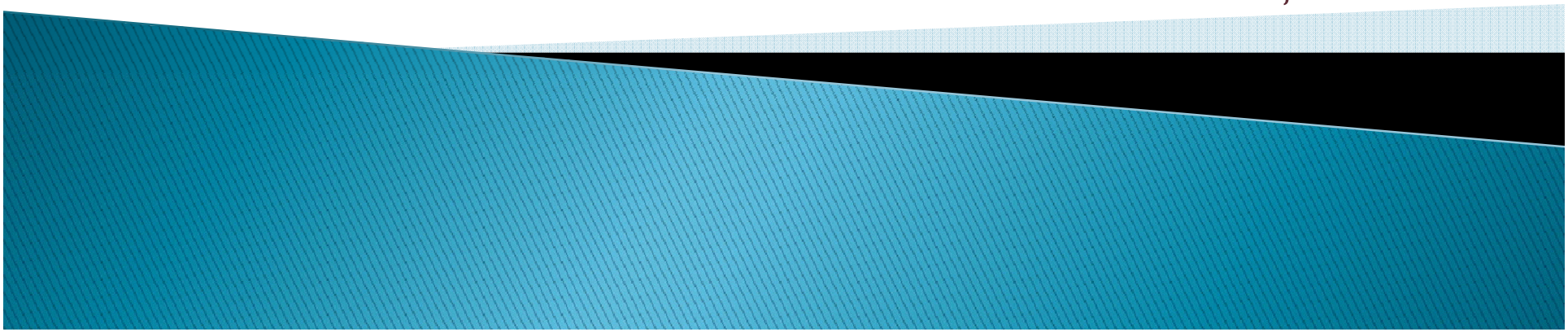
DRY KILN EMISSIONS

Title 5 Considerations

SOUTHWEST CLEAN AIR AGENCY
Paul T. Mairose, P.E.
Clint H. Lamoreaux, P.E.

Title 5 Conference – Cle Elum November 3, 2009



Title V Issue

- Important to continue emission characterization of existing sources. Examples of major-emitting facilities that were initially overlooked in 1990s:
  - Corn ethanol plants
  - Compost facilities
  - Formaldehyde from engines
  - Truck bed liners – VOCs / HAPs / TAPs
  - Natural gas glycol dehydrators
  - Hg from gold roasters
  - Dry kilns
  - SOCMI, refinery fugitive VOCs
- Enforceable dry kiln process limitations (e.g., limiting maximum kiln temperatures, use of water-soaked wood) can be used to limit PTE.

Why are Dry Kilns an Issue?

- Limited EF data from dry kiln operations.
- Existing data has errors, e.g. VOC scaling.
- VOC data exists but little HAP/TAP data.
- Factors are highly dependent on several independent variables.
- Depending on production additional emissions from kilning can exceed T5 thresholds →Boiler MACT applicability.

Dry Kiln Data Sources

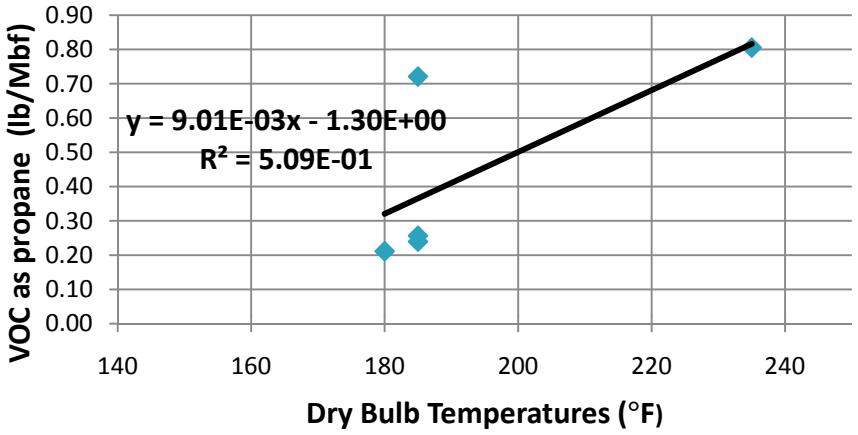
- Most northwest data has been generated by testing at OSU kiln – Mike Milota
- Most of the tests are from sources regulated by SWCAA
- Some tests by Oregon mills to ensure they were not Title 5 sources
- Most data is VOC data from softwood mills
- Data initially compiled by Jim Broad – ODEQ in memo dated 5/8/07

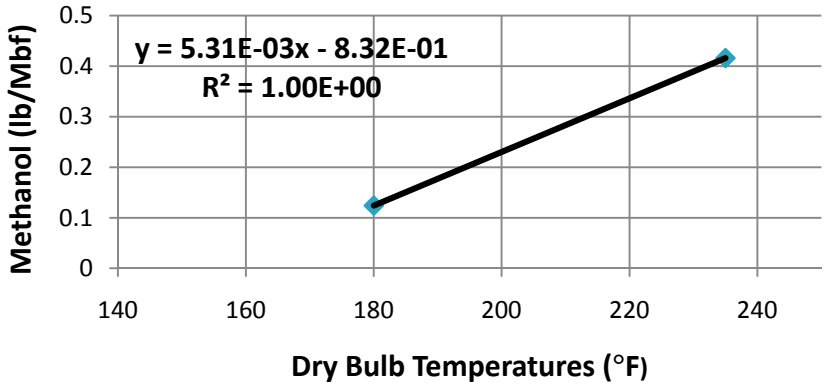
Kilning Factors to Consider

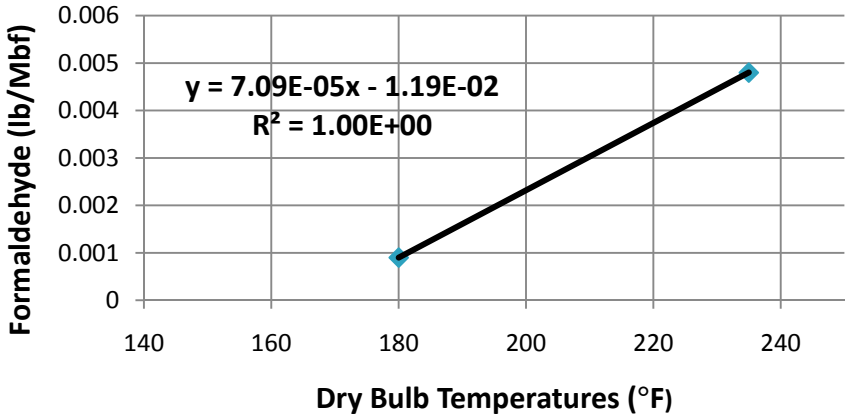
- Species of wood
- Maximum drying temperature
- Time at maximum temperature
- Length of drying cycle
- Some emission factors are temperature dependant
- Annual maximum throughput for PTE purposes
- Hardwood vs. softwood
- Water soaked wood – water transport via river or stored in pond may lead to increased emissions
- Test results corrected to carbon? Propane? as VOC species? Something else?

Alder's Emissions

(VOC, Methanol, Formaldehyde)

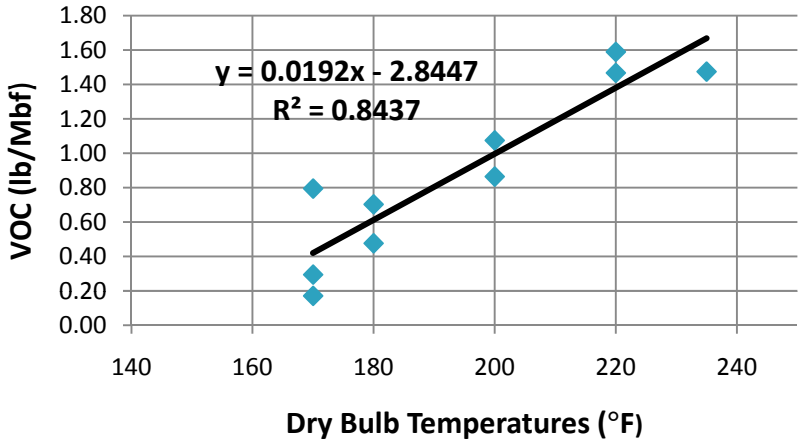


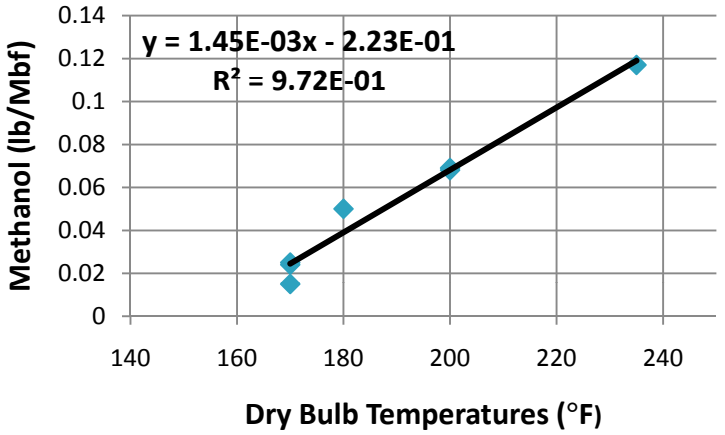


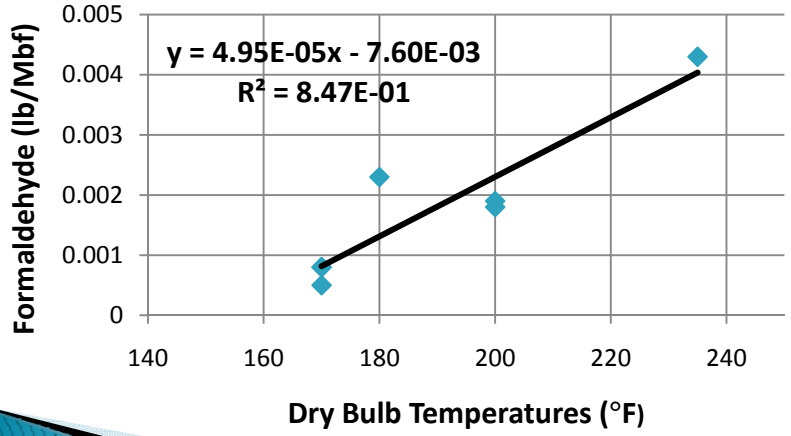


Douglas Fir's Emissions

(VOC, Methanol, Formaldehyde)

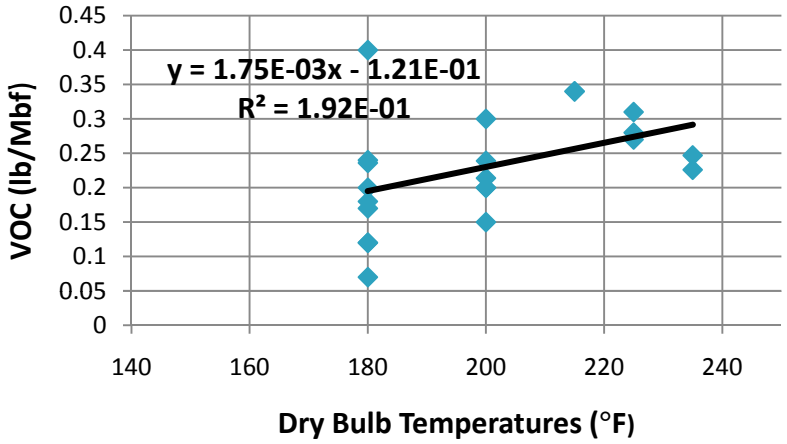


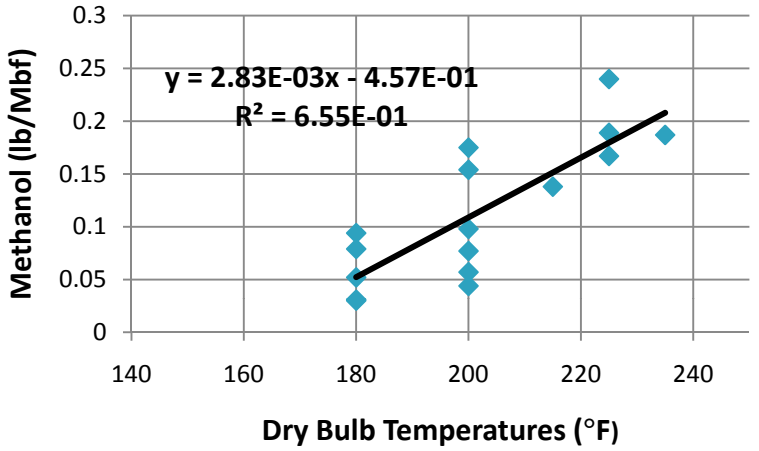


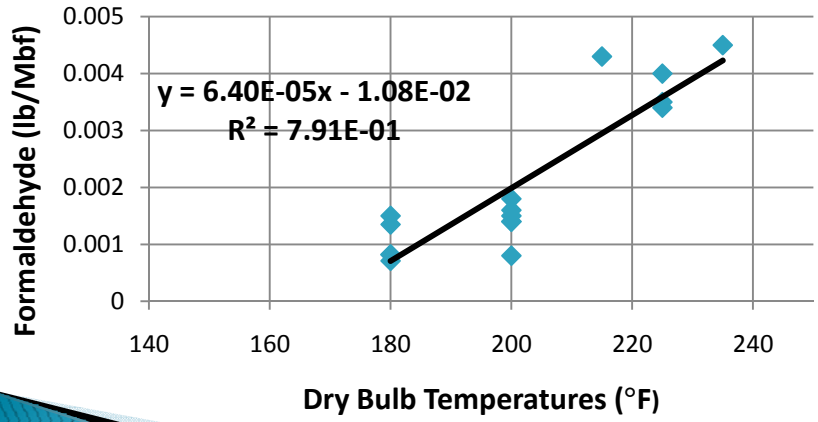


Hemlock's Emissions

(VOC, Methanol, Formaldehyde)

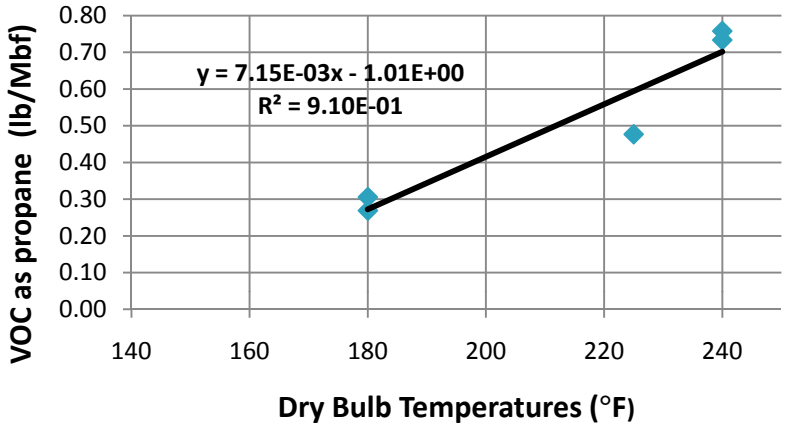


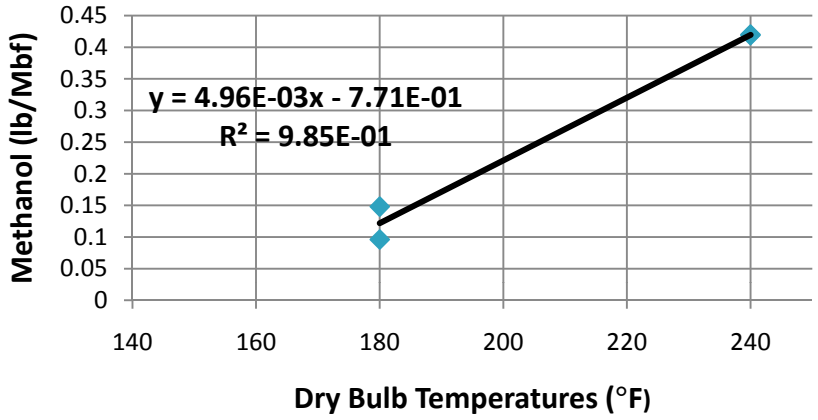


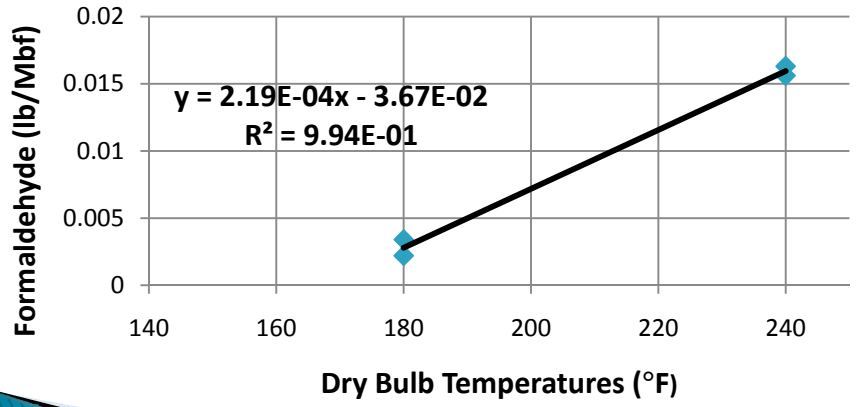


White Fir's Emissions

(VOC, Methanol, Formaldehyde)







Dry Kiln Conclusions

- Existing speciated VOC and HAP data is insufficient – additional testing is needed. Regional/national cooperation possible?
- Only 5 HAPs species identified. What comprises the remaining VOCs? PM? CO?
- No HAP data available for water-soaked wood.
- Some existing facilities reclassified as major.

Future Work

- Additional kiln testing all wood species with focus on HAPs/TAPs.
- Water soaked wood testing – VOC, HAP, TAP.
- Test methodology refinement.
- Test results correction factor – as VOC.
- Revising NSR permits to include maximum temperature and facility throughput limits.
- Regional consistency on treatment of dry kiln emissions is good but can improve.

Closing

- SWCAA's dry kiln information at: http://www.swcleanair.org/otherreports.html

SWCAA Dry Kiln Facilities

Name of Facility	Location	Kiln Capacity Bf	Annual Throughput Million Bf	Max Drying Temp deg F	Primary Species Kilned
Alexander Lumber Mill, Inc.	Chehalis, WA	60,000	~3.0	Unknown	alder, maple
Cascade Hardwoods, LLC	Chehalis, WA	1,460,140	101.5	250	alder, maple
Columbia Vista Corporation / Vancouver	Vancouver, WA	148,972	40.3	225	alder, maple
Exterior Wood, Inc.	Washougal, WA	50,000	25.0?	250	Treated and untreated Douglas fir, hemlock
Hambleton Lumber Sales, LLC	Washougal, WA	+110,000+3*?	Unknown	Unknown	Douglas fir
Hampton Drying Company	Morton, WA	(4) as 12' x 60'	60.0	250	Douglas fir
Hampton Lumber Mills/Washington, Inc. - Morton	Morton, WA	918,000	170.0	250	Douglas fir, hemlock, pine, spruce
Hampton Lumber Mills/Washington, Inc. - Randle	Randle, WA	812,000	200	250	Douglas fir, hemlock, pine and spruce
Shakertown 1992, Inc.	Winlock, WA	Unknown	4.0	Unknown	cedar
Sierra Pacific Industries - Centralia Division	Centralia, WA	1,380,000	300.0	200	Douglas fir, hemlock, and spruce
TrueGuard, LLC	Washougal, WA	120,000	15.0	160	not listed
Wayne-Dalton Corporation	Centralia, WA	354,000	54.9	Unknown	not listed
Weyerhaeuser Hardwoods - Centralia	Centralia, WA	Unknown	47.9	250	alder, maple
Weyerhaeuser Hardwoods - Longview	Longview, WA	Unknown	44.2	250	alder, maple
Wilkins, Kaiser & Olsen, Inc.	Carson, WA	540,000	120.0	250	Douglas fir, white fir, and hemlock

Dry Kiln Emission Data

Species	Max Kiln Temp. Deg. F	PM/PM_{10} /$PM_{2.5}$ Lb/MMbf	Method 25A VOC as C_3H_8 Lb/MMbf	Unspeciated VOC Lb/million bf as mono turpenes	Total VOCs Lb/MMbf	Methanol Lb/MMbf	Formaldehyde Lb/MMbf	Acetaldehyde Lb/MMbf	Propionaldehyde Lb/MMbf	Acrolein Lb/MMbf	Ethanol Lb/MMbf	Acetic Acid Lb/MMbf	Mono Turpenes Llb/MMbf	Carbon Monoxide Lb/MMBf
Hemlock	180	50.5	194	129	297	52	0.72	113	1.20	1.75				
	190		212	136	334	81	1.36	113	1.20	1.75				
	200		229	144	371	109	2.00	113	1.20	1.75				
	Not specified		1.79*(T) – 146			2.83*(T) – 457	6.40E-02*(T) – 10.8	113	1.20	1.75				
Douglas Fir	180	21	611	541	630	38	1.31	49	0.53	0.73				
	190		803	715	819	53	1.81	49	0.53	0.73				
	200		995	889	1,008	67	2.30	49	0.53	0.73				
	Not specified		19.2*(T) – 2,845			1.45*(T) – 223	4.95E-02*(T) – 7.6	49	0.53	0.73				
White Fir	180	50.5	277	185	426	122	2.72	113	1.20	1.75				
	190		349	237	529	171	4.91	113	1.20	1.75				
	200		420	289	633	221	7.10	113	1.20	1.75				
	Not specified		7.15*(T) – 1,010			4.96*(T) – 771	2.19E-01*(T) – 36.7	113	1.20	1.75				
Alder	180	50.5	322	224	473	124	0.86	122	1.50	1.45				
	190		412	292	595	177	1.57	122	1.50	1.45				
	200		502	360	717	230	2.28	122	1.50	1.45				
	Not specified		9.01*(T) – 1,300			5.31*(T) – 832	7.09E-02*(T) – 11.9	122	1.50	1.45				
Alder (Stored in Water)	180	50.5	4,085	3,719	3,968	124	0.86	122	1.50	1.45				
	190		5,229	4,766	5,069	177	1.57	122	1.50	1.45				
	200		6,372	5,812	6,169	230	2.28	122	1.50	1.45				
	Not specified		12.7*(9.01*(T) – 1,300)			5.31*(T) – 832	7.09E-02*(T) – 11.9	122	1.50	1.45				
Maple	180	50.5	322	224	473	124	0.86	122	1.50	1.45				
	190		412	292	595	177	1.57	122	1.50	1.45				
	200		502	360	717	230	2.28	122	1.50	1.45				
	Not specified		9.01*(T) – 1,300			5.31*(T) – 832	7.09E-02*(T) – 11.9	122	1.50	1.45				

Kiln Data Notes

Assumptions Component	Response Factor	Molecular Weight	Notes	Source
Methanol	0.69	32.04	CH_40	JUM Technical Information – for model VE-7
Formaldehyde	0	30.04	CH_2O	EPA guidance
Acetaldehyde	1.0	44.05	C_2H_4O	Effective Carbon Number (ECN) = 1.0 "Modern Practice of Gas Chromatography – Robert Lee Grob, Eugene F. Barry
Propionaldehyde	2.0	58.08	C_3H_6O	Effective Carbon Number (ECN) = 2.0 "Modern Practice of Gas Chromatography – Robert Lee Grob, Eugene F. Barry
Acrolein	1.95	56.06	C_3H_40	Effective Carbon Number (ECN) = 1.95 "Modern Practice of Gas Chromatography – Robert Lee Grob, Eugene F. Barry
Ethanol	1.4	46.07	C_2H_6O	Clint Lamoreaux experience with JUM 3-100 FID instruments
Acetic Acid	0.453	60.05	$C_2H_40_2$	Thermo Environmental Instruments, Inc. – TVA 1000 "Toxic Vapor Analyzer – Response Factors" at 50 ppm
Mono Turpenes**	10	136.23	$C_{10}H_{16}$	No reference found by SWCAA – assumes response based on carbon count

Where response factor = ppm as CH_4/ppm compound

Assume all unknown VOC is mono turpenes ($C_{10}H_{16}$), Mwt. = 136.23

ODEQ Kiln Data Memo 5/8/07

Species	Max. Kiln Temp. ºF	Total HAP lb/MMBF	Methanol lb/MMBF	Formaldehyde lb/MMBF	Acetaldehyde lb/MMBF	Propionaldehyde lb/MMBF	Acrolein lb/MMBF
Hemlock	< 200 º F	189	72	1.24	113	1	1.6
Hemlock	> 200 º F	305	186	3.8	113 (1)	1 (1)	1.6 (1)
Douglas Fir	< 200 º F	97	38	1	57	0.55	0.65
Douglas Fir	> 200 º F	116	57	1 (1)	57 (1)	0.55 (1)	0.65 (1)
White Fir	< 200 º F	240	122	2.8	113 (2)	1 (1)(2)	1.6 (1)(2)
White Fir	> 200 º F	301	183	2.8 (1)	113 (1)(2)	1 (1)(2)	1.6 (1)(2)
Ponderosa Pine (3)	< 200 º F	184	65	2.9	113 (1)(2)	1 (1)(2)	1.6 (1)(2)
Lodgepole Pine (3)	< 200 º F	73.6	55	04	12	1 (1)(2)	1.6 (1)(2)
Lodgepole Pine (3)	> 200 º F	78.6	60	4 (6)	12 (6)	1 (1)(2)	1.6 (1)(2)
Slash Pine (4)	> 200 º F	215	164	4 (5)	44.7	1 (1)(2)	1.6 (1)(2)

(1) Assumes emissions of this HAP not temperature dependent. There is insufficient data to know for sure.
(2) Assumes emissions are the same as hemlock
(3) Pine is not normally dried at temperatures > 200º F
(4) No data for Slash Pine dried < 200º F
(5) Assume to be the same as for Lodgepole Pine
(6) Assumes emissions the same as for Lodgepole Pine dried at < 200 º F