&CPM		DFIRE		13.0	SY PINE		0.055	1.8	0.40 lb/MBF	All data questionable until it can be checked further. These values do not match values in summary table.
033-102694A	1K033	1	PM&CPM	M5/202	DFIRE	169.0	24.0	SY PINE					Flow and concentration yield different results from test report.
035-051794A	1K035	1	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0104	1.63	0.1304 lb/MBF	
035-051794A	1K035	2	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0073	1.1	0.088 lb/MBF	
035-051794A	1K035	3	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.009	1.27	0.1016 lb/MBF	
035-051894A	1K035	1	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0115	1.41	0.1128 lb/MBF	
035-051894A	1K035	2	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0089	1.35	0.108 lb/MBF	
035-051894A	1K035	3	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0285	3.62	0.2896 lb/MBF	
035-051994A	1K035	1	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0054	0.77	0.0616 lb/MBF	
035-051994A	1K035	2	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0083	1.11	0.0888 lb/MBF	
035-051994A	1K035	3	PM&CPM	M5/202	IHEAT	300.0	24.0	SY PINE		0.0163	2.07	0.1656 lb/MBF	
036-020294B	1K036	1	PM&CPM	M5	DFIRE	105.0	17.1	SY PINE		0.0461	2.94	0.48 lb/MBF	Representative vent method.
036-020394B	1K036	1	PM&CPM	M5	DFIRE	105.0	17.4	SY PINE		0.0492	3.12	0.52 lb/MBF	Representative vent method.
036-020494B	1K036	1	PM&CPM	M5	DFIRE	105.0	16.9	SY PINE		0.0455	2.92	0.47 lb/MBF	Representative vent method.
040-031694A	1K040	1	PM&CPM	M5/202	IHEAT	127.6	24.7	SY PINE		0.006	0.079	0.0153 lb/MBF	
040-031694A	1K040	2	PM&CPM	M5/202	IHEAT	127.6	24.7	SY PINE		0.004	0.061	0.0118 lb/MBF	
040-031694A	1K040	3	PM&CPM	M5/202	IHEAT	127.6	24.7	SY PINE		0.009	0.103	0.0197 lb/MBF	
051-020794A	1K051	1	PM&CPM	M5/202	DFIRE	106.7	20.3	SY PINE		0.091	5.55	1.05 lb/MBF	
051-020794A	1K051	2	PM&CPM	M5/202	DFIRE	106.7	20.3	SY PINE		0.116	6.98	1.33 lb/MBF	
051-020794A	1K051	3	PM&CPM	M5/202	DFIRE	106.7	20.3	SY PINE		0.093	4.54	0.862 lb/MBF	
098-022394B	1K098	1	PM&CPM	M5/202	DFIRE	130.0	26.5	SY PINE		0.027	2.08	0.423 lb/MBF	
098-022394B	1K098	2	PM&CPM	M5/202	DFIRE	130.0	26.5	SY PINE		0.02	1.56	0.317 lb/MBF	
098-022394B	1K098	3	PM&CPM	M5/202	DFIRE	130.0	26.5	SY PINE		0.026	1.98	0.403 lb/MBF	
098-022494B	2K098	1	PM&CPM	M5/202	DFIRE	128.0	17.5	SY PINE		0.026	1.71	0.233 lb/MBF	
098-022494B	2K098	2	PM&CPM	M5/202	DFIRE	128.0	17.5	SY PINE		0.03	1.99	0.272 lb/MBF	
098-022494B	2K098	3	PM&CPM	M5/202	DFIRE	128.0	17.5	SY PINE		0.016	1.04	0.142 lb/MBF	
098-090294C	2K098	1	PM&CPM	M5/202	DFIRE	104.5	17.3	SY PINE		0.055	1.47	0.239 lb/MBF	
098-090294C	2K098	2	PM&CPM	M5/202	DFIRE	104.5	17.3	SY PINE		0.072	1.93	0.313 lb/MBF	
098-090294C	2K098	3	PM&CPM	M5/202	DFIRE	104.5	17.3	SY PINE		0.071	1.9	0.309 lb/MBF	
098-090294D	2K098	1	PM&CPM	M5/202	DFIRE	104.5	17.3	SY PINE		0.175	11.8	1.92 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
098-090294D	2K098	2	PM&CPM	M5/202	DFIRE	104.5	17.3	SY PINE		0.143	10.6	1.72 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
098-090294D	2K098	3	PM&CPM	M5/202	DFIRE	104.5	17.3	SY PINE		0.135	9.95	1.70 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
164-062894A	1K164	1	PM&CPM	M5	IHEAT	156.1	23.0	SY PINE		0.0034	0.09	0.013 lb/MBF	
164-062894A	1K164	2	PM&CPM	M5	IHEAT	156.1	23.0	SY PINE		0.0032	0.065	0.0088 lb/MBF	
164-062894A	1K164	3	PM&CPM	M5	IHEAT	156.1	23.0	SY PINE		0.0057	0.105	0.016 lb/MBF	
193-092894A	1K193	1	PM&CPM	M5/202	DFIRE	124.3	22.5			0.11	1.15	0.191 lb/MBF	
193-092894A	1K193	2	PM&CPM	M5/202	DFIRE	124.3	22.5			0.05	0.527	0.087 lb/MBF	
193-092894A	1K193	3	PM&CPM	M5/202	DFIRE	124.3	22.5			0.073	0.788	0.131 lb/MBF	

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PM TABLE (PARTICULATE MATTER, front half)

Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
026-091494A	1K026	1	PM	M5		133.5		SY PINE		0.0019	0.17		Cannot calculate lb/MBF because total kiln cycle time not provided.
026-091494A	1K026	2	PM	M5		133.5		SY PINE		0.0014	0.13		Cannot calculate lb/MBF because total kiln cycle time not provided.
026-091494A	1K026	3	PM	M5		133.5		SY PINE		0.0013	0.05		Cannot calculate lb/MBF because total kiln cycle time not provided.
031-071494A	1K031	1	PM		DFIRE		13.0	SY PINE		0.442	1.42	0.32 lb/MBF	All data questionable until it can be checked further. These values do not match values in summary table.
033-102694A	1K033	1	PM	M5	DFIRE	169.0	24.0	SY PINE					Flow and concentration yield different results from test report.
035-051794A	1K035	1	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0038	0.59	0.0472 lb/MBF	
035-051794A	1K035	2	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0026	0.39	0.0312 lb/MBF	
035-051794A	1K035	3	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0035	0.49	0.0392 lb/MBF	
035-051894A	1K035	1	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0062	0.76	0.0608 lb/MBF	
035-051894A	1K035	2	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0033	0.5	0.0400 lb/MBF	
035-051894A	1K035	3	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0163	2.07	0.1656 lb/MBF	
035-051994A	1K035	1	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0027	0.38	0.00304 lb/MBF	
035-051994A	1K035	2	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0036	0.49	0.0392 lb/MBF	
035-051994A	1K035	3	PM	M5	IHEAT	300.0	24.0	SY PINE		0.0068	0.87	0.0696 lb/MBF	
036-020294B	1K036	1	PM	M5	DFIRE	105.0	17.1	SY PINE		0.0434	2.77	0.45 lb/MBF	Representative vent method.
036-020394B	1K036	1	PM	M5	DFIRE	105.0	17.4	SY PINE		0.047	2.98	0.49 lb/MBF	Representative vent method.
036-020494B	1K036	1	PM	M5	DFIRE	105.0	16.9	SY PINE		0.0421	2.71	0.44 lb/MBF	Representative vent method.
040-031694A	1K040	1	PM	M5	IHEAT	127.6	24.7	SY PINE		0.0007	0.009	0.0017 lb/MBF	
040-031694A	1K040	2	PM	M5	IHEAT	127.6	24.7	SY PINE		0.0004	0.006	0.00116 lb/MBF	
040-031694A	1K040	3	PM	M5	IHEAT	127.6	24.7	SY PINE		0.0009	0.011	0.0021 lb/MBF	
051-020794A	1K051	1	PM	M5	DFIRE	106.7	20.3	SY PINE		0.084	5.12	0.972 lb/MBF	
051-020794A	1K051	2	PM	M5	DFIRE	106.7	20.3	SY PINE		0.112	6.74	1.28 lb/MBF	
051-020794A	1K051	3	PM	M5	DFIRE	106.7	20.3	SY PINE		0.088	4.3	0.816 lb/MBF	
098-022394B	1K098	1	PM	M5	DFIRE	130.0	26.5	SY PINE		0.017	1.31	0.267 lb/MBF	
098-022394B	1K098	2	PM	M5	DFIRE	130.0	26.5	SY PINE		0.013	0.99	0.201 lb/MBF	
098-022394B	1K098	3	PM	M5	DFIRE	130.0	26.5	SY PINE		0.014	1.11	0.226 lb/MBF	
098-022494B	2K098	1	PM	M5	DFIRE	128.0	17.5	SY PINE		0.017	1.12	0.152 lb/MBF	
098-022494B	2K098	2	PM	M5	DFIRE	128.0	17.5	SY PINE		0.02	1.33	0.181 lb/MBF	
098-022494B	2K098	3	PM	M5	DFIRE	128.0	17.5	SY PINE		0.011	0.715	0.098 lb/MBF	
098-090294C	2K098	1	PM	M5	DFIRE	104.5	17.3	SY PINE		0.0147	0.393	0.0640 lb/MBF	
098-090294C	2K098	2	PM	M5	DFIRE	104.5	17.3	SY PINE		0.0126	0.337	0.0548 lb/MBF	
098-090294C	2K098	3	PM	M5	DFIRE	104.5	17.3	SY PINE		0.0107	0.286	0.0466 lb/MBF	
098-090294D	2K098	1	PM	M5	DFIRE	104.5	17.3	SY PINE		0.148	9.96	1.62 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
098-090294D	2K098	2	PM	M5	DFIRE	104.5	17.3	SY PINE		0.126	9.35	1.52 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
098-090294D	2K098	3	PM	M5	DFIRE	104.5	17.3	SY PINE		0.112	8.27	1.41 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
164-062894A	1K164	1	PM	M5	IHEAT	156.1	23.0	SY PINE		0.0028	0.074	0.011 lb/MBF	
164-062894A	1K164	2	PM	M5	IHEAT	156.1	23.0	SY PINE		0.0019	0.038	0.006 lb/MBF	
164-062894A	1K164	3	PM	M5	IHEAT	156.1	23.0	SY PINE		0.0041	0.075	0.011 lb/MBF	
181-092794B	1K181	1	PM	M5	DFIRE	133.0	20.3	SY PINE		0.0456	2.73	0.417 lb/MBF	
181-092794B	1K181	2	PM	M5	DFIRE	133.0	20.3	SY PINE		0.0369	2.28	0.348 lb/MBF	
181-092894B	1K181	1	PM	M5	DFIRE	131.0	20.0	SY PINE		0.0513	3.13	0.48 lb/MBF	
181-092894B	1K181	2	PM	M5	DFIRE	131.0	20.0	SY PINE		0.0416	2.68	0.41 lb/MBF	
181-092894B	1K181	3	PM	M5	DFIRE	131.0	20.0	SY PINE		0.0381	2.34	0.36 lb/MBF	
193-092894A	1K193	1	PM	M5	DFIRE	124.3	22.5			0.0641	0.673	0.112 lb/MBF	
193-092894A	1K193	2	PM	M5	DFIRE	124.3	22.5			0.013	0.136	0.023 lb/MBF	
193-092894A	1K193	3	PM	M5	DFIRE	124.3	22.5			0.0426	0.447	0.074 lb/MBF	

CPM TABLE ([redacted]. CONDENSIBLE PARTICULATE MATTER, back-half)

Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
031-071494A	1K031	1	CPM		DFIRE		13.0	SY PINE		0.0107	0.35	0.08 lb/MBF	All data questionable until it can be checked further. These values do not match values in summary table.
033-102694A	1K033	1	CPM	M202	DFIRE	169.0	24.0	SY PINE					Flow and concentration yield different results from test report.
035-051794A	1K035	1	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0066	1.04	0.0832 lb/MBF	
035-051794A	1K035	2	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0047	0.71	0.0568 lb/MBF	
035-051794A	1K035	3	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0055	0.78	0.0624 lb/MBF	
035-051894A	1K035	1	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0053	0.65	0.052 lb/MBF	
035-051894A	1K035	2	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0056	0.85	0.068 lb/MBF	
035-051894A	1K035	3	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0122	1.55	0.124 lb/MBF	
035-051994A	1K035	1	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0027	0.39	0.0312 lb/MBF	
035-051994A	1K035	2	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0047	0.62	0.0496 lb/MBF	
035-051994A	1K035	3	CPM	M202	IHEAT	300.0	24.0	SY PINE		0.0095	1.2	0.0960 lb/MBF	
036-020294B	1K036	1	CPM	M5	DFIRE	105.0	17.1	SY PINE		0.0027	0.17	0.03 lb/MBF	Representative vent method.
036-020394B	1K036	1	CPM	M5	DFIRE	105.0	17.4	SY PINE		0.0022	0.14	0.02 lb/MBF	Representative vent method.
036-020494B	1K036	1	CPM	M5	DFIRE	105.0	16.9	SY PINE		0.0034	0.219	0.04 lb/MBF	Representative vent method.
040-031694A	1K040	1	CPM	M202	IHEAT	127.6	24.7	SY PINE		0.0056	0.07	0.0135 lb/MBF	
040-031694A	1K040	2	CPM	M202	IHEAT	127.6	24.7	SY PINE		0.0036	0.055	0.0106 lb/MBF	
040-031694A	1K040	3	CPM	M202	IHEAT	127.6	24.7	SY PINE		0.0078	0.092	0.0178 lb/MBF	
051-020794A	1K051	1	CPM	M202	DFIRE	106.7	20.3	SY PINE		0.008	0.488	0.093 lb/MBF	
051-020794A	1K051	2	CPM	M202	DFIRE	106.7	20.3	SY PINE		0.004	0.241	0.046 lb/MBF	
051-020794A	1K051	3	CPM	M202	DFIRE	106.7	20.3	SY PINE		0.005	0.244	0.046 lb/MBF	
098-022394B	1K098	1	CPM	M202	DFIRE	130.0	26.5	SY PINE		0.01	0.774	0.157 lb/MBF	
098-022394B	1K098	2	CPM	M202	DFIRE	130.0	26.5	SY PINE		0.007	0.573	0.117 lb/MBF	
098-022394B	1K098	3	CPM	M202	DFIRE	130.0	26.5	SY PINE		0.011	0.871	0.177 lb/MBF	
098-022494B	2K098	1	CPM	M202	DFIRE	128.0	17.5	SY PINE		0.009	0.592	0.081 lb/MBF	
098-022494B	2K098	2	CPM	M202	DFIRE	128.0	17.5	SY PINE		0.011	0.73	0.100 lb/MBF	
098-022494B	2K098	3	CPM	M202	DFIRE	128.0	17.5	SY PINE		0.005	0.325	0.044 lb/MBF	
098-090294C	2K098	1	CPM	M202	DFIRE	104.5	17.3	SY PINE		0.04	1.07	0.174 lb/MBF	
098-090294C	2K098	2	CPM	M202	DFIRE	104.5	17.3	SY PINE		0.0594	1.59	0.259 lb/MBF	
098-090294C	2K098	3	CPM	M202	DFIRE	104.5	17.3	SY PINE		0.0601	1.61	0.262 lb/MBF	
098-090294D	2K098	1	CPM	M202	DFIRE	104.5	17.3	SY PINE		0.0271	1.82	0.296 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
098-090294D	2K098	2	CPM	M202	DFIRE	104.5	17.3	SY PINE		0.0166	1.23	0.200 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
098-090294D	2K098	3	CPM	M202	DFIRE	104.5	17.3	SY PINE		0.0227	1.67	0.284 lb/MBF	This is test data for burner outlet. Does not represent kiln emissions. Test code 098-090294C represents kiln emissions.
164-062894A	1K164	1	CPM	M5	IHEAT	156.1	23.0	SY PINE		0.0006	0.016	0.0024 lb/MBF	
164-062894A	1K164	2	CPM	M5	IHEAT	156.1	23.0	SY PINE		0.0013	0.026	0.0038 lb/MBF	
164-062894A	1K164	3	CPM	M5	IHEAT	156.1	23.0	SY PINE		0.0016	0.03	0.0044 lb/MBF	
193-092894A	1K193	1	CPM	M202	DFIRE	124.3	22.5			0.0457	0.48	0.080 lb/MBF	
193-092894A	1K193	2	CPM	M202	DFIRE	124.3	22.5			0.0372	0.391	0.065 lb/MBF	
193-092894A	1K193	3	CPM	M202	DFIRE	124.3	22.5			0.0325	0.341	0.057 lb/MBF	

NOX TABLE (nitrogen oxides, NO2)

Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
025-011995A	1K025	1	NOX	M7E	DFIRE	116.0	20.5	SY PINE	46.6			0.303 lb/MBF	F factor method.
031-071494A	1K031	1	NOX		DFIRE		13.0	SY PINE	27.2		0.75	0.17 lb/MBF	All data questionable until it can be checked further.
036-020294A	1K036	1	NOX	M7E	DFIRE	105.0	17.1	SY PINE	30		1.8	0.29 lb/MBF	Representative vent method.
036-020394A	1K036	1	NOX	M7E	DFIRE	105.0	17.4	SY PINE	34		1.8	0.29 lb/MBF	Representative vent method.
036-020494A	1K036	1	NOX	M7E	DFIRE	105.0	16.9	SY PINE	35		1.78	0.29 lb/MBF	Representative vent method.
051-020794A	1K051	1	NOX	M7E	DFIRE	106.7	20.3	SY PINE	30.7		1.56	0.296 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794A	1K051	2	NOX	M7E	DFIRE	106.7	20.3	SY PINE	36.3		1.82	0.347 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794A	1K051	3	NOX	M7E	DFIRE	106.7	20.3	SY PINE	52.5		2.14	0.406 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794B	1K051	1	NOX	M7E	DFIRE	106.7	20.3	SY PINE	50.7		2.4	0.455 lb/MBF	F factor flow rate used. Results do not match company results or EPA results.
098-022394A	1K098	1	NOX	M7E	DFIRE	130.0	26.5	SY PINE			0.665	0.135 lb/MBF	
098-022494A	2K098	1	NOX	M7E	DFIRE	128.0	17.5	SY PINE			0.131	0.018 lb/MBF	
098-022494D	2K098	1	NOX	M7E	DFIRE	128.0	15.0	SY PINE			0.423	0.049 lb/MBF	
098-090194A	2K098	1	NOX	M7E	DFIRE	104.5	17.3	SY PINE	4.7		0.105	0.017 lb/MBF	Data does not match Company or EPA data.
098-090194B	2K098	1	NOX	M7E	DFIRE	104.5	17.3	SY PINE	74.7		1.67	0.276 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090194A for kiln emissions.
098-090294A	2K098	1	NOX	M7E	DFIRE	104.5	17.8	SY PINE	6.5		0.139	0.024 lb/MBF	Data does not match company or EPA data.
098-090294B	2K098	1	NOX	M7E	DFIRE	104.5	17.8	SY PINE	21.4		0.458	0.078 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090294A for kiln emissions.
180-072894A	2K180	1	NOX	M7E	DFIRE	138.2	95.9	SY PINE	2.4		0.019	0.0128 lb/MBF	Fugitives not included.
181-092794A	1K181	1	NOX	M7E	DFIRE	133.0	20.3	SY PINE	37		1.92	0.293 lb/MBF	
181-092894A	1K181	1	NOX	M7E	DFIRE	131.0	20.0	SY PINE	39		2.04	0.31 lb/MBF	
181-092994A	1K181	1	NOX	M7E	DFIRE	133.1	18.2	SY PINE	41		2.2	0.30 lb/MBF	
193-092894B	1K193	1	NOX	M7E	DFIRE	124.3	22.5		54		0.49	.088 lb/MBF	
193-092994A	1K193	1	NOX	M7E	DFIRE	133.8	25.0		45.6		0.31	.058 lb/MBF	

CARBON MONOXIDE TABLE

Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
025-011995A	1K025	1	CO	M10	DFIRE	116.0	20.5	SY PINE	185.2			0.746 lb/MBF	F factor method.
031-071494A	1K031	1	CO		DFIRE		13.0	SY PINE	206		3.44	0.77 lb/MBF	All data questionable until it can be checked further.
033-102694A	1K033	1	CO	M10	DFIRE	169.0	24.0	SY PINE	259		8.96	1.27 lb/MBF	Correct
036-020294A	1K036	1	CO	M10	DFIRE	105.0	17.1	SY PINE	78		2.7	0.44 lb/MBF	Representative vent method.
036-020394A	1K036	1	CO	M10	DFIRE	105.0	17.4	SY PINE	87		3.15	0.51 lb/MBF	Representative vent method.
036-020494A	1K036	1	CO	M10	DFIRE	105.0	16.9	SY PINE	106		3.57	0.57 lb/MBF	Representative vent method.
051-020794A	1K051	1	CO	M10	DFIRE	106.7	20.3	SY PINE	720		22.34	4.24 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794A	1K051	2	CO	M10	DFIRE	106.7	20.3	SY PINE	725		22.2	4.21 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794A	1K051	3	CO	M10	DFIRE	106.7	20.3	SY PINE	530		13.17	2.50 lb/MBF	Does not represent total kiln cycle. Represents 1 hour only. See test code 051-020794B for full cycle results.
051-020794B	1K051	1	CO	M10	DFIRE	106.7	20.3	SY PINE	438		12.63	2.40 lb/MBF	F factor flow rate used. Results do not match company results or EPA results.
098-022394A	1K098	1	CO	M10	DFIRE	130.0	26.5	SY PINE			3.3	0.669 lb/MBF	
098-022494A	2K098	1	CO	M10	DFIRE	128.0	17.5	SY PINE			1.25	0.171 lb/MBF	
098-022494D	2K098	1	CO	M10	DFIRE	128.0	15.0	SY PINE			1.25	0.147 lb/MBF	
098-090194A	2K098	1	CO	M10	DFIRE	104.5	17.3	SY PINE	70.9		0.965	0.159 lb/MBF	Data does not match Company or EPA data.
098-090194B	2K098	1	CO	M10	DFIRE	104.5	17.3	SY PINE	16.17		0.22	0.036 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090194A for kiln emissions.
098-090294A	2K098	1	CO	M10	DFIRE	104.5	17.8	SY PINE	77.5		1.01	0.172 lb/MBF	Data does not match company or EPA data.
098-090294B	2K098	1	CO	M10	DFIRE	104.5	17.8	SY PINE	9.29		0.121	0.021 lb/MBF	Data for gasifier; does not represent kiln emissions. See 098-090294A for kiln emissions.
180-072894A	2K180	1	CO	M10	DFIRE	138.2	95.9	SY PINE	76.6		0.33	0.228 lb/MBF	Fugitives not included.
181-092794A	1K181	1	CO	M10	DFIRE	133.0	20.3	SY PINE	190		6.02	0.919 lb/MBF	
181-092894A	1K181	1	CO	M10	DFIRE	131.0	20.0	SY PINE	205		6.52	1.00 lb/MBF	
181-092994A	1K181	1	CO	M10	DFIRE	133.1	18.2	SY PINE	206		6.72	0.92 lb/MBF	
193-092894B	1K193	1	CO	M10	DFIRE	124.3	22.5		200.9		1.31	0.234 lb/MBF	Reported value does not match NCASI calculations.
193-092994A	1K193	1	CO	M10	DFIRE	133.8	25.0		192.4		0.75	0.140 lb/MBF	

GENERIC TABLE (contains "other pollutants", not typical or criteria pollutants)

Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
031-071494A	1K031	1	ACETALD		DFIRE		13.0	SY PINE			0.116	0.03 lb/MBF	All data questionable until it can be checked further.
031-071494A	1K031	1	METHANOL		DFIRE		13.0	SY PINE			0.42	0.09 lb/MBF	All data questionable until it can be checked further.
033-102694A	1K033	1	ACETALD	TO-5	DFIRE	169.0	24.0	SY PINE			0.48	0.068 lb/MBF	
033-102694A	1K033	1	ACETONE	TO-5	DFIRE	169.0	24.0	SY PINE					Flow and concentration yield different results from test report.
033-102694A	1K033	1	HEXALD	TO-5	DFIRE	169.0	24.0	SY PINE			0.131	0.019 lb/MBF	
033-102694A	1K033	1	MEK	TO-5	DFIRE	169.0	24.0	SY PINE			0.053	0.008 lb/MBF	
033-102694A	1K033	1	METHANOL	TO-8	DFIRE	169.0	24.0	SY PINE					Methanol given as less than 2.3 lb/hr.
040-031694A	1K040	1	ACETALD	TO-5	IHEAT	127.6	24.7	SY PINE			0.029	0.0056 lb/MBF	
040-031694A	1K040	2	ACETALD	TO-5	IHEAT	127.6	24.7	SY PINE			0.028	0.0054 lb/MBF	
040-031694A	1K040	3	ACETALD	TO-5	IHEAT	127.6	24.7	SY PINE			0.064	0.0123 lb/MBF	
040-031694A	1K040	1	ACETONE	TO-5	IHEAT	127.6	24.7	SY PINE			0.057	0.0110 lb/MBF	
040-031694A	1K040	2	ACETONE	TO-5	IHEAT	127.6	24.7	SY PINE			0.065	0.0126 lb/MBF	
040-031694A	1K040	3	ACETONE	TO-5	IHEAT	127.6	24.7	SY PINE			0.071	0.0137 lb/MBF	
040-031694A	1K040	1	HEXALD	TO-5	IHEAT	127.6	24.7	SY PINE					BDL
040-031694A	1K040	2	HEXALD	TO-5	IHEAT	127.6	24.7	SY PINE					BDL
040-031694A	1K040	3	HEXALD	TO-5	IHEAT	127.6	24.7	SY PINE					BDL
040-031694A	1K040	1	MEK	TO-5	IHEAT	127.6	24.7	SY PINE			0.006	0.0012 lb/MBF	
040-031694A	1K040	2	MEK	TO-5	IHEAT	127.6	24.7	SY PINE			0.005	0.00097 lb/MBF	
040-031694A	1K040	3	MEK	TO-5	IHEAT	127.6	24.7	SY PINE			0.009	0.0017 lb/MBF	
040-031694A	1K040	1	PHENOL	TO-8	IHEAT	127.6	24.7	SY PINE					BDL
040-031694A	1K040	2	PHENOL	TO-8	IHEAT	127.6	24.7	SY PINE					BDL
040-031694A	1K040	3	PHENOL	TO-8	IHEAT	127.6	24.7	SY PINE					BDL
098-022394B	1K098	1	PHENOL	TO-8	DFIRE	130.0	26.5	SY PINE	0.54		0.142	0.029 lb/MBF	
098-022394B	1K098	2	PHENOL	TO-8	DFIRE	130.0	26.5	SY PINE	0.34		0.089	0.018 lb/MBF	
098-022394B	1K098	3	PHENOL	TO-8	DFIRE	130.0	26.5	SY PINE	0.15		0.039	0.008 lb/MBF	
098-022494C	2K098	1	PHENOL	TO-8	DFIRE	128.0	17.5	SY PINE	0.13		0.016	0.0022 lb/MBF	
098-022494C	2K098	2	PHENOL	TO-8	DFIRE	128.0	17.5	SY PINE	0.23		0.028	0.0039 lb/MBF	
098-022494C	2K098	3	PHENOL	TO-8	DFIRE	128.0	17.5	SY PINE	0.03		0.0035	0.00048 lb/MBF	
164-062894A	1K164	1	ACETALD	TO-5	IHEAT	156.1	23.0	SY PINE	0.594		0.0086	0.0013 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	2	ACETALD	TO-5	IHEAT	156.1	23.0	SY PINE	1.161		0.0126	0.0019 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	3	ACETALD	TO-5	IHEAT	156.1	23.0	SY PINE	0.753		0.0075	0.0011 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	1	ACETONE	TO-5	IHEAT	156.1	23.0	SY PINE	0.311		0.0045	0.00066 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	2	ACETONE	TO-5	IHEAT	156.1	23.0	SY PINE	0.674		0.0073	0.00108 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	3	ACETONE	TO-5	IHEAT	156.1	23.0	SY PINE	0.433		0.0043	0.00064 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	1	HEXALD	TO-5	IHEAT	156.1	23.0	SY PINE	0.047		0.0007	0.0001 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	2	HEXALD	TO-5	IHEAT	156.1	23.0	SY PINE	0.151		0.0016	0.0002 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	3	HEXALD	TO-5	IHEAT	156.1	23.0	SY PINE	0.008		0.0001	0.0001 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	1	MEK	TO-5	IHEAT	156.1	23.0	SY PINE	0.004		6E-05	9.7E-6 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	2	MEK	TO-5	IHEAT	156.1	23.0	SY PINE	0.005		5E-05	6.5E-6 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	3	MEK	TO-5	IHEAT	156.1	23.0	SY PINE	0.005		5E-05	6.5E-6 lb/MBF	Report states that aldehyde and ketone results are suspect.
193-092894A	1K193	1	ACETALD	TO-5	DFIRE	124.3	22.5		11.5		0.097	0.016 lb/MBF	
193-092894A	1K193	2	ACETALD	TO-5	DFIRE	124.3	22.5		11.2		0.094	0.016 lb/MBF	
193-092894A	1K193	3	ACETALD	TO-5	DFIRE	124.3	22.5		6.43		0.054	0.009 lb/MBF	
193-092894A	1K193	1	ACETONE	TO-5	DFIRE	124.3	22.5		3.88		0.043	0.007 lb/MBF	
193-092894A	1K193	2	ACETONE	TO-5	DFIRE	124.3	22.5		1.71		0.019	0.003 lb/MBF	
193-092894A	1K193	3	ACETONE	TO-5	DFIRE	124.3	22.5		0.36		0.004	0.007 lb/MBF	
193-092894A	1K193	1	HEXALD	TO-5	DFIRE	124.3	22.5						HEXALDEHYDE tested for but not detected.
193-092894A	1K193	2	HEXALD	TO-5	DFIRE	124.3	22.5						HEXALDEHYDE tested for but not detected.
193-092894A	1K193	3	HEXALD	TO-5	DFIRE	124.3	22.5						HEXALDEHYDE tested for but not detected.
193-092894A	1K193	1	MEK	TO-5	DFIRE	124.3	22.5						MEK tested for but not detected.
193-092894A	1K193	2	MEK	TO-5	DFIRE	124.3	22.5						MEK tested for but not detected.
193-092894A	1K193	3	MEK	TO-5	DFIRE	124.3	22.5						MEK tested for but not detected.

FORMALDEHYDE TABLE

Test Code	Unit Code	Run	Pollutant	Test Method	Kiln Type	Production (MBF/Chg.)	Cycle Time (Hr.)	Wood Species 1	PPM	Gr/DSCF	Lb/hr	Other (units)	Comments_3
031-071494A	1K031	1	FOR		DFIRE		13.0	SY PINE			0.144	0.03 lb/MBF	All data questionable until it can be checked further.
033-102694A	1K033	1	FOR	TO-5	DFIRE	169.0	24.0	SY PINE			0.53	0.075 lb/MBF	
040-031694A	1K040	1	FOR	TO-5	IHEAT	127.6	24.7	SY PINE			0.025	0.0048 lb/MBF	
040-031694A	1K040	2	FOR	TO-5	IHEAT	127.6	24.7	SY PINE			0.013	0.0025 lb/MBF	
040-031694A	1K040	3	FOR	TO-5	IHEAT	127.6	24.7	SY PINE			0.029	0.0056 lb/MBF	
098-022394B	1K098	1	FOR	TO-5	DFIRE	130.0	26.5	SY PINE	1.6		0.07	0.014 lb/MBF	
098-022394B	1K098	2	FOR	TO-5	DFIRE	130.0	26.5	SY PINE	4.5		0.191	0.039 lb/MBF	
098-022394B	1K098	3	FOR	TO-5	DFIRE	130.0	26.5	SY PINE	3.6		0.15	0.031 lb/MBF	
098-022494C	2K098	1	FOR	TO-5	DFIRE	128.0	17.5	SY PINE	2.1		0.0815	0.011 lb/MBF	
098-022494C	2K098	2	FOR	TO-5	DFIRE	128.0	17.5	SY PINE	1.9		0.075	0.010 lb/MBF	
098-022494C	2K098	3	FOR	TO-5	DFIRE	128.0	17.5	SY PINE	5.1		0.2	0.027 lb/MBF	
164-062894A	1K164	1	FOR	TO-5	IHEAT	156.1	23.0	SY PINE	0.088		0.0013	0.00019 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	2	FOR	TO-5	IHEAT	156.1	23.0	SY PINE	1.327		0.0144	0.0021 lb/MBF	Report states that aldehyde and ketone results are suspect.
164-062894A	1K164	3	FOR	TO-5	IHEAT	156.1	23.0	SY PINE	0.335		0.0033	0.0005 lb/MBF	Calculations do not match report or EPA data. Calculated from Appendix 4.
193-092894A	1K193	1	FOR	TO-5	DFIRE	124.3	22.5		23		0.132	0.022 lb/MBF	
193-092894A	1K193	2	FOR	TO-5	DFIRE	124.3	22.5		21.3		0.122	0.020 lb/MBF	
193-092894A	1K193	3	FOR	TO-5	DFIRE	124.3	22.5		9.76		0.056	0.009 lb/MBF	

SIRRINE
ENVIRONMENTAL
CONSULTANTS

3500-B Regency Parkway
P.O. Box 1308
Cary, NC 27511

July 6, 1992

Mr. Jeff Stamps
Weyerhaeuser Company
Post Office Box 280
Ayden, North Carolina 28513

Re: Lumber Volatile Organic Compound (VOC) Test Results
Sirrine Project No. R-1996

Dear Jeff:

Attached is the summary report from the Research Triangle Institute (RTI) presenting the results of the VOC analysis of the wood samples we submitted. The complete report, including laboratory worksheets, instrument chromatograms, and computer printouts, has been sent to Victor Dallons of Weyerhaeuser R&D for technical review.

As shown in the attached calculations, emission factors for VOC from lumber drying can be estimated from these results as:

BATCH	PRODUCT	LB VOC/10^3 BOARD FEET
1	2-inch	2.04
2	2-inch	3.97
3	1-inch	2.70
4	thinnings	3.85

$\bar{x}$ = 3.14 lb/MBF

A published literature value of 4.8 lb VOC/10^3 board feet was used to estimate your facility's lumber drying emissions in previous reports.

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 14
To Clifford Bowling	From Don Wynne
Co. Georgia-Pacific	Co. EH&R
Dept.	Phone #
Fax # 404-230-5678	Fax # 919 975-3716

These emission factors were estimated by presuming a 50% moisture content for the green lumber in batches 1 through 3, and a 60% moisture content for the plantation thinnings (batch 4). If the actual wood moisture of the samples was higher than estimated here, the resulting emission factors will also be higher. Effort is currently being made to obtain actual moisture values from the collected samples to improve the accuracy of these factors.

If the factors shown above are used to estimate VOC emissions from the Greenville Lumber Facility, the average value (3.14) predicts that the facility would reach the 250 ton per year regulatory threshold for major source VOC emissions at a production rate of 159 million board feet per year. Preliminary results, therefore, indicate that the Greenville Lumber Facility is close to being a major source, but has not exceeded the allowable emission rate to date.

If you have any questions about the test results or this interpretation, please feel free to call me at (919) 481-0397.

Sincerely,

SIRRINE ENVIRONMENTAL CONSULTANTS

Linda M. Lamb

Linda M. Lamb, P.E.
Air Quality Engineer

LML/ra

cc: Mr. John Furman, Ayden
Mr. Jerry Coker, Plymouth
Mr. Victor Dallons, Tacoma
Mr. Dale Wolfe, Sirrine
Project File

RESEARCH TRIANGLE INSTITUTE

RTI

Center for Environmental Measurements and Quality Assurance

June 24, 1991

Ms. Linda M. Lamb, P.E.
Sirrine Environmental Consultants
3500B Regency Parkway
P.O. Box 1[illegible]08
Cary, NC 27511

RE: Lumber Volatile Organic Compounds (VOC) Tests - Method 25D
Sirrine Project No. R-1996
RTI Project No. 91C-4848-06C

Dear Ms. Lamb:

Research Triangle Institute prepared four batches of ten 40-mL sample vials each for collection of Method 25D samples by Sirrine Environmental Consultants. The pre-weighed, labeled vials contained ~30 mL of PEG that had been cleaned and blank-checked. The four 10-vial batches, along with four additional vials per batch to be used as trip blanks and field blanks, were shipped in a cooler at 0°C to Weyerhaeuser, Greenville Lumber Facility, State Road 1110, Grifton, NC 28530, on Monday, April 20, 1992. Sirrine subsequently returned (at 0°C) all vials (samples and blanks) in batches 1, 2, and 3 on April 28 and all vials in batch 4 on May 21, 1992, to RTI for analysis by Method 25D.

You will find enclosed a table summarizing the results of the analysis of the four batches of samples. Analysis of the two field blanks from each batch confirmed that no measurable contamination occurred during storage, shipment, sampling, or handling of the sample vials. Since the measured amounts of carbon (as CH_4) and organochlorine (as Cl^-) in the field blanks in all cases were below the quantitation limits for the two species, neither the trip blanks nor the lab blanks (retained at RTI as part of our QC program) were analyzed.

Please call me at (919) 541-5824 if you have questions.

Sincerely,

Max R. Peterson

Max R. Peterson, Ph.D.
Coordinator
Source Measurement Programs

Method 25D Analysis of Lumber Samples Submitted by Sirrine Environmental Consultants

Printed 6/17/92

BATCH 1

Sample	Sample Weight (g)	CH_4 (mg)[a]	Cl^- (mg)[b]	Total VO (mg)	Concentration (PPM)[c] CH_4	Cl^-	VO
B1-I-FB	-----	ND	ND	----	----	----	----
B1-I-100A	6.72	1.76	ND	1.76	262	----	262
B1-I-101A	9.04	4.22	ND	4.22	467	----	467
B1-I-102A	9.48	5.45	ND	5.45	575	----	575
B1-I-103A	10.20	3.86	ND	3.86	378	----	378
B1-I-104A	8.02	150[d]	ND	150[d]	19,000[d]	----	19,000[d]
B1-O-FB	----	ND	ND	----	----	----	----
B1-O-100A	7.83	0.76	ND	0.76	97	----	97
B1-O-101A	8.66	2.32	ND	2.32	268	----	268
B1-O-102A	9.13	1.06	ND	1.06	116	----	116
B1-O-103A	10.21	0.96	ND	0.96	94	----	94
B1-O-104A	9.21	200[d]	ND	200[d]	21,000[d]	----	21,000[d]

[a]Measured amount of carbon (as CH_4) was corrected by subtracting the mean amount of carbon in the two field blanks.

[b]Measured amount of organochlorine as (Cl^-) was corrected by subtracting the mean amount of organochlorine in the two field blanks.

[c]PPM = (1,000,000)*(measured mass in mg)/[(sample weight in g)*(1,000 mg/g)]

[d]These values are far above the calibration range, which goes up to approximately 1,000 ppm for a 10-g sample.

	CH_4	Cl^-
Limit of Detection (3s)	0.08 mg	0.06 mg
Limit of Quantitation (10s)	0.26 mg	0.22 mg

Method 25D Analysis of Lumber Samples Submitted by Sirrine Environmental Consultants

Printed 6/17/92

BATCH 2

Sample	Sample Weight (g)	CH_4 (mg)[a]	Cl^- (mg)[b]	Total VO (mg)	Concentration (PPM)[c] CH_4	Cl^-	VO
B2-I-FB	-----	<0.26	ND	----	----	----	----
B2-I-100A	9.12	4.14	ND	4.14	454	----	454
B2-I-101A	9.89	5.82	ND	5.82	589	----	589
B2-I-102A	9.82	5.66	ND	5.66	577	----	577
B2-I-103A	9.93	7.68	ND	7.68	773	----	773
B2-I-104A	9.02	9.52	ND	9.52	1055	----	1055
B2-O-FB	-----	ND	ND	----	----	----	----
B2-O-100A	10.61	0.68	ND	0.68	64	----	64
B2-O-101A	9.82	0.73	ND	0.73	74	----	74
B2-O-102A	11.87	0.54	<0.22	0.54	46	----	46
B2-O-103A	10.25	0.60	ND	0.60	59	----	59
B2-O-104A	9.79	1.26	ND	1.26	129	----	129

[a]Measured amount of carbon (as CH_4) was corrected by subtracting the mean amount of carbon in the two field blanks.

[b]Measured amount of organochlorine as (Cl^-) was corrected by subtracting the mean amount of organochlorine in the two field blanks.

[c]PPM = (1,000,000)*(measured mass in mg)/[(sample weight in g)*(1,000 mg/g)]

	CH_4	Cl^-
Limit of Detection (3s)	0.08 mg	0.06 mg
Limit of Quantitation (10s)	0.26 mg	0.22 mg

Method 25D Analysis of Lumber Samples Submitted by Sirrine Environmental Consultants

Printed 6/17/92

BATCH 4

Sample	Sample Weight (g)	CH_4 (mg)[a]	Cl^- (mg)[b]	Total VO (mg)	Concentration (PPM)[c] CH_4	Cl^-	VO
B4-I-FB	-----	ND	ND	----	----	----	----
B4-I-100A	8.41	4.50	ND	4.50	535	----	535
B4-I-101A	9.18	9.08	ND	9.08	989	----	989
B4-I-102A	8.83	1.50	ND	1.50	170	----	170
B4-I-103A	7.04	3.02	ND	3.02	429	----	429
B4-I-104A	6.97	3.99	ND	3.99	572	----	572
B4-O-FB	-----	ND	ND	----	----	----	----
B4-O-100A	10.14	<0.26	ND	<0.26	<26[d]	----	<26[d]
B4-O-101A	8.91	1.42	ND	1.42	159	----	159
B4-O-102A	10.28	<0.26	ND	<0.26	<25[d]	----	<25[d]
B4-O-103A	10.67	1.66	ND	1.66	155	----	155
B4-O-104A	8.15	0.85	ND	0.85	105	----	105

[a]Measured amount of carbon (as CH_4) was corrected by subtracting the mean amount of carbon in the two field blanks.

[b]Measured amount of organochlorine as (Cl^-) was corrected by subtracting the mean amount of organochlorine in the two field blanks.

[c]PPM = (1,000,000)*(measured mass in mg)/[(sample weight in g)*(1,000 mg/g)]

[d]Measured amount of carbon (as CH_4) was below the Limit of Quantitation, thus the VO concentration (calculated as in footnote c above) is known to be less than the concentration corresponding to the LOQ with the given sample weight.

	CH_4	Cl^-
Limit of Detection (3s)	0.08 mg	0.06 mg
Limit of Quantitation (10s)	0.26 mg	0.22 mg

SIRRINE ENVIRONMENTAL CONSULTANTS

CALCULATION NO. 1

NO. OF PAGES 6

CALCULATION COVER SHEET

CLIENT Weyerhaeuser JOB NO. Z-1996

LOCATION Greenville, NC

SUBJECT/SYSTEM Method 25D (VOC) Lab Samples

PURPOSE OF CALCULATION:

Estimate emission factors (lb VOC/10^3 board feet) from lab results. Predict total plant drying emissions and compare with regulatory threshold for major source emissions.

REFERENCES:

Research Triangle Institute letter report dated 6/24/91 (sic), attached.

RESULTS AND CONCLUSIONS:

Facility does not appear to have exceeded 250 tpy VOC emissions, but factors need refining with actual moisture content information.

PREPARED BY Linda Lamb / Julie Ray DATE 7/1/92

CHECKED BY ______ DATE ______

REV'D. BY PROJECT ENGINEER ______ DATE ______

SEC. DONOHUE CALCULATION SHEET

CLIENT Weyerhaeuser LOCATION Greenville, NC JOB NO. R-1996

SUBJECT Method 25D Results Summary

BY Linda Lamb DATE 6/29/92 CHECKED BY Dale Wolfe DATE 7/2/92

I. Batch average emission factors:

Batch	lb VOC/10^3 board feet
1	2.04
2	3.97
3	2.70
4	3.85
avg.	3.14

II. Board feet necessary to emit 250 tpy VOC:

$$250 \frac{ton}{yr} \times \frac{2000\ lb}{ton} \times \frac{10^3\ board\ feet}{3.14\ lb} = 159 \times 10^6\ board\ feet/yr$$

SEC DONOHUE CALCULATION SHEET

CLIENT Weyerhaeuser LOCATION Greenville, NC JOB NO. R-1996

SUBJECT Method 25D Results Summary

BY Linda Lamb DATE 6/29/92 CHECKED BY Dale Wolfe DATE 7/2/92

I. Batch 1 - 2-inch product w/ 50% inlet M.C, 19% outlet

Sample No	VOC Inlet ppm	VOC Outlet ppm	lb VOC lost/10^3 board feet, 50% M.C. inlet
100	262	97	1.25
101	467	268	1.86
102	575	116	3.10
103	378	94	1.97
104	19,000[a]	21,000[a]	NA
		Batch average	2.04 lb VOC/10^3 board ft.

[a] Not included in batch average.

$\frac{2.04 \text{ lb}}{10^3 \text{ feet}} \times \frac{100 \times 10^6 \text{ ft}}{\text{yr}} \times \frac{\text{ton}}{2000 \text{ lb}} = 102$ tpy, max. actual emissions

$\frac{2.04 \text{ lb}}{10^3 \text{ feet}} \times \frac{156 \text{ MM ft}}{\text{yr}} \times \frac{\text{ton}}{2000} = 160$ tpy, max potential emissions

SEC DONOHUE CALCULATION SHEET

CLIENT Weyerhaeuser LOCATION Greenville, NC JOB NO. R-1996

SUBJECT Method 25D Results Summary

BY Linda Lamb DATE 6/29/92 CHECKED BY Dale Wolfe DATE 7/2/92

Where:

$$\frac{\text{lb VOC lost}}{10^3\text{ board foot}} = \left[\frac{\text{VO inlet, ppm}}{(1-0.50)} - \frac{\text{VO outlet, ppm}}{(1-0.19)}\right] \times \frac{37\text{ lb dry wood}}{\text{ft}^3} \times \frac{1/12\text{ ft}^3}{\text{board feet}} \times \frac{10^3}{10^6}$$

and:

$$\frac{\text{batch avg. lb VOC}}{\text{board ft}} \times x\ \frac{\text{mm board ft}}{\text{yr}} \times \frac{\text{ton}}{2000\text{ lb}} = \frac{\text{tons VOC emitted}}{\text{yr}}$$

where $x = 100$ for maximum historical production (1990)

$x = 156$ for maximum plant capacity (potential)

SEC DONOHUE CALCULATION SHEET

CLIENT Weyerhaeuser LOCATION Greenville, NC JOB NO. [illegible]

SUBJECT Method 25D Results Summary

BY Julie Ray DATE 6-30-92 CHECKED BY LMLamb DATE 6/30/92

II. Batch 2 - 2-inch product w/ 50% M.C. inlet, 19% outlet

Sample No.	VOC Inlet (ppm)	VOC Outlet (ppm)	lb VOC lost/10³ board feet, @ 50% M.C. Inlet
100	454	64	2.56
101	589	74	3.35
102	577	46	3.38
103	773	59	4.54
104	1,055	129	6.01

Batch average 3.97 lb VOC/10³ board feet

$$\frac{3.97\ \text{lb}}{10^3\ \text{feet}} \times \frac{100 \times 10^6\ \text{ft}}{\text{yr}} \times \frac{\text{ton}}{2000\ \text{lb}} = 199\ \text{tpy, max. actual}$$

$$\frac{3.97\ \text{lb}}{10^3\ \text{feet}} \times \frac{156 \times 10^6\ \text{ft}}{\text{yr}} \times \frac{\text{ton}}{2000\ \text{lb}} = 310\ \text{tpy, max. potential}$$

Where:

$$\frac{\text{lb VOC lost}}{10^3\ \text{board ft @ 50\%}} = \left[\frac{(\text{VOC Inlet, ppm})}{(1-0.50)} - \frac{(\text{VOC Outlet, ppm})}{(1-0.19)}\right] \times \frac{37\ \text{lb dry wood}}{\text{ft}^3} \times \frac{1/12\ \text{ft}^3}{\text{board feet}} \times \frac{\quad}{10^6 \times 10^{-3}}$$

and:

$$\frac{\text{batch average lb VOC}}{\text{board feet}} \times \frac{\text{mm board ft}}{\text{yr}} \times \frac{\text{ton}}{2000\ \text{lb}} = \frac{\text{tons VOC emitted}}{\text{yr}}$$

SEC DONOHUE CALCULATION SHEET

CLIENT Weyerhaeuser LOCATION Greenville, SC JOB NO. R-1996

SUBJECT Method 25D Results Summary

BY Julie Ray DATE 6-30-92 CHECKED BY L.M. Lamb DATE 6/30/92

III Batch 3 - 1-inch product w/50% M.C. inlet and 15% M.C. outlet

Sample No.	VOC Inlet (ppm)	VOC Outlet (ppm)	lb VOC lost/10^3 board feet, 50% M.C. Inlet
100	696	50	4.11 ✓
101	445	300	1.66 ✓
102	620	61	3.60 ✓
103	347	21	2.04 ✓
104	572	390	2.11 ✓

Batch average 2.70 lb VOC/10^3 board

$$\frac{2.70\ lb}{10^3\ feet} \times \frac{100 \times 10^6\ ft}{yr} \times \frac{ton}{2000\ lb} = 135\ tpy,\ max.\ actual$$

$$\frac{2.70\ lb}{10^3\ feet} \times \frac{156 \times 10^6\ ft}{yr} \times \frac{ton}{2000\ lb} = 211\ tpy;\ max.\ potential$$

Where.

$$\frac{lb\ VOC\ lost}{10^3\ board\ ft\ @\ 50\%} = \left[\frac{(VOC\ Inlet, ppm)}{(1-0.50)} - \frac{(VOC\ Outlet, ppm)}{(1-0.15)}\right] \times \frac{37\ lb\ dry\ wood}{ft^3}$$

$$\times \frac{1/12\ ft^3}{board\ feet} \times \frac{}{(10^6)(10^{-3})}$$

and: $\frac{batch\ average\ lb\ VOC}{board\ feet} \times \frac{mm\ board\ feet}{yr} \times \frac{ton}{2000\ lb}$

$= \frac{tons\ VOC\ emitted}{yr.}$

SEC DONOHUE CALCULATION SHEET

CLIENT Weyerhaeuser LOCATION Greenville, SC JOB NO. R-1996

SUBJECT Method 25D Results Summary

BY Julie Ray DATE 6-30-92 CHECKED BY L.M. Lamb DATE 6/30/92

IV Batch 4 - Plantation thinnings at 60% M.C. inlet and 15% M.C. outlet

Sample No.	VOC Inlet (ppm)	VOC Outlet (ppm)	lb VOC lost / 10^3 board feet, 60% M.C. Inlet
100	535	<26	4.12 > x < 4.03
101	989	159	7.05
102	170	<25	1.31 > x < 1.22
103	429	155	2.74
104	572	105	4.03

Batch average <3.85 lb VOC / 10^3 board ft

$$\frac{3.85}{10^3 \text{ feet}} \times \frac{100 \times 10^6 \text{ ft}}{\text{yr}} \times \frac{\text{ton}}{2000 \text{ lb}} = 192.5 \text{ tpy, max. actual}$$

$$\frac{3.85}{10^3 \text{ feet}} \times \frac{156 \times 10^6 \text{ ft}}{\text{yr}} \times \frac{\text{ton}}{2000 \text{ lb}} = 300 \text{ tpy, max. potential}$$

Where:

$$\frac{\text{lb VOC lost}}{10^3 \text{ board ft @ 60\%}} = \left[\frac{(\text{VOC Inlet, ppm})}{(1-0.60)} - \frac{(\text{VOC Outlet, ppm})}{(1-0.15)}\right] \times \frac{37 \text{ dry wood}}{\text{ft}^3} \times \frac{1/12 \text{ ft}^3}{\text{board feet}} \times \frac{1}{(10^6)(10^{-3})}$$

and:

$$\frac{\text{batch average lb VOC}}{\text{board feet}} \times \frac{\text{mm board ft}}{\text{yr}} \times \frac{\text{ton}}{2000 \text{ lb}} = \frac{\text{tons VOC emitted}}{\text{yr}}$$

P. O. BOX 1391, SAVANNAH, GA. 31402 TELEPHONE (912) 238-7484

CORPORATE OFFICE OF
ENVIRONMENTAL AFFAIRS

January 13, 1994

Mr. Dallas Safriet (MD-14)
Emissions Inventory Branch
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

RE: Proposed Revision to AP-42 Section 10.1, Lumber and Wood Products Manufacturing and Woodworking Operations.

Dear Mr. Safriet;

Union Camp Corporation is a major producer of paper and wood products in the Southeastern United States. In the production of wood products we employ some of the techniques described in the above-referenced document. As a result, the information in Section 10.1 is relevant to our company. We have reviewed the proposed draft revision to AP-42 and respectfully submit the following comments:

1. **The Quality of the Data in the Proposed Revision are Too Poor for Release to the Regulated Community.**

   EPA has reviewed the available data from selected source tests, regional EPA file information and EPA air emission bulletin boards. The air emission information gleaned from these sources was sparse. EPA apparently performed no source testing of its own nor worked through industry groups to canvas woods products plants for additional data. The data EPA selected for inclusion in this AP-42 revision were classified according to a quality rating system.

   The Agency sorted data according to testing methodology and how representative the source was compared to the rest of the industry. The system provides an A through E factor, with A being rated as "Excellent" and E having a rating of "Poor." This rating system is very valuable to the user of AP-42, and the Agency is commended for this analysis. What this rating system reveals, however is very disappointing and a cause for concern. According to EPA's rating criteria ALL of the emission factors are rated "D - below average," or "E - poor." These ratings draw into question the utility and wisdom of issuing this section for use by the regulated community.

2. EPA Should Improve the Quality of It Data Before Inclusion in AP-42.

The Agency has recognized that little air emission data exists in the wood products industry. EPA also realizes that AP-42 is frequently consulted to estimate emissions by facility owners, regulators, and pollution control equipment companies. The inadvertent mis-use of poor data could easily lead to an inaccurate emission number and resulting regulatory jeopardy; or faulty equipment design. The Agency should not publish solely "D" and "E" rated data no matter how many caveats are associated with its use.

Instead EPA should work through industry groups, universities, private business and the like to obtain reliable data. Many forest products companies will be generating air emission data with the advent of Title V of the Clean Air Act Amendments. These data will be publicly available when applications are filed with the states. Industry groups also have programs to assist their members in determining air emissions to aid in Title V application preparation. EPA should work with these groups to foster this information gathering effort. It is believed that much air emission testing will be conducted in 1994 and 1995 for Title V purposes. <u>EPA should work with industry groups to help with quality assurance, and should wait until these data are available before inclusion in AP-42.</u> We believe that the poor quality data in the proposal will not be of substantial use to the wood products industry.

Thank you for the opportunity to comment on the proposed revision to AP-42. Should you have any questions, please feel free to contact Allan E. Cawrse of my staff at (912) 238-7484.

Sincerely,

AECawrse for

Duane W. Marshall, Director
Corporate Office of
Environmental Affairs

cc:
AE Cawrse, Savannah
JF Godbee, Savannah
GA Ethridge, Savannah
Dr. John Pinkerton, NCASI, NY

Weyerhaeuser

Victor Dallons
WTC 2F2
Tacoma WA 98477
Tel (206) 924-6096
Fax (206) 924-6182

original sent to RTI on 10-11-94

Dallas Safriet
Environmental Engineer
Emission Inventory Branch (MD-14)
Research Triangle Park
North Carolina 27711

Dear Mr. Safriet

These are my comments on the second draft of AP-42 (August 5, 1994) Lumber and wood products emission factors.

The units on tables 10.1 - 1 through 10.1-4 are not clearly stated. I think they are mass emissions per mass production, although some appear to be mass pollutant per volume production. It is not stated if the mass production wet weight or dry weight. It would help the user to include the wood density you assumed to convert between MBF and wood weight.

Any VOC emission factor listed in these tables should be wood species specific! Emission factors for drying Douglas fir, Hemlock, Cedar and other softwoods are considerably different than those for Southern Pine. Emissions from sapwood and heart wood are different for some species.

Emission factors for Southern Pine differ with region of the country. It would be helpful to list a range of emission factors in the tables. Other variables, such as the amount of time between cutting and drying or lumber dimension may also impact the VOC emissions from lumber drying. These factors should be discussed in the AP-42 document.

I could not reproduce the emission factors you reported that were based on Weyerhaeuser source tests. Attached are my calculations of what those emission factors should be.

If you have any questions, please call.

Sincerely

Victor Dallons

Victor Dallons

copy: Mike Rast - Columbus Sort 153
Dave Mumper - CH1L28
Chuck Vaught - Newbern

Reference 15
VOCs, lumber kiln Bruce - MS

Time				Elapsed Time	Avg	Rate for		
Start		End			Emission	period		
				hr	Rate	lbs		
					lb/hr			
3	0	4	52	1.88	21.0	39.6		
4	53	6	0	1.35	16.9	22.8		
6	14	7	51	1.75	14.7	25.8		
7	59	9	2	1.32	12.2	16.0		
9	18	10	56	1.78	12.5	22.4		
11	5	13	46	2.95	15.3	45.1		
14	2	16	58	3.00	24.2	72.5		
17	2	19	36	2.57	24.4	62.6		
						306.7		
				Production =		143.0	MBF	
				Emissions =		2.1	lb C/MBF	

= 2.8 lb CH_4/MBF

Bruce MS   Reference 15

VOCs wood fired kiln

Test	time	CO_2 %	Fuel lb/min	Heat Input MMBtu/hr	Exhaust Flow DSCFM	VOCs as carbon ppm	VOCs as carbon lb/MMBtu	VOCs as carbon lb/hr	VOCs as carbon lb/MBF	CO ppm	CO lb/MMBtu	CO lb/hr	CO lb/MBF	NOx ppm	NOx lb/MMBtu	NOx lb/hr	NOx lb/MBF
1	3:02	3.3	15	7.65	7091	1026	1.77	13.5	3.2	117	0.47	3.60	0.9	20	0.13	1.01	0.25
2	4:43	4.6	15	7.65	5087	450	0.56	4.3	1.0	92	0.27	2.03	0.5	25	0.12	0.91	0.23
3	6:17	4.2	15	7.65	5571	2901	3.93	30.1	7.2	310	0.98	7.50	1.9	14	0.07	0.56	0.14
						Avg.	2.1	15.9	3.8	Avg.	0.57	4.38	1.1	Avg.	0.11	0.82	0.21

→ = 5.1 lb CH_4/MBF

Mountain Pine

NO. 2 LUMBER KILN Steam Heated Southern Pine	Reference 17	Reference 16
Test #:	K1	K2
Date:	8/12/92	8/17/92
Total Run Time (hrs):	17.18	18.17
Lumber Moisture Content (%)		
Green:	93.7	94.3
Dry:	10.1	9.2
Kiln Load (bd. ft.):	119,000	119,250
Avg. Wet Bulb Temp. (°F):	158	160
Avg. Dry Bulb Temp. (°F):	196	196
VOC EMISSIONS, lb/hr	21.8	19.2
hrs/load	16.3	17.75
total VOCs/load	355.34	340.8
VOCs, lb C/MBF	3.0	2.9
lb CH_4/MBF	4.0	3.8 ⇐
Filterable PM EMISSIONS, lb/hr		0.44
hrs/load		18
total PM/load		7.92
PM/MBF		0.066
Total PM EMISSIONS, lb/hr		1.32
hrs/load		18
total PM/load		23.76
PM/MBF		0.199

Reference 18 - Bruce MS

Steam Heated kiln emission data

Sample Period Start Time	Sample Period End Time	Elapsed time hr	Cumulative time hr	Avg Emission Rate lb/hr	% of Avg	Avg Emission Rate lb/min	Rate for period lbs
3 :00	4 :52	1.88	1.88	21.0	19%	0.4	39.6
4 :53	6 :00	1.35	3.23	16.9	-4%	0.3	22.8
6 :14	7 :51	1.75	4.98	14.7	-17%	0.2	25.8
7 :59	9 :02	1.32	6.30	12.2	-31%	0.2	16.0
9 :18	10 :56	1.78	8.08	12.5	-29%	0.2	22.4
11 :05	13 :46	2.95	11.03	15.3	-13%	0.3	45.1
14 :02	16 :58	3.00	14.03	24.2	37%	0.4	72.5
17 :02	19 :36	2.57	16.60	24.4	38%	0.4	62.6
Average				17.6			306.7

Production = 158 MBF

Emissions = 1.9 lb C/MBF

= 2.5 lb CH_4/MBF

DRAFT

Emissions of TOC from the steam-heated lumber kiln were measured at east stack #2 and west stack #1 using EPA Method 25A. Volumetric flow rates were measured using EPA Methods 1-4. The kiln has eight identical stacks, four on the east side and four on the west side. At any given time, four of the stacks are drawing air, while the other four are venting the kiln emissions. One stack was sampled from each side. Therefore, the measured emissions and flow rates were multiplied by four to account for four (assumed identical) emission points. Total drying time in the kiln was reported as 19.3 hours, but as specified in Reference 19, the kiln did not vent for the first two hours. Therefore, the measured emissions were assumed to represent a 17.3 hour drying time. The TOC results were reported as propane and converted to a methane basis using the ratio of the molecular weight of methane to the molecular weight of propane. Run-by-run TOC emission factors were calculated by dividing the mass emission rates (lb/hr) by the kiln charge rate (143 MBF/17.3 hr) provided in the report appendix.

The data from the tests on both kilns are assigned a B rating. The testing methodology appeared to be sound, adequate detail was provided in the report, and no problems were reported during the test runs. The data are rated B (rather than A) because the assumption that emissions from all four emitting stacks are identical may not be totally accurate, although it appears to be a reasonable assumption.

4.1.16 Reference 16

This test report documents the results of an emission test conducted by Radian Corporation at the Weyerhauser Company Mountain Pine Mill in Mountain Pine, Arkansas, on August 17-18, 1992. The test was conducted on a steam-heated kiln that was drying Southern yellow pine. Two boilers, an MDF press vent and a new MDF veneer dryer were also tested, but the results of these tests are not included in this discussion.

Emissions from the kiln were measured at two of eight identical stacks (stacks #2 and #6). The targeted pollutants and corresponding test methods used were filterable PM (EPA Method 5), condensible inorganic and organic PM (EPA Method 5 [back half analysis]), formaldehyde (NIOSH Method 3500), CO (EPA Method 10), and TOC (EPA Method 25A). The PM and formaldehyde tests comprised four test runs of at least 60 minutes each during the same kiln cycle, and the CO and TOC tests were continuous tests that spanned the entire kiln cycle. Stack parameters, including volumetric flow rates, were measured using EPA Methods 1-4. At any given time, four of the eight kiln stacks vent the kiln emissions. Therefore, the emission and flow rates measured at a single stack were multiplied by four to account for the four (assumed identical) stacks. Total drying time in the kiln (kiln cycle) was reported as 18.17 hours. The TOC results were reported as carbon and converted to a methane basis. Run-by-run emission factors were calculated by dividing the mass emission rates (lb/hr) by the kiln charge rate (119.25 MBF/18.17 hr) provided in Appendix O of the report.

The data, with the exception of the formaldehyde data, are assigned a B rating. The testing methodology appeared to be sound (except for the formaldehyde test), adequate detail was provided in the report, and no problems were reported during the test runs. The data are rated B (rather than A) because the assumption that emissions from all four emitting stacks are identical may not be totally accurate, although it appears to be a reasonable assumption. The formaldehyde data are assigned a C rating because several potential interferences may bias NIOSH Method 3500, as discussed in Reference 20.

4.1.17 Reference 17

This test report documents the results of an emission test conducted by Radian Corporation at the Weyerhauser Company Mountain Pine Mill in Mountain Pine, Arkansas, on August 12-13, 1992. The source tested was a steam-heated lumber kiln that was drying Southern yellow pine.

Emissions from the kiln were measured at each of eight identical stacks. The targeted pollutants and corresponding test methods used were CO (EPA Method 10) and TOC (EPA Method 25A). The tests were continuous tests and spanned the entire kiln cycle. Stack parameters, including volumetric flow rates, were measured using EPA Methods 1-4. At any given time, four of the eight kiln stacks vent the kiln emissions. Volumetric flow rates were measured one at a time for each of four stacks. Therefore, the flow rates measured at a single stack were multiplied by four to account for the four (assumed identical) stacks. Total drying time in the kiln (kiln cycle) was reported as 17.18 hours. The TOC results were reported as carbon and converted to a methane basis. Emission factors were calculated by dividing the mass emission rates (lb/hr) by the kiln charge rate (119 MBF/ 17.18 hr) provided in Appendix O of Reference 16.

The data are assigned an A rating. The testing methodology appeared to be sound, adequate detail was provided in the report, and no problems were reported during the test runs.

4.1.18 Reference 18

This test report documents the results of an emission test conducted by Clean Air Engineering at the Weyerhauser Company, Bruce, Mississippi, facility on May 4-6, 1993. The test was conducted on a steam-heated lumber kiln (east and west stacks), which is the same as one of the kilns described in Reference 15. The wood species dried during the test was Southern yellow pine. Two boiler stacks were also tested, but the results of these tests are not included in this discussion.

Emissions of TOC from the steam-heated lumber kiln were measured at east stack No. 2 and west stack No. 1 using EPA Method 25A. Volumetric flow rates were measured using EPA Methods 1-4. The kiln has eight identical stacks, four on the east side and four on the west side. At any given time, four of the stacks are drawing air, while the other four are venting the kiln emissions. Therefore, the flow and emission rates measured at one stack were multiplied by four to account for the four (assumed identical) emitting stacks. The measured emissions were assumed to represent the full 17.96 hour drying time. The TOC results were reported as propane and converted to a methane basis. Run-by-run TOC emission factors were calculated by dividing the mass emission rates (lb/hr) by the kiln charge rate (157.5 MBF/17.96 hr) provided in Attachment A of Reference 19.

The data are assigned a C rating. The testing methodology appeared to be sound, adequate detail was provided in the report, and no problems were reported during the test runs. However, Reference 19 reports that a water balance shows that about 59 percent of the water that was lost from the lumber during the drying cycle could be accounted for in the emissions based on the moisture content of the exhaust stream. These data suggest that the sampling measured only about 59 percent of the emissions. This discrepancy may have been due to an imbalance in flows from the eight vents, possibly caused by the stack extensions attached to the two vents that were sampled.

TABLE 4-5. SUMMARY OF TEST DATA FOR LUMBER AND WOOD PRODUCTS MANUFACTURING AND WOODWORKING OPERATIONS–LUMBER DRYING[a]

Type of kiln	Pollutant	No. of test runs	Data rating	Emission factor range, lb/MBF[b]	Average emission factor, lb/MBF[b]	Ref. No.
Steam-heated[c]	Condensible organic PM	1	D	NA	0.106	12
Steam-heated[c]	Condensible inorganic PM	1	D	NA	0.0485	12
Steam-heated[c]	TOC[d]	1	D	NA	1.67	12
Direct-fired[e]	CO_2	3	B	382	382	15
Direct-fired[e]	NO_x	3	B	0.133-0.242	0.197	15
Direct-fired[e]	CO	3	B	0.486-1.79	1.05	15
Direct-fired[e]	TOC[d]	3	B	1.65-11.7	1.71	15
Steam-heated[f]	TOC[d]	6	B	0.884-1.75	1.01	15
Steam-heated[g]	Filterable PM	4	B	0.0440-0.0989	0.0677	16
Steam-heated[g]	Condensible organic PM	4	B	0.0774-0.179	0.124	16
Steam-heated[g]	Condensible inorganic PM	4	B	0.00385-0.0107	0.00714	16
Steam-heated[g]	Formaldehyde	4	C	0.00483-0.00797	0.00675	16
Steam-heated[g]	CO	h	B	NA	0.0280	16
Steam-heated[g]	TOC[d]	h	B	NA	2.91	16
Steam-heated[j]	CO	h	A	NA	0.109	17
Steam-heated[j]	TOC[d]	h	A	NA	16.8	17
Steam-heated[k]	TOC[d]	6	C	1.63-2.97	2.35	18

[a]NA = not applicable. Emission factors represent uncontrolled emissions unless noted.
[b]Emission factors in units of pounds per thousand board feet (lb/MBF) of lumber dried.
[c]For Ponderosa pine dried from about 50 percent moisture on a wet basis to 12 to 18 percent moisture. Data is based on cumulative totals for one 100-hour batch run with TOC emission concentrations measured at 5-minute intervals, and condensibles measured only as a single composite sample.
[d]Total organic compounds on a methane basis as measured using EPA Method 25A.
[e]For Southern yellow pine dried from about 40 percent moisture (assumed wet basis) to about 17 percent moisture.
[f]For Southern yellow pine dried from about 60 percent moisture (assumed wet basis) to about 19.6 percent moisture.
[g]For Southern yellow pine dried from about 94.3 percent moisture (assumed dry basis) to about 9.2 percent moisture.
[h]Emission factors based on a single continuous monitoring run that spanned a full kiln cycle.
[j]For Southern yellow pine dried from about 93.7 percent moisture (assumed dry basis) to about 10.1 percent moisture.
[k]For Southern yellow pine dried from about 104 percent moisture on a dry basis to about 13 percent moisture.

Building Board - Lumber 8/94

A survey of firms kiln-drying lumber in the United States: volume, species, kiln capacity, equipment, and procedures

R.W. Rice
Jeffrey L. Howe
R. Sidney Boone
J.L. Tschernitz

Abstract

Between June 1992 and May 1993, a survey was conducted of primary and secondary manufacturing firms that had a least one dry kiln and processed at least 2 million board feet (MMBF) of lumber annually. Over 1,500 questionnaires were completed representing manufacturers in 43 states. According to survey respondents, just over 29 billion board feet (BBF) of lumber were kiln-dried. About 24 BBF were from softwood species and about 5 BBF were from hardwoods. Southern firms dried more than twice as much lumber as any other region. More southern yellow pine is dried than any other softwood species or species group. The leading hardwood is red oak. Drying data and volume totals are presented for the five leading softwoods and the six leading hardwoods.There are over 7,000 dry kilns in the United States with a total holding capacity of 447 MMBF. Most are steam heated. The holding capacity of dry kilns varies by species, but softwood kilns are the largest. There is also a regional size variation. The most commonly used maximum operating temperature for dry kilns is between 160° and 180°F. The kiln schedule type is dependent on the species being dried. Softwood producers generally used time-based schedules and hardwood producers used schedules based on moisture content. The is the first survey of its type with a national scope to be conducted in the United States.

The drying of wood is critical to its overall performance and value. During the conversion of logs to lumber and related products, more time and expense is incurred in drying than in any other single processing step.

The purpose of this study was to assess the drying practices of the major primary and secondary lumber processors or manufacturers in the United States. Specifically, the following objectives were established:

1. Determine the approximate volume and the species of lumber kiln-dried by primary and secondary manufacturers producing over 2 million board feet (MMBF) annually and having at least one dry kiln.

2. Determine the kiln capacities and kiln types used by major primary and secondary manufacturers.

3. Determine the moisture monitoring methods and the maximum drying temperatures being used.

Methods

Survey sample

The intent of the study was to survey all primary and secondary manufacturers in the 48 contiguous states and Alaska that have at least 1 dry kiln and produce or process a minimum of 2 MMBF of lumber annually. We estimate that this excluded between 20 and 30 percent of the primary and secondary manufacturers in the United States based on statistics reported by the U.S. Department of Commerce.

The exclusive nature of the survey created difficulty in defining the term "production." References to production in this text refer to the annual throughput or the amount of lumber handled by a given manufacturer, regardless of whether primary log breakdown

The authors are, respectively, Assistant Professor of Wood Science, Univ. of Maine, Forest Prod. Lab., 5755 Nutting Hall, Orono, ME 04469-5755; Research Assistant, Univ. of Minnesota, Dept. of Forest Prod., Kaufert Lab., 2004 Folwell Ave.; St. Paul, MN 55108; and Wood Technologist and Chemical Engineer, USDA Forest Serv., Forest Products Lab. (FPL), One Gifford Pinchot Dr., Madison, WI 53705-2398. This survey was sponsored by the Maine Toxicology Institute, the Maine Agri. Expt. Sta. (Report No. 1822), and the FPL. A more comprehensive version of this report has been published as an FPL general technical report and is available through the FPL. The authors would like to thank graduate research assistants Daniel Phillips and Mark D'Onofrio for assisting with data collection. This paper was received for publication in February 1994.

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occurred at the manufacturer's site or elsewhere. The production figures listed should not be compared to U.S. Department of Commerce lumber production figures that are derived from different sources and are more inclusive.

In all cases, our main concern was the volume of wood dried by the manufacturer rather than where primary breakdown of the lumber occurred. The criteria led, naturally, to some apparent anomalies where species such as southern yellow pine were counted in the production statistics for Minnesota or mahogany was produced in Mississippi. Overall, these extraordinary situations probably occurred in fewer than 1 percent of the manufacturers surveyed.

More important were situations where green lumber was produced at one manufacturer, purchased by another manufacturer, and dried in the purchaser's kiln. Neither this survey, nor other surveys of forest products output, account for this type of situation. Within the limits and objectives of this survey, the entire throughput of the mill was considered production or as being processed by the manufacturer.

Another difficulty concerned the term "lumber." Rarely, manufacturers drying products other than lumber such as poles or large timbers were encountered. The volumes of these products were mathematically converted from cubic feet or other units to board feet and the result was tallied as lumber. Overall, this situation probably occurred in fewer than 1 percent of the mills surveyed.

Lists of potential companies and firms for the survey were obtained by contacting personnel from state forestry and university extension organizations and other knowledgeable persons who provided directories or information about the industry. State directories were supplemented by lists from the *1993 Directory of the Wood Products Industry*[1] and by membership lists from regional and state kiln-drying associations.

Verification to determine if a manufacturer/company met the requirements of our survey was made by telephone. About 30 percent of the plants were excluded because they did not meet our criteria. About 8 percent of the manufacturers included in the final tally produced somewhat less than 2 MMBF during the 12 months preceding the survey, many due to an economic recession. Finally, lists of survey respondents were sent to knowledgeable individuals from each state for review and to assure that the maximum effort had been made to identify all producers meeting the survey criteria.

Survey instrument

The survey instrument (questionnaire) was intended to gather information about facilities, production, and drying activities. The questionnaire involved nine partially open-ended[2] questions that utilized check lists to speed the process. Every effort was made to make the language unambiguous and to allow the opportunity for clarification of answers. Two questions involved mill type and the respondent's position. Three questions were used to determine production by species, and four questions were specific to the firm's drying capacity and equipment.

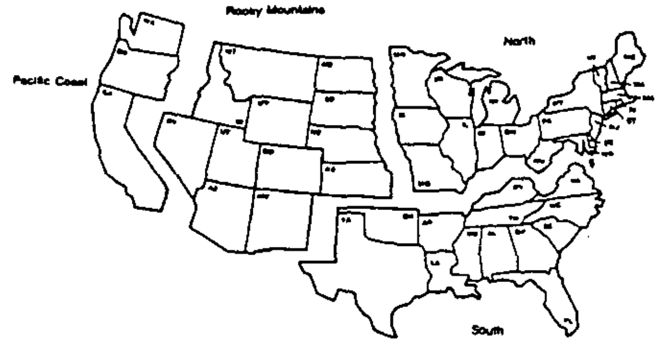

Figure 1. — RPA assessment regions.

Conduct of the survey

The survey was conducted by telephone. To minimize caller bias, a standard introductory message was utilized and surveyors were selected who had training in kiln-drying activities. The surveyors also clarified terms such as predryer and maximum operating temperature if the respondents seemed uncertain or requested clarification. To assure consistency, responses from each state were reviewed on an individual basis as the survey of each state was completed.

The preliminary questionnaire was reviewed by personnel from the USDA Forest Service, Forest Products Laboratory, and was pretested on four companies in each of three states (Louisiana, Montana, and New Hampshire). The review process produced several clarifications and editing was done to remove some perceived ambiguity in the questions.

The survey was conducted from June 1992 through May 1993. During this period, substantial changes in industry structure and ownership were occurring in Washington and Oregon and the situation caused concern among the surveyors. As a result, many of the mills in the Pacific Northwest were surveyed twice and several knowledgeable individuals were asked to verify all or some of the information obtained.

In polling the sample, very few refusals were encountered. When manufacturers chose not to cooperate, surveyors attempted to piece the information together by using alternative sources. In some cases, no one could be reached who could provide information and after three tries the attempts were halted. In several instances, information about firms who could not be contacted by phone was available through kiln-drying membership directories or other member-

[1] Miller-Freeman. 1993. Directory of the Wood Products Industry. Pamela Malpas, ed. Miller-Freeman, Inc., San Francisco, Calif.

[2] Partially open-ended in this case involves answers that generally fit in certain categories, but allow for options not previously considered to provide a richer response.

TABLE 1. — *Survey results arranged by region.*[a]

Region and state	No. of completed surveys	Volume produced (MMBF)	No. of steam kilns	No. of direct-fired kilns	No. of dehumidification kilns	Other kilns	Total kiln capacity (MMBF)	Total kiln-dried (MMBF)	No. of predryers	Predryer capacity (MMBF)	No. of fan sheds	Fan shed capacity (MMBF)
Northern												
CT	3	26.5	33	0	0	0	0.6	23.1	0	0	0	0
IL	8	29.5	25	0	1	0	1.1	22.4	0	0	0	0
IN	28	162.3	141	3	20	0	6.6	138.9	5	2.5	0	0
IA	8	22.0	20	4	2	0	1.2	14.8	2	0.6	0	0
ME	45	757.9	167	0	26	3	10.1	716.9	5	2.1	4	0.1
MD	4	41.0	10	1	0	0	0.6	39.4	0	0	0	0
MA	11	53.4	37	0	8	0	2.2	45.3	2	1.5	0	0
MI	43	450.7	211	5	20	0	9.8	270.3	7	6.7	0	0
MN	41	294.4	87	3	25	1	4.8	211.4	6	2.2	1	0.2
MO	38	242.5	170	10	8	0	9.3	222.4	11	4.1	1	0.1
NH	26	169.3	88	0	15	2	4.2	145.7	1	0.3	0	0
NJ	2	9.0	9	0	0	0	0.3	8.9	0	0	0	0
NY	51	317.5	294	2	17	6	14.9	263.4	17	9.2	11	3.6
OH	39	263.7	208	0	21	0	9.9	226.0	26	8.4	2	0.5
PA	73	521.9	419	14	31	3	24.7	380.9	21	14	2	0.4
VT	21	117.9	112	0	20	0	4.8	95.0	4	1.1	0	0
WV	29	287.9	144	1	35	0	9.5	188.7	2	0.9	0	0
WI	81	482.9	328	6	24	7	15.3	347.9	20	6.9	0	0
Regional total	551	4,249.8	2,503	49	273	22	130.5	3,361.3	129	60.4	21	4.9
Pacific Coast												
CA	46	3,002.3	527	0	0	0	38.3	2,191.6	1	0.1	0	0
OR	68	3,869.0	424	1	26	0	35.9	2,629.0	0	0	0	0
WA	56	2,968.5	302	4	19	0	27.7	2,359.3	0	0	0	0
Regional total	170	9,875.9	1,253	5	45	0	101.8	7,195.6	1	0.1	0	0
Rocky Mountain												
AZ	7	347.2	55	0	0	0	5.1	305.7	0	0	0	0
CO	4	85.0	6	0	2	0	0.7	65.99	0	0	0	0
ID	30	1,854.2	152	9	7	0	15	1,727.7	0	0	0	0
KS	4	9.9	17	1	0	1	0.7	9.8	0	0	0	0
MT	24	1,112.0	104	1	4	0	8.9	1,067.7	0	0	0	0
NM	3	76.0	7	0	0	0	0.6	57.6	0	0	0	0
SD	3	151.0	7	0	0	0	0.9	151.0	0	0	0	0
UT	1	8.0	0	1	0	0	0	1.2	0	0	0	0
WY	8	200.0	17	1	0	0	1.5	165.5	0	0	0	0
Regional total	84	3,843.3	365	13	13	1	33.4	3,552.2	0	0	0	0
Southern												
AL	78	2,266.4	159	29	16	0	15	2,012.9	2	1.7	0	0
AR	44	1,476.8	151	21	4	0	14.3	1,368.0	7	6.1	1	0.1
FL	25	769.2	22	15	4	1	3.8	708.4	0	0	1	0
GA	60	2,147.2	86	44	6	0	11.8	1,924.3	0	0	0	0
KY	53	433.0	174	10	40	22	13.4	298.0	20	12.5	0	0
LA	34	1,145.0	63	28	2	0	8.2	1,024.0	3	1.3	2	0.1
MS	89	2,914.9	270	50	4	1	24.1	2,734.5	14	10.3	9	2
NC	108	1,665.9	453	25	21	0	34.3	1,507.5	8	3.2	2	1.6
OK	2	170.0	7	1	0	0	0.8	169.9	0	0	0	0
SC	46	1,383.6	104	21	0	1	10	1,325.9	2	0.1	1	0.6
TN	77	578.6	359	11	23	1	22	523.6	21	15.5	0	0
TX	31	986.3	61	13	1	1	5.7	939.8	0	0	0	0
VA	57	533.2	255	2	20	0	17.5	494.9	7	5.6	2	.2
Regional total	709	16,470.0	2,164	270	141	27	180.8	15,031.6	84	56	18	4.6
All regions	1,509	34,439.0	6,285	337	472	50	446.5	29,141.0	214	116.4	39	9.5

[a] Kiln capacity refers to capacity of 4/4 lumber.

TABLE 2. — *Lumber dried and produced by region and leading states within each region.*

Region and state	Volume dried	Volume produced	Volume kiln-dried
	(MMBF)		(%)
Northern			
ME	717	758	94.6
PA	381	522	73.0
WI	348	483	72.0
MI	270	451	59.9
NY	263	317	83.0
Regional total	3,361	4,250	79.1
Pacific Coast			
OR	2,629	3,869	68.0
WA	2,359	2,969	79.5
CA	2,192	3,002	73.0
Regional total	7,196	9,876	72.9
Rocky Mountain			
ID	1,728	1,854	93.2
MT	1,068	1,112	96.0
AZ	306	347	88.2
WY	166	200	83.0
SD	151	151	100.0
Regional total	3,552	3,843	92.4
Southern			
MS	2,735	2,915	93.8
AL	2,013	2,266	88.8
GA	1,924	2,147	89.6
NC	1,508	1,666	90.6
AR	1,368	1,477	92.6
Regional total	15,032	16,470	91.3
Grand total	29,141	34,439	84.6

ship lists. These exceptions amounted to less than 1 percent of the sample.

After tallying all of the valid questionnaires, about 5 percent of the manufacturers identified as meeting our criteria could not be included for various reasons; giving a response rate of 95 percent.

Many of the tables in this study are arranged by region. When needed, the regional breakdown was done using the Resources Planning Act (RPA) assessment regions (Fig. 1).

Results and discussion

Most of the survey results are summarized in Tables 1 and 5. Summary information was taken from Tables 1 and 5 to emphasize certain aspects of the data, which are discussed in the following sections.

A total of 1,509 questionnaires were completed. Occasionally, a single respondent provided information about other facilities owned or controlled by the manufacturer, so the actual number of facilities is greater than the number of questionnaires completed. Over half (53%) of the surveyed mills had integrated manufacturing operations.[3] Of the total, 13 percent operated only a sawmill and dry kiln. Nearly 35 percent were manufacturers with only nonprimary operations.

Volume of lumber kiln-dried

According to the respondents, approximately 29 billion board feet (BBF) of lumber were kiln-dried annually. A total of 91 percent (15 BBF) of product from the Southern region was kiln-dried (Table 2). Alabama, Arkansas, Georgia, Mississippi, and North Carolina dried nearly 64 percent of all the kiln-dried lumber in the 13-state region.

Manufacturers in the Pacific Coast region reported slightly more than 7 BBF of kiln-dried product, or about 73 percent of production. Oregon, Washington, and California each dried more than 2 BBF. Of the states surveyed, the manufacturers of Oregon produced and dried more wood than any other. No operating dry kilns were found in Alaska at the time of our survey, although two are currently operating near Seward.

The manufacturers of the Rocky Mountain and Northern regions each dried about 3.5 BBF, with Idaho and Montana the leaders in the Rocky Mountain region and Maine, Pennsylvania, and Wisconsin leading the Northern region. In the Rocky Mountain region, about 92 percent of the lumber was kiln-dried. In the North, about 79 percent was kiln-dried.

Species of lumber kiln-dried by volume

The volume of lumber kiln-dried for 55 species or species groups was collected from 43 states. Data for the five leading softwood and the six leading hardwood species/species groups are shown in Table 3.

Softwoods. — Just over 24 BBF or 86 percent of reported softwood lumber production was kiln-dried. Southern yellow pine (SYP) kiln-dried lumber accounted for 12.5 BBF, which represented 94 percent of reported production. The states producing the largest volumes of kiln-dried southern pine included

[3] Integrated mills were those having secondary operations, usually in addition to a sawmill and a dry kiln.

TABLE 3. — *Volumes of leading softwood and hardwood species dried and produced by the leading states.*

Species and state	Volume dried	Volume produced[a]	Volume kiln-dried
	(MMBF)		(%)
Softwoods			
Southern pine			
MS	2,431	2,472	98.3
AL	1,823	1,983	91.2
GA	1,806	1,956	92.3
SC	1,268	1,302	97.4
AR	1,172	1,184	98.9
All other states	4,050	4,433	91.3
Total	12,550	13,330	94.1
Ponderosa pine			
OR	907	945	96.0
CA	660	743	88.8
WA	312	326	95.7
AZ	275	302	91.1
ID	242	245	98.8
All other states	427	463	92.2
Total	2,823	3,024	93.4
Douglas-fir			
OR	686	1,397	49.1
WA	556	855	65.0
MT	363	373	97.3
ID	323	333	97.0
CA	271	599	45.2
All other states	26	42	61.9
Total	2,225	3,599	61.8
Western firs			
WA	554	760	72.9
ID	467	509	91.7
CA	451	597	75.5
OR	375	438	85.6
All other states	55	65	84.6
Total	1,902	2,369	80.3
Western hemlock			
WA	525	554	94.8
OR	250	423	59.1
ID	40	48	83.3
All other states	9	31	29.0
Total	824	1,056	80.3
All other softwoods combined	3,858	4,687	82.3
Total softwoods	24,182.0	28,065.0	86.2
Hardwoods			
Red oak			
TN	216	235	92.0
PA	153	200	76.5
MS	129	199	64.8
WI	119	157	75.8
AR	115	146	78.8
All other states	1,031	1,276	80.8
Total	1,763	2,213	79.7
White oak			
TN	154	165	93.3
KY	72	85	84.7
AL	56	80	70.0
AR	51	67	76.1
MO	55	61	90.2
All other states	343	424	80.9
Total	731	882	82.9
Yellow-poplar			
VA	86	94	91.5
NC	73	81	90.1
KY	55	65	84.6
OH	35	46	76.1
WV	33	67	49.2
All other states	125	151	82.8
Total	407	504	80.7

TABLE 3. — *continued.*

Species and state	Volume dried	Volume produced[a]	Volume kiln-dried
	(MMBF)		(%)
Maple			
NY	71	75	94.7
MI	65	84	77.4
WI	37	51	72.5
NC	30	33	90.1
OR	30	30	100.0
All other states	153	182	84.1
Total	386	455	84.8
Red alder			
WA	119	161	74.0
OR	100	107	93.5
All other states	0	1	0
Total	219	269	81.4
Cherry			
PA	46	67	68.7
NY	20	21	95.2
VA	9	9	100.0
OH	8	8	100.0
WV	8	14	57.1
All other states	29	36	80.6
Total	120	155	77.4
All other hardwoods combined	1,315	1,878	70.0
Total hardwoods	4,941	6,356	78.0

[a] Volume of lumber processed and/or produced by secondary or primary manufacturers that have dry kilns and handle 2 MMBF or more annually.

Mississippi, Alabama, Georgia, South Carolina, and Arkansas.

Respondents kiln-dried more ponderosa pine (2.8 BBF) than Douglas-fir (2.2 BBF). This finding was rather surprising. However, only 62 percent of Douglas-fir production was kiln-dried while 93 percent of ponderosa pine was kiln-dried. We speculate that substantial quantities of Douglas-fir are sold without kiln-drying.

The western firs were grouped in our survey.[4] Manufacturers reported about 1.9 BBF (80%) of production was kiln-dried. Western hemlock was tallied separately, with about .8 BBF kiln-dried. In many cases, the breakdown between hemlock and fir reported by manufacturers was considered speculative by surveyors.

Hardwoods. — Almost 5 BBF of hardwood lumber was kiln-dried (Table 3) representing about 78 percent of the volume processed by the surveyed manufacturers. Products such as furniture, cabinets, flooring, paneling, and moulding require final moisture contents (MC) of 6 to 8 percent and almost all the lumber for these products is kiln-dried. In addition, more than 4 BBF of hardwood lumber was used by the pallet and container industry during 1991 to 1992.[5] Little, if any, of this lumber is kiln-dried.

Overall, the oaks are the main species group. Slightly more than 1.7 BBF of red oak was kiln-dried. The states drying the most red oak were Tennessee, Pennsylvania, Mississippi, Wisconsin, and Arkansas.

TABLE 4. — *Kiln capacity by region and type of wood dried.*

Region and states	Average kiln capacity	Total no. of kilns[a]
	(MBF)	
Northern	46.1	2,825
Pacific Coast	78.1	1,303
Rocky Mountain	85.3	391
Southern	70.2	2,575
CA, OR (Softwood)	75.8	978
NY, OH, PA (Hardwood)	48.7	1,015
KY, TN (Hardwood)	55.3	640
ID, MT, WY (Softwood)	85.9	295
GA, SC, TX (Softwood)	81.3	338

[a] Does not include dehumidifier, direct-fired, and hybrid systems.

Over 700 MMBF of white oak was kiln-dried (Table 3). The leading states include Tennessee, Kentucky, Alabama, Arkansas, and Missouri. Tennessee dried nearly twice as much as any of the other states. When combined with the red oaks, the total volume of oak accounts for nearly 50 percent of all the hardwood lumber that was kiln-dried.

Following the oaks, the species with the most lumber kiln-dried is yellow-poplar, with approximately 407 MMBF. The five leading states drying this species are Virginia, North Carolina, Kentucky, Ohio, and West Virginia.

Approximately 386 MMBF of maple was kiln-dried. New York (71 MMBF) and Michigan (65 MMBF) were leaders, followed by Wisconsin (37 MMBF), North Carolina (30 MMBF), and Oregon (30 MMBF).

[4] Generally comprised of six separate species as outlined in *Wood Handbook No. 72* (1987). USDA Forest Serv., Forest Prod. Lab., Madison, Wis. Ultimately, the species produced was based on the judgment of the respondent.

[5] Cristoforo, J., R.J. Bush, and W.G. Luppold. 1994. A profile of the U.S. pallet and container industry. Forest Prod. J. 44(2):9-14.

About 269 MMBF of red alder was kiln-dried. Leading states drying alder were Washington (119 MMBF) and Oregon (100 MMBF).

Cherry ranked next with 120 MMBF kiln-dried. Pennsylvania, with 46 MMBF, dried more than twice as much as New York, with 20 MMBF. Virginia, Ohio, and West Virginia completed the top five states drying cherry.

Kiln-drying capacity, number and types of kilns

The total dry kiln holding capacity reported by survey respondents was approximately 447 MMBF (Table 1). The total number of dry kilns was 7,144, of which 6,285 were steam kilns (88%), 472 were dehumidification kilns (6.6%), and 337 were direct-fired kilns (5%). The category "other" consisted of vacuum, radio frequency, and other systems that made up only two-thirds of 1 percent of the total. Dehumidifier, direct-fired, and hybrid systems that would be classified as other are often used in smaller facilities that were outside the scope of this survey.

The Northern region has approximately 130 MMBF of kiln capacity with about 2,800 dry kilns, of which 2,503 were steam heated, 273 were dehumidification kilns, and 49 were direct fired. States having kiln capacities of 10 MMBF or more include Pennsylvania, New York, Wisconsin, Maine, Michigan, Ohio, and West Virginia. Like the Southern region, the Northern region dries substantial quantities of both hardwoods and softwoods.

The Pacific Coast region of California, Oregon, and

TABLE 5. — *Summary of drying practices.*

State and region	Maximum drying temperature (°F)					Volume air-dried prior to kiln-drying	Schedule basis		
	120 to 159	160 to 180	181 to 211	212+	Other/ unknown		Time	MC	Other/ unknown
Northern									
CT	4	4	25	0		4.00	29	4	25
IL	0	21	4	0	1	14.15	8	25	1
IN	8	124	0	0	32	100.07	71	146	0
IA	4	20	0	0	2	7.20	6	22	6
ME	67	106	7	12	4	91.37	130	113	84
MD	8	0	0	3		9.00	3	8	1
MA	7	38	0	0		29.25	21	38	1
MI	17	184	19	1	15	93.47	67	199	25
MN	24	80	6	0	6	87.83	32	85	24
MO	46	136	4	2		170.11	50	151	13
NH	54	46	0	0	5	22.52	72	84	4
NJ	0	9	0	0		8.85	9	9	0
NY	48	232	0	0	39	99.74	97	266	31
OH	17	196	4	0	12	97.93	77	198	37
PA	16	415	11	0	25	116.24	95	452	79
VT	22	77	3	0	30	25.94	42	94	10
WV	8	169	3	0		83.64	*48	157	97
WI	38	271	27	0	29	155.55	20	66	15
Regional total	388	2,128	113	18	200	1,216.91	877	2,117	453
Pacific Coast									
CA	13	355	133	0	26	446.55	442	64	166
OR	27	277	130	17		224.82	387	73	157
WA	21	185	97	18	27	51.80	281	43	159
Regional total	61	817	360	35	53	723.17	1,110	180	482
Rocky Mountain									
AZ	0	16	27	12		7.14	55	0	0
CO	4	2	0	2		2.62	8	4	0
ID	13	99	31	25		264.97	22	10	6
KS	1	18	0	0		9.45	7	17	1
MT	5	43	24	28	9	41.32	103	30	15
NM	0	7	0	0		7.20	7	0	0
SD	0	3	2	2		0.00	7	0	2
UT	0	1	0	0		0	0	0	1
WY	1	9	6	2		47.80	17	0	7
Regional total	24	198	90	71	9	380.51	227	61	32
Southern									
AL	7	74	22	80	21	91.49	114	96	26
AK	0	98	16	62		199.52	93	106	35
FL	4	4	2	30	2	80.72	28	10	10
GA	10	44	14	68		133.38	100	29	42
KY	31	144	33	0	38	147.63	81	188	41
LA	6	43	3	41		69.37	80	35	18
MS	23	152	33	90	27	182.38	146	164	106
NC	19	365	62	34	19	212.67	243	393	64
OK	0	0	7	1		16.80	8	1	1
SC	6	42	16	58	4	63.16	109	44	6
TN	35	313	42	3	1	330.98	137	292	82
TX	8	20	10	32	6	41.89	46	30	22
VA	22	226	21	5	3	255.56	78	264	73
Regional total	171	1,525	281	504	121	1,825.55	1,263	1,652	526

TABLE 6. — *Drying methods by region and type of wood dried.*

Region and states	MC	Time	Air-drying prior to kiln-drying
	(%)		
Northern	61.4	25	36.2
Pacific Coast	10.15	62.6	10.0
Rocky Mountain	19.4	71.0	10.7
Southern	48.0	36.7	12.1
CA, OR (Softwood)	10.6	64.3	13.8
NY, OH, PA (Hardwood)	68.8	20.2	36.1
KY, TN (Hardwood)	58.5	26.6	58.2
ID, MT, WY (Softwood)	19.0	67.6	12.0
GA, SC, TX (Softwood)	24.1	59.6	5.7

Washington reported a kiln capacity of 101 MMBF and approximately 1,300 kilns. Of these, 1,253 were steam heated, 45 were dehumidification, and 5 were direct fired. Most of the kiln-drying was done with softwoods. The only major hardwood species kiln-dried is red alder.

The kiln capacity in the Rocky Mountain region was 33.4 MMBF in 392 kilns. Steam-heated kilns accounted for 365 of the total with direct fired and dehumidification each having 13 kilns. Softwoods constitute the bulk of the lumber dried in this region. Idaho and Montana are the leaders in kiln capacity in this region, 15 and 9 MMBF, respectively.

The Southern region has the largest capacity at 181 MMBF and about 2,600 dry kilns. Most of the direct-fired kilns identified in the survey (270) are located in the south, as are most of the kilns in the other category (27). States with 15 MMBF or more of kiln capacity include North Carolina, Mississippi, Tennessee, Virginia, and Alabama. Both softwood and hardwoods are kiln-dried in substantial quantities in this region.

Average kiln size

The average kiln size varied substantially (Table 4). Using the standard assessment regions for kiln size can be somewhat misleading because many states produce substantial quantities of both hardwood and softwood. A more precise approach is to determine the average kiln size for states where the production of either softwood or hardwood dominates. These data are also shown in Table 4. In each of the chosen states, the production of softwoods or hardwoods is 10 times the other. Based on the reported information, it is apparent that the typical softwood kiln is substantially larger than a typical hardwood kiln.

Predryer and fan shed dryers

Predryer use seems confined to areas where hardwood production dominates (Table 1). Overall, 51 percent of the units were found in Ohio, Pennsylvania, Tennessee, Kentucky, and Wisconsin. The average predryer capacity was 544 MBF.

The use of fan shed type dryers is scattered throughout the eastern United States (Table 1). The average fan shed capacity was about 24 MBF.

Drying practices

A summary of drying practices is shown in Table 5. The majority of kilns (69%) are operated at maximum temperatures in the range of 160° to 180°F. Elevated-temperature drying (181° to 211°F) was the second most popular method with 12 percent of the total. High-temperature drying (>212°F) and kilns operating below 160°F each comprised about 9 percent of the total. The other/unknown category is primarily the result of receiving responses from persons who were not aware of the drying temperature details or from persons who chose not to respond.

A total of 44.7 percent of the respondents used MC-based drying schedules (Table 5). About 39 percent of the surveyed mills used time-based schedules, and about 16 percent used a hybrid system such as temperature drop across the load.

The drying method used was also a function of the region and the species or species group being dried (Table 6). It is clear that the use of sample boards dominates in regions producing hardwoods while time-based methods are favored by at least a 2:1 margin by softwood producers.

Overall, about 12 percent of the lumber processed undergoes some air-drying prior to kiln-drying (Table 6). The practice of air-drying before kiln-drying is both region and species dependent. Softwoods undergo substantially less air-drying than do hardwoods. Both end use and kiln size may be factors in these statistics. Softwoods tend to be used as construction lumber and are usually dried to less than 19 percent MC while hardwoods used for interior use are often bracketed between 7 and 10 percent MC.

Summary and conclusions

Over one-half of the total lumber dried was dried in the Southern region (15 BBF), about 7 BBF was kiln-dried in the Pacific Coast region, and the Northern and Rocky Mountain regions each dried about 3.5 BBF.

Just over one-half of the softwood that was kiln-dried was southern pine (12.5 BBF), followed by ponderosa pine (2.8 BBF), and Douglas-fir (2.2 BBF). About 5 BBF of hardwood lumber was kiln-dried, with oak comprising about 50 percent of the total. Other hardwoods with substantial quantities dried were: yellow-poplar (407 MMBF), maple (386 MMBF), red alder (220 MMBF), and cherry (120 MMBF).

There are over 7,000 dry kilns in the United States with a total holding capacity of 447 MMBF. Of these, 88 percent were steam heated. The Southern region had the largest dry kiln capacity (181 MMBF) and about 2,600 kilns. Over 2,800 kilns are found in the Northern region with a holding capacity of 131 MMBF. The Pacific Coast region's kiln capacity is 102 MMBF in 1,300 kilns, followed by the Rocky Mountain region with 33.4 MMBF in 392 kilns.

The most commonly used maximum operating temperature is between 160° and 180°F. The kiln schedule type (time, MC-based, or other) was dependent on the species being dried. Softwood producers generally used time-based schedules and hardwood producers used MC-based schedules.