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Atmospheric Pollutant Emission Factors From Open Burning of Agricultural and Forest Biomass by Wind Tunnel Simulations

Volume 3:
Results, Wood Fuels

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY



AIR RESOURCES BOARD
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Final Report

Atmospheric pollutant emission factors from open burning of agricultural and forest biomass by wind tunnel simulations

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Determination of Emissions from Open Burning of Agricultural and Forestry Wastes:
Phase II

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Table 3.5.1**Fuel and Ash Analyses**

Run Date	12-Nov-92	12-Nov-92	12-Nov-92	12-Nov-92
Fuel Type	Walnut	Walnut	Walnut	Walnut
Sample Type	Fuel	Fuel	Ash	Ash
	Small Branch	Large Branch	Test #1	Test #2
Ultimate Analysis				
<u>(% dry weight)</u>				
C	48.71	47.33	8.22	8.46
H	6.06	5.90	0.09	0.06
N	0.67	0.65	0.11	0.12
Elemental Analysis				
<u>(% by weight dry basis)</u>				
N	0.63	0.56	0.12	0.11
P	0.04	0.03	0.02	0.01
K	0.28	0.35	6.31	5.45
Ca	1.17	1.64	33.10	31.50
Mg	0.26	0.31	6.25	5.63
Na	0.01	0.01	0.14	0.19
Cl	0.19	0.02	0.05	0.03
<u>(mg/kg dry weight)</u>				
S	405	311	1,220	1,120
B	32	25	442	395
Zn	11	7	4	4
Mn	30	38	24	24
Fe	259	161	12	12
Cu	3	2	4	3
Si				
Total (% dry weight)	57.42	56.21	54.47	51.59
Proximate Analysis				
<u>(% dry weight)</u>				
Ash	3.33	4.31	97.39	97.85
Volatiles	83.66	81.65	19.07	20.18
Fixed Carbon	13.01	14.04	-16.46	-18.03
Higher Heating Value				
<u>(MJ/kg dry weight)</u>				
	19.2808	19.2799	-1.0996	0.3276

Table 3.5.2

Fuel: Walnut
Date of Test: 12-Nov-92

Fuel Properties

	<u>Large Branch</u>	<u>Small Branch</u>	<u>Total</u>
Diameter (mm)	> 50	< 50	
Mass Fraction (% wet weight)	32.6	67.4	100.0
Moisture (% wet weight)	27.56	35.79	33.10
Mass Fraction (% dry weight)	35	65	100
Carbon (% dry weight)	47.33	48.71	48.22
Nitrogen (% dry weight)	0.56	0.63	0.61
Sulfur (mg/kg dry weight)	311	405	372
Ash (% dry weight)	4.31	3.33	3.68
Heating Value (MJ/kg dry weight)	19.28	19.28	19.28

Table 3.5.3. Operating conditions and concentrations, 12 November 92.

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

	Test 1	Test 2	
Total Fuel Consumption (kg w.b.)	34.0	149.7	
Total Ash Recovered (kg w.b.)	1.2	6.6	
Ash Fraction (w.b.)	0.03	0.04	

	Traverse 1	Traverse 2	Test 1
<u>Mean Values</u>			
Air Temperature (°C)	10.77	18.14	11.68
Air Relative Humidity (%)	58.16	29.23	54.73
Inlet Air Temperature (°C)	11.70	19.27	12.68
Stack Temperature (°C)	32.37	50.04	26.42
Impinger Outlet Temperature (°C)	10.89	18.70	13.64
Stack Gas Velocity (m/s)	2.97	2.66	2.33
Duration (minutes)	48	39	83
<u>Gas and PM Concentrations (less background)</u>			
CO (ppmv)	88.20	59.53	71.07
NO (ppmv)	3.37	4.85	2.08
NOx (ppmv)	4.70	6.93	2.93
SO2 (ppmv)	0.14	0.49	0.09
THC (ppmv as CH4)	18.64	14.66	15.63
HC (ppmv as CH4 by GC)	7.54	7.30	5.60
CH4 (ppmv by GC)	5.06	5.75	4.08
NMHC (ppmv as CH4)	13.58	8.91	11.55
NMHC (ppmv as CH4 by GC)	2.48	1.55	1.52
CO2 (ppmv by GC)	2,118	2,150	1,485
Total S (ppmv as SO2)	0.15	0.48	0.10
PM (mg/cu.m)	9.29	13.64	
PM10 (mg/cu.m)	9.10	13.37	
PM2.5 (mg/cu.m)	8.55	12.55	

Table 3.5.4. Mass balance, walnut tree prunings, 12 November 92.

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Test 1
Fuel Moisture Content (% w.b.)	33	33	33
Fuel Consumption* (g w.b.)	32,313	44,273	34,014
Fuel Consumption (g d.b.)	21,617	29,617	22,754
Residual Ash (g w.b.)	2,866	1,959	1,166
Fuel Vaporized (g w.b.)	31,148	42,314	32,848
Average Burning Rate (g/s w.b.)	11.22	18.92	6.83
Average Burning Rate (g/s d.b.)	7.51	12.66	4.57
Fuel Vaporization Rate (g/s w.b.)	10.82	18.08	6.60
Stack Gas Density (kg/cu.m)	1.1568	1.0936	1.1798
Stack Gas Flow Rate (cu.m/s)	4.42	3.95	3.47
Stack Gas Mass Flow Rate (kg/s)	5.11	4.32	4.09
Inlet Air Mass Flow Rate (kg/s)	5.10	4.30	4.09
Overall Air-Fuel Ratio (w.b.)	454.51	227.41	598.28
Overall Air-Fuel Ratio (d.b.)	679.42	339.94	894.33

*Estimated as 95% of total for Traverse 1.

Table 3.5.5. Emission factors, walnut prunings, 12 November 92 (integrated basis).

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Test 1
CO	6.193	2.024	7.096
NO	0.253	0.176	0.249
NOx (as NO2)	0.537	0.382	0.532
SO2	0.021	0.037	0.021
THC (as CH4)	0.714	0.277	0.834
HC (as CH4 by GC)	0.283	0.137	0.277
CH4 (by GC)	0.190	0.108	0.202
NMHC (as CH4)	0.524	0.169	0.633
NMHC (as CH4 by GC)	0.093	0.029	0.075
CO2 (by GC)	218.777	111.356	201.828
Total S (as SO2)	0.022	0.035	0.022
SO2/Total S	0.97	1.05	0.94
PM	0.508	0.384	
PM10	0.498	0.377	
PM2.5	0.468	0.354	
MMAD	0.107	0.124	
σ	6.498	4.778	

Table 3.5.6. Emission factors, walnut prunings, 12 November 92 (average basis).

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Test 1
CO	5.798	1.962	6.147
NO	0.237	0.171	0.193
NOx (as NO2)	0.507	0.375	0.417
SO2	0.021	0.037	0.017
THC (as CH4)	0.700	0.276	0.773
HC (as CH4 by GC)	0.283	0.137	0.277
CH4 (by GC)	0.190	0.108	0.202
NMHC (as CH4)	0.510	0.168	0.571
NMHC (as CH4 by GC)	0.093	0.029	0.075
CO2 (by GC)	218.777	111.356	201.828
Total S (as SO2)	0.023	0.036	0.020
SO2/Total S	0.91	1.03	0.87
PM	0.508	0.384	
PM10	0.498	0.377	
PM2.5	0.468	0.354	
MMAD	0.107	0.124	
σ	6.498	4.778	

Table 3.5.7. Carbon balance.

Date of Test: Fuel	12-Nov-92 Walnut tree prunings		
	Traverse 1	Traverse 2	Test 1
<u>Carbon Balance</u>			
Dry Fuel Consumption Rate (g/s)	7.51	12.66	4.57
Ash Generation Rate (g/s)	1.00	0.84	0.23
Ash Fraction* (% dry basis)	13.26	6.61	5.03
Fuel Carbon Concentration (%)	48.22	48.22	48.22
Residual Ash Carbon Concentration* (%)	62.78	8.46	8.22
Carbon released to stack (g/s)	3.00	6.03	2.18
Maximum CO2 emission factor (%)	146.28	174.76	175.29
Stack Gas Density (kg/cubic meter)	1.16	1.09	1.18
Average CO2 concentration (ppmv)	2,118	2,150	1,485
Average CO concentration (ppmv)	88.20	59.53	71.07
Average THC concentration (ppmv as CH4)	18.64	14.66	15.63
PM Concentration (mg/cubic meter)	9.29	13.64	5.37
PM Carbon Concentration (%)	69.00	83.83	69.00
PM Carbon (mg/cubic meter)	6.41	11.43	3.71
Stack Gas Temperature (°C)	32.37	50.04	26.42
Impinger Temperature (°C)	10.89	18.70	13.64
PM molar concentration (ppm)	12.45	22.82	7.27
Estimated Average Stack Gas Velocity (m/s)	1.88	3.99	1.91
Emission Factors (% Average Basis):			
CO2	218.777	111.356	201.828
CO	5.798	1.962	6.147
THC (as CH4)	0.700	0.276	0.773
PM	0.508	0.384	0.508
Emission Factors (% Integrated Basis):			
CO2	218.777	111.356	201.828
CO	6.193	2.024	7.096
THC (as CH4)	0.714	0.277	0.834
PM	0.508	0.384	0.508
Closure (% Average Basis)	158	67	123
Closure (% Integrated Basis)	158	66	123

*computed for traverse 1.

Table 3.5.8. Nitrogen balance

Date of Test:

Fuel

	12-Nov-92 Walnut tree prunings		Test 1
	Traverse 1	Traverse 2	
Nitrogen Balance			
Fuel Nitrogen Concentration (% dry weight)	0.61	0.61	0.61
Ash Nitrogen Concentration (% weight)	0.11	0.12	0.11
Emission Factors (% Average Basis):			
NOx (as NO ₂)	0.507	0.375	0.417
PM	0.508	0.384	0.508
Emission Factors (% Integrated Basis):			
NOx (as NO ₂)	0.537	0.382	0.532
NO ₃ - Concentration of PM (% weight)	0.848	1.055	0.848
NH ₄ ⁺ Concentration of PM (% weight)	1.034	1.255	1.034
Nitrogen Concentration of PM (%)	0.996	1.214	0.996
Fuel Nitrogen (mg/s)	45.81	77.23	27.88
Ash Nitrogen (mg/s)	0.44	1.00	0.25
Nitrogen as NOx (mg/s Average Basis)	11.59	14.45	5.80
Nitrogen as NOx (mg/s Integrated Basis)	12.27	14.72	7.40
Nitrogen as PM (mg/s Average Basis)	0.38	0.59	0.23
Nitrogen as NOx+PM (mg/s Average Basis)	11.97	15.04	6.03
Nitrogen as NOx+PM (mg/s Integrated Basis)	12.65	15.31	7.63
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.261	0.195	0.216
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.276	0.198	0.274
Ash Nitrogen/Fuel Nitrogen	0.010	0.013	0.009
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.271	0.208	0.225
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.286	0.211	0.283

Table 3.5.9. Sulfur balance.

Date of Test: Fuel	12-Nov-92 Walnut tree prunings		
	Traverse 1	Traverse 2	Test 1
Sulfur Balance			
Fuel Sulfur Concentration (mg/kg dry weight)	372	372	372
Ash Sulfur Concentration (mg/kg weight)	1,220	1,120	1,220
Emission Factors (% Average Basis)			
SO ₂	0.021	0.037	0.017
PM	0.508	0.384	0.508
Emission Factors (% Integrated Basis)			
SO ₂	0.021	0.037	0.021
Sulfur Concentration of PM (% weight)			
Fuel Sulfur (mg/s)	2.79	4.71	1.70
Ash Sulfur (mg/s)	0.49	0.94	0.28
Sulfur as SO ₂ (mg/s Average Basis)	0.79	2.34	0.39
Sulfur as SO ₂ (mg/s Integrated Basis)	0.79	2.34	0.48
Sulfur as PM (mg/s Average Basis)	0.74	0.90	0.45
Sulfur as SO ₂ +PM (mg/s Average Basis)	1.53	3.24	0.84
Sulfur as SO ₂ +PM (mg/s Integrated Basis)	1.53	3.24	0.93
SO ₂ +PM Sulfur/Fuel Sulfur (Average Basis)	0.547	0.688	0.493
SO ₂ +PM Sulfur/Fuel Sulfur (Integrated Basis)	0.547	0.688	0.547
Ash Sulfur/Fuel Sulfur	0.174	0.199	0.165
Closure (% Average Basis)	72	89	66
Closure (% Integrated Basis)	72	89	71

Table 3.5.10. Water balance

Estimated Stack Humidity

Fuel Configuration	Walnut Pile	
Date of Test	12-Nov-92	
	Traverse 1	Traverse 2
Ambient Air Temperature (°C)	11	18
Ambient Air Relative Humidity (%)	58	29
Air Temperature (K)	284	291
Saturation Pressure (Pa)	1,293	2,083
Vapor Pressure (Pa)	752	609
Air Dew Point Temperature (°C)	2.9	-0.1
Ambient Volume Fraction Water Vapor	0.0074	0.0060
Ambient Mass Fraction Water Vapor	0.0046	0.0037
Fuel Burning Rate (g/s wet basis)	11.22	18.92
Fuel Moisture Content (%)	33.0	33.0
Ash Fraction (wet basis)	0.09	0.04
Fuel Hydrogen Content (%)	6.00	6.00
Asn Hydrogen Content* (%)	0.00	0.06
Moisture Evaporated (g/s)	3.70	6.24
Water of Combustion (g/s)	4.06	6.84
Total Fuel Water Added (g/s)	7.76	13.08
Inlet Air Mass Flowrate (g/s)	5,100	4,300
Inlet Air Water Vapor Flowrate (g/s)	23	16
Total Stack Water Vapor Flowrate (g/s)	31	29
Stack Gas Mass Flowrate (g/s)	5,110	4,318
Mass Fraction Water Vapor in Stack	0.0061	0.0067
Volume Fraction Water Vapor in Stack	0.0099	0.0109
Stack Vapor Pressure (Pa)	998	1,101
Stack Temperature (°C)	32	50
Stack Temperature (K)	306	323
Stack Saturation Pressure (Pa)	4,859	12,374
Stack Relative Humidity (%)	21	9
Stack Dew Point Temperature (°C)	7.0	8.4
Impinger Outlet Temperature (°C)	10.9	18.7
Volume Stack Gas Sampled for PM (L)	603	462
Estimated Impinger/Desiccant Weight Gain (g)	4.6	3.8
Totals:		
	Estimated	Measured
Total Impinger/Desiccant Weight Gain (g)	8.4	9.8
Estimated/Measured Weight Gain	0.85	

*assumes full hydrogen volatilization during traverse 1

Table 3.5.11. Power balance.

Date of Test: Fuel	12-Nov-92 Walnut tree prunings		
	Traverse 1	Traverse 2	Test 1
<u>Power Balance</u>			
Fuel Heating Value (MJ/kg dry weight)	19.28	19.28	19.28
Ash Heating Value* (MJ/kg dry weight)	0	0.3276	0
Average Energy Release Rate (kW)	144.8	243.8	88.1
Products of Incomplete Combustion (kW)			
CO	4.4	2.5	2.8
THC (as CH ₄)	2.9	1.9	2.0
PM	0.9	1.3	0.5
Heat Release Rate (kW)	136.6	238.0	82.8
Stack Gas Flow (kg/s)	5.11	4.32	4.09
Stack Gas Temperature (°C)	32.37	50.04	26.42
Ambient Temperature (°C)	10.77	18.14	11.68
Sensible Power at Top of Stack (kW)	111.0	138.6	60.6
Tunnel Dissipation (kW)	25.6	99.4	22.1

*Negative values assumed to be zero.

Table 3.5.12. Operating conditions and concentrations, Walnut tree prunings*.

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

	Test 1	Test 2	
Total Fuel Consumption (kg w.b.)	34.0	149.7	
Total Ash Recovered (kg w.b.)	1.2	6.6	
Ash Fraction (w.b.)	0.03	0.04	
	Traverse 1	Traverse 2	Test 1
<u>Mean Values</u>			
Air Temperature (°C)	10.77	18.14	11.68
Air Relative Humidity (%)	58.16	29.23	54.73
Inlet Air Temperature (°C)	11.70	19.27	12.68
Stack Temperature (°C)	32.37	50.04	26.42
Impinger Outlet Temperature (°C)	10.89	18.70	13.64
Stack Gas Velocity (m/s)	1.88	3.99	1.91
Duration (minutes)	48	39	83
<u>Gas and PM Concentrations (less background)</u>			
CO (ppmv)	88.20	59.53	71.07
NO (ppmv)	3.37	4.85	2.08
NOx (ppmv)	4.70	6.93	2.93
SO2 (ppmv)	0.14	0.49	0.09
THC (ppmv as CH4)	18.64	14.66	15.63
HC (ppmv as CH4 by GC)	7.54	7.30	5.60
CH4 (ppmv by GC)	5.06	5.75	4.08
NMHC (ppmv as CH4)	13.58	8.91	11.55
NMHC (ppmv as CH4 by GC)	2.48	1.55	1.52
CO2 (ppmv by GC)	2,118	2,150	1,485
Total S (ppmv as SO2)	0.15	0.48	0.10
PM (mg/cu.m)	9.29	13.64	
PM10 (mg/cu.m)	9.10	13.37	
PM2.5 (mg/cu.m)	8.55	12.55	

*stack gas velocity from carbon balance.

Table 3.5.13. Mass balance, Walnut tree prunings*.

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Test 1
Fuel Moisture Content (% w.b.)	33	33	33
Fuel Consumption† (g w.b.)	32,313	44,273	34,014
Fuel Consumption (g d.b.)	21,617	29,617	22,754
Residual Ash (g w.b.)	2,866	1,959	1,166
Fuel Vaporized (g w.b.)	31,148	42,314	32,848
Average Burning Rate (g/s w.b.)	11.22	18.92	6.83
Average Burning Rate (g/s d.b.)	7.51	12.66	4.57
Fuel Vaporization Rate (g/s w.b.)	10.82	18.08	6.60
Stack Gas Density (kg/cu.m)	1.1568	1.0936	1.1798
Stack Gas Flow Rate (cu.m/s)	2.79	5.93	2.84
Stack Gas Mass Flow Rate (kg/s)	3.23	6.49	3.35
Inlet Air Mass Flow Rate (kg/s)	3.22	6.47	3.34
Overall Air-Fuel Ratio (w.b.)	287.13	341.82	489.40
Overall Air-Fuel Ratio (d.b.)	429.22	510.97	731.57

*stack gas velocity from carbon balance.

†Estimated as 95% of total for Traverse 1.

Table 3.5.14. Emission factors, Walnut tree prunings (average basis)*.

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis	Traverse 1	Traverse 2	Test 1
CO	3.667	2.945	5.030
NO	0.150	0.257	0.158
NOx (as NO2)	0.321	0.563	0.341
SO2	0.013	0.056	0.014
THC (as CH4)	0.443	0.415	0.632
HC (as CH4 by GC)	0.179	0.206	0.226
CH4 (by GC)	0.120	0.163	0.165
NMHC (as CH4)	0.323	0.252	0.467
NMHC (as CH4 by GC)	0.059	0.044	0.061
CO2 (by GC)	138.380	167.147	165.156
Total S (as SO2)	0.015	0.054	0.016
SO2/Total S	0.91	1.03	0.87
PM	0.322	0.577	
PM10	0.315	0.566	
PM2.5	0.296	0.531	
MMAD	0.107	0.124	
σ	6.498	4.778	

*stack gas velocity from carbon balance.

Table 3.5.15. Carbon balance, Walnut tree prunings*.

Fuel: Walnut tree prunings Date of Test: 12-Nov-92
 Configuration: Pile

Carbon Balance

	Traverse 1	Traverse 2	Test 1
Dry Fuel Consumption Rate (g/s)	7.51	12.66	4.57
Ash Fraction (%)	13.26	6.61	5.12
Ash Generation Rate (g/s)	1.00	0.84	0.23
Fuel Carbon Concentration (%)	48.22	48.22	48.22
Residual Ash Carbon Concentration** (%)	62.78	8.46	8.22
Carbon Released to Stack (g/s)	2.99	6.03	2.18
Maximum CO2 emission factor (%)	146.30	174.77	175.27
Average CO2 concentration (ppmv)	2,118	2,150	1,485
Average CO concentration (ppmv)	88.20	59.53	71.07
Average THC concentration (ppmv)	18.64	14.66	15.63
PM concentration (mg/cubic meter)	9.29	13.64	5.37
PM Carbon concentration† (%)	69.00	83.83	69.00
PM Carbon (mg/cubic meter)	6.41	11.43	3.71
PM Molar concentration (ppm)	12.45	22.82	7.27
Estimated Average Stack Gas Velocity (m/s)	1.88	3.99	1.91
Closure (% Average Basis)	100	100	100
Closure (% Integrated Basis)	103	98	102

*stack gas velocity from carbon balance. Closure forced.

**Computed for Traverse 1.

Table 3.5.16. Water balance*

Estimated Stack Humidity

Fuel Configuration	Walnut Pile	
Date of Test	12-Nov-92	
	Traverse 1	Traverse 2
Ambient Air Temperature (°C)	11	18
Ambient Air Relative Humidity (%)	58	29
Air Temperature (K)	284	291
Saturation Pressure (Pa)	1,293	2,083
Vapor Pressure (Pa)	752	609
Air Dew Point Temperature (°C)	2.9	-0.1
Ambient Volume Fraction Water Vapor	0.0074	0.0060
Ambient Mass Fraction Water Vapor	0.0046	0.0037
Fuel Burning Rate (g/s wet basis)	11.22	18.92
Fuel Moisture Content (%)	33.0	33.0
Ash Fraction (wet basis)	0.09	0.04
Fuel Hydrogen Content (%)	6.00	6.00
Ash Hydrogen Content** (%)	0.00	0.06
Moisture Evaporated (g/s)	3.70	6.24
Water of Combustion (g/s)	4.06	6.84
Total Fuel Water Added (g/s)	7.76	13.08
Inlet Air Mass Flowrate* (g/s)	3,220	6,470
Inlet Air Water Vapor Flowrate (g/s)	15	24
Total Stack Water Vapor Flowrate (g/s)	23	37
Stack Gas Mass Flowrate (g/s)	3,230	6,488
Mass Fraction Water Vapor in Stack	0.0070	0.0057
Volume Fraction Water Vapor in Stack	0.0113	0.0092
Stack Vapor Pressure (Pa)	1,142	936
Stack Temperature (°C)	32	50
Stack Temperature (K)	306	323
Stack Saturation Pressure (Pa)	4,859	12,374
Stack Relative Humidity (%)	23	8
Stack Dew Point Temperature (°C)	8.9	6.0
Impinger Outlet Temperature (°C)	10.9	18.7
Volume Stack Gas Sampled for PM (L)	603	462
Estimated Impinger/Desiccant Weight Gain (g)	5.2	3.2
Totals:		
	Estimated	Measured
Total Impinger/Desiccant Weight Gain (g)	8.5	9.8
Estimated/Measured Weight Gain	0.86	

*air and stack gas flow rates from carbon balance

**assumes full hydrogen volatilization during traverse 1

Table 3.5.17. Mass concentrations (%) from DRI filter samples

Date Fuel	12-Nov-92 Walnut Prunings		12-Nov-92 Walnut Prunings		PM2.5/PM10
	PM2.5		PM10		
Size Fraction					
Teflon Filter ID	ABTT046		ABTT047		
Quartz Filter ID	ABTQ046		ABTQ047		
Teflon Field Sample Flag					
Quartz field sample field					
Teflon mass sample flag					
Quartz mass sample flag					
Anions sample flag					
Ammonium analysis flag					
Sodium ion analysis flag					
Magnesium ion analysis flag					
Potassium ion analysis flag					
Carbon analysis flag					
XRF analysis flag					
		<u>±Uncertainty</u>		<u>±Uncertainty</u>	
Teflon sample volume (m ³)	0.46	0.02	0.46	0.02	
Quartz sample volume (m ³)	0.46	0.02	0.46	0.02	
Teflon mass concentration (µg/m ³)	6,228	313	6,337	319	
	<u>Concentration (%)</u>	<u>±Uncertainty</u>	<u>Concentration (%)</u>	<u>±Uncertainty</u>	
Cl-	3.1715	0.2631	3.0554	0.2535	1.04
NO3-	0.8565	0.0683	0.8480	0.0676	1.01
SO4=	3.9254	0.2899	3.9322	0.2903	1.00
NH4+	1.0377	0.0778	1.0339	0.0775	1.00
Na+	0.0994	0.0135	0.0789	0.0123	1.26
K+	5.1591	0.3886	5.1747	0.3898	1.00
C(org)	43.0805	4.1523	43.3330	4.1765	0.99
C(oh)	36.6588	5.5704	37.9271	5.7588	0.97
C(e)	28.4119	2.6867	25.6672	2.4274	1.11
C(eht)	1.9930	1.2167	1.8319	1.1199	1.09
C	71.4924		69.0002		1.04
Al	0.0519	0.0131	0.0485	0.0133	1.07
Si	0.0685	0.0239	0.1330	0.0255	0.52
P	0.0215	0.0568	0.0362	0.0593	0.59
S	1.8632	0.1330	1.9370	0.1383	0.96
Cl	2.6256	0.1878	2.7738	0.1983	0.95
K	5.6762	0.4029	5.8423	0.4146	0.97
Ca	0.1639	0.0299	0.3413	0.0374	0.48
Ti	0.0000	0.0230	0.0018	0.0229	0.00
V	0.0000	0.0100	0.0000	0.0100	0.00
Cr	0.0000	0.0022	0.0001	0.0022	0.00
Mn	0.0016	0.0011	0.0027	0.0011	0.59
Fe	0.0091	0.0041	0.0264	0.0045	0.34
Co	0.0000	0.0009	0.0000	0.0011	
Ni	0.0000	0.0010	0.0000	0.0010	
Cu	0.0009	0.0011	0.0013	0.0008	0.69
Zn	0.0714	0.0052	0.0726	0.0052	0.98
Ga	0.0000	0.0019	0.0000	0.0019	
As	0.0011	0.0044	0.0003	0.0047	3.67
Se	0.0009	0.0012	0.0002	0.0012	4.50
Br	0.0347	0.0026	0.0355	0.0027	0.98
Rb	0.0048	0.0009	0.0049	0.0009	0.98
Sr	0.0018	0.0008	0.0033	0.0008	0.55
Y	0.0000	0.0014	0.0000	0.0014	
Zr	0.0000	0.0016	0.0000	0.0017	
Mo	0.0000	0.0028	0.0000	0.0028	
Pd	0.0000	0.0099	0.0000	0.0099	
Ag	0.0000	0.0114	0.0038	0.0115	0.00
Cd	0.0000	0.0122	0.0000	0.0123	
In	0.0000	0.0137	0.0000	0.0139	
Sn	0.0000	0.0173	0.0000	0.0174	
Sb	0.0000	0.0199	0.0000	0.0196	
Ba	0.0216	0.0694	0.0132	0.0690	1.64
La	0.0000	0.0929	0.0117	0.0929	0.00
Au	0.0000	0.0042	0.0000	0.0042	
Hg	0.0000	0.0025	0.0000	0.0026	
Tl	0.0000	0.0026	0.0000	0.0026	
Pb	0.0217	0.0028	0.0242	0.0029	0.90
U	0.0004	0.0026	0.0002	0.0027	2.00
Sum of measured species	84.1266	4.9706	82.2753	4.8577	1.02

Table 3.5.18. Element ratios from DRI filter samples.

Date	12-Nov-92		12-Nov-92
Fuel	Walnut Prunings		Walnut Prunings
Configuration	Pile		Pile
Size Fraction	PM2.5	PM10	PM2.5/PM10
Teflon Filter ID	ABTT046	ABTT047	
Quartz Filter ID	ABTQ046	ABTQ047	
Cl-/Cl	1.21	1.10	1.10
K+/K	0.91	0.89	1.03
Sulfate S/Total S	0.70	0.68	1.04
C(org)/C	0.60	0.63	0.96
Cl/K	0.46	0.47	0.97
Cl-/K+	0.61	0.59	1.04
Cl-/Na+	31.91	38.72	0.82
S/K	0.33	0.33	0.99
S/Na+	18.74	24.55	0.76
Al/Si	0.76	0.36	2.08

Table 3.5.19. Emission factors (mg/kg) from DRI filter samples.

Date	12-Nov-92		12-Nov-92		
Fuel	Walnut Prunings		Walnut Prunings		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT046		ABTT047		
Quartz Filter ID	ABTQ046		ABTQ047		
Start Time	9:06				
Stop Time	9:52				
Start Time					
End Time					
Elapsed Time (minutes)	46				Traverse 1
PM (mg/m ³ by total filter)					9.290
PM10 (by total filter/impactor)					9.100
PM2.5 (by total filter/impactor)					8.550
PM emission factor (%)					0.322
PM10 emission factor (%)					0.315
PM2.5 emission factor (%)					0.296
		±Uncertainty		±Uncertainty	
Teflon sample volume (m ³)	0.46	0.02	0.46	0.02	
Quartz sample volume (m ³)	0.46	0.02	0.46	0.02	
Teflon mass concentration (mg/m ³)	6.228	0.313	6.337	0.319	
Teflon mass/Total mass	0.728		0.696		
	Emission (mg/kg)	±Uncertainty	Emission (mg/kg)	±Uncertainty	PM2.5/PM10
Cl-	111.5894	7.7878	116.9793	7.9853	0.95
NO3-	30.1360	2.0217	32.4666	2.1294	0.93
SO4=	138.1155	8.5810	150.5486	9.1445	0.92
NH4+	36.5115	2.3029	39.5840	2.4413	0.92
Na+	3.4974	0.3996	3.0208	0.3875	1.16
K+	181.5233	11.5026	198.1191	12.2787	0.92
C(org)	1515.7902	122.9081	1659.0514	131.5598	0.91
C(oh)	1289.8423	164.8838	1452.0806	181.4022	0.89
C(e)	999.6746	79.5263	982.6969	76.4631	1.02
C(eht)	70.1238	36.0143	70.1363	35.2769	1.00
C	2515.4648	0.0000	2641.7483	0.0000	0.95
Al	1.8261	0.3878	1.8569	0.4190	0.98
Si	2.4102	0.7074	5.0921	0.8033	0.47
P	0.7565	1.6813	1.3860	1.8680	0.55
S	65.5568	3.9368	74.1602	4.3565	0.88
Cl	92.3819	5.5589	106.1980	6.2465	0.87
K	199.7175	11.9258	223.6789	13.0599	0.89
Ca	5.7668	0.8850	13.0670	1.1781	0.44
Ti	0.0000	0.6808	0.0689	0.7214	0.00
V	0.0000	0.2960	0.0000	0.3150	
Cr	0.0000	0.0651	0.0038	0.0693	0.00
Mn	0.0563	0.0326	0.1034	0.0347	0.54
Fe	0.3202	0.1214	1.0108	0.1418	0.32
Co	0.0000	0.0266	0.0000	0.0347	
Ni	0.0000	0.0296	0.0000	0.0315	
Cu	0.0317	0.0326	0.0498	0.0252	0.64
Zn	2.5122	0.1539	2.7796	0.1638	0.90
Ga	0.0000	0.0562	0.0000	0.0599	
As	0.0387	0.1302	0.0115	0.1481	3.37
Se	0.0317	0.0355	0.0077	0.0378	4.14
Br	1.2209	0.0770	1.3592	0.0851	0.90
Rb	0.1689	0.0266	0.1876	0.0284	0.90
Sr	0.0633	0.0237	0.1263	0.0252	0.50
Y	0.0000	0.0414	0.0000	0.0441	
Zr	0.0000	0.0474	0.0000	0.0536	
Mo	0.0000	0.0829	0.0000	0.0882	
Pd	0.0000	0.2930	0.0000	0.3119	
Ag	0.0000	0.3374	0.1455	0.3623	0.00
Cd	0.0000	0.3611	0.0000	0.3875	
In	0.0000	0.4055	0.0000	0.4379	
Sn	0.0000	0.5121	0.0000	0.5481	
Sb	0.0000	0.5890	0.0000	0.6174	
Ba	0.7600	2.0542	0.5054	2.1735	1.50
La	0.0000	2.7498	0.4479	2.9264	0.00
Au	0.0000	0.1243	0.0000	0.1323	
Hg	0.0000	0.0740	0.0000	0.0819	
Tl	0.0000	0.0770	0.0000	0.0819	
Pb	0.7635	0.0829	0.9265	0.0914	0.82
U	0.0141	0.0770	0.0077	0.0851	1.84
Sum of measured species	2,960	147	3,150	144	0.94

Table 3.5.20. Mass concentrations (%) from DRI filter samples.

Date	12-Nov-92		12-Nov-92		
Fuel	Walnut Prunings		Walnut Prunings		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT048		ABTT049		
Quartz Filter ID	ABTQ048		ABTQ049		
Teflon Field Sample Flag	S		F5,S		
Quartz field sample field	S		S		
Teflon mass sample flag	s		s		
Quartz mass sample flag	s		s		
Anions sample flag	s		s		
Ammonium analysis flag	s		s		
Sodium ion analysis flag	s		s		
Magnesium ion analysis flag	s		s		
Potassium ion analysis flag	s		s		
Carbon analysis flag	s		s		
XRF analysis flag	s		f3,s		
	<u>±Uncertainty</u>		<u>±Uncertainty</u>		
Teflon sample volume (m ³)	0.35	0.02	0.35	0.02	
Quartz sample volume (m ³)	0.35	0.02	0.35	0.02	
Teflon mass concentration (µg/m ³)	7,431	374	6,834	345	
	<u>Concentration (%)</u>	<u>±Uncertainty</u>	<u>Concentration (%)</u>	<u>±Uncertainty</u>	<u>PM2.5/PM10</u>
Cl-	2.2870	0.1907	3.4324	0.2853	0.67
NO3-	0.6897	0.0566	1.0548	0.0841	0.65
SO4=	2.7898	0.2067	4.6565	0.3442	0.60
NH4+	0.9408	0.0721	1.2546	0.0942	0.75
Na+	0.0673	0.0128	0.0916	0.0147	0.73
K+	3.3571	0.2532	5.1045	0.3850	0.66
C(org)	34.6158	3.3548	51.1395	4.9331	0.68
C(oh)	31.2678	4.7720	42.6829	6.4891	0.73
C(e)	17.1280	1.6219	32.6923	3.0937	0.52
C(eht)	0.7420	0.4555	3.0644	1.8696	0.24
C	51.7438		83.8318		0.62
Al	0.0403	0.0130	0.0681	0.0147	0.59
Si	0.0686	0.0249	0.1218	0.0280	0.56
P	0.0256	0.0560	0.0329	0.0600	0.78
S	1.6846	0.1208	1.8470	0.1324	0.91
Cl	3.1030	0.2219	3.1792	0.2275	0.98
K	6.0295	0.4283	6.2437	0.4438	0.97
Ca	0.1656	0.0316	0.5109	0.0475	0.32
Ti	0.0000	0.0266	0.0011	0.0289	0.00
V	0.0000	0.0115	0.0000	0.0125	
Cr	0.0000	0.0026	0.0003	0.0028	0.00
Mn	0.0007	0.0018	0.0038	0.0013	0.18
Fe	0.0059	0.0045	0.0325	0.0054	0.18
Co	0.0000	0.0011	0.0001	0.0013	0.00
Ni	0.0000	0.0012	0.0000	0.0013	
Cu	0.0011	0.0008	0.0014	0.0009	0.79
Zn	0.1190	0.0085	0.1210	0.0087	0.98
Ga	0.0000	0.0023	0.0000	0.0024	
As	0.0008	0.0054	0.0000	0.0056	
Se	0.0008	0.0014	0.0008	0.0015	1.00
Br	0.0292	0.0023	0.0281	0.0023	1.04
Rb	0.0062	0.0010	0.0068	0.0010	0.91
Sr	0.0020	0.0009	0.0060	0.0010	0.33
Y	0.0000	0.0016	0.0000	0.0017	
Zr	0.0000	0.0019	0.0000	0.0021	
Mo	0.0000	0.0033	0.0000	0.0035	
Pd	0.0000	0.0113	0.0012	0.0120	0.00
Ag	0.0026	0.0130	0.0000	0.0137	
Cd	0.0000	0.0138	0.0000	0.0150	
In	0.0000	0.0156	0.0000	0.0168	
Sn	0.0000	0.0198	0.0003	0.0213	0.00
Sb	0.0000	0.0225	0.0075	0.0243	0.00
Ba	0.0000	0.0789	0.0000	0.0848	
La	0.0000	0.1062	0.0000	0.1141	
Au	0.0002	0.0057	0.0000	0.0061	
Hg	0.0000	0.0030	0.0000	0.0031	
Tl	0.0002	0.0031	0.0000	0.0032	
Pb	0.0281	0.0033	0.0285	0.0035	0.99
U	0.0000	0.0030	0.0000	0.0033	
Sum of measured species	64.7556	3.7638	98.4760	5.8497	0.66

Table 3.5.21. Element ratios from DRI filter samples.

Date	12-Nov-92		12-Nov-92	
Fuel	Walnut Prunings		Walnut Prunings	
Configuration	Pile		Pile	
Size Fraction	PM2.5	PM10	PM2.5/PM10	
Teflon Filter ID	ABTT048	ABTT049		
Quartz Filter ID	ABTQ048	ABTQ049		
Cl-/Cl	0.74	1.08		0.68
K+/K	0.56	0.82		0.68
Sulfate S/Total S	0.55	0.84		0.66
C(org)/C	0.67	0.61		1.10
Cl-/K	0.51	0.51		1.01
Cl-/K+	0.68	0.67		1.01
Cl-/Na+	33.98	37.47		0.91
S/K	0.28	0.30		0.94
S/Na+	25.03	20.16		1.24
Al/Si	0.59	0.56		1.05

Table 3.5.22. Emission factors (mg/kg) from DRI filter samples.

Date	12-Nov-92		12-Nov-92		
Fuel	Walnut Prunings		Walnut Prunings		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT048		ABTT049		
Quartz Filter ID	ABTQ048		ABTQ049		
Start Time	11:15				
Stop Time	11:41				
Start Time	12:46				
End Time	12:55				
Elapsed Time (minutes)	35				Traverse 2
PM (mg/m ³ by total filter)					13.640
PM10 (by total filter/impactor)					13.370
PM2.5 (by total filter/impactor)					12.550
PM emission factor (%)					0.577
PM10 emission factor (%)					0.566
PM2.5 emission factor (%)					0.531
		\pm Uncertainty		\pm Uncertainty	
Teflon sample volume (m ³)	0.35	0.02	0.35	0.02	
Quartz sample volume (m ³)	0.35	0.02	0.35	0.02	
Teflon mass concentration (mg/m ³)	7.431	0.374	6.834	0.345	
Teflon mass/Total mass	0.592		0.511		
	<u>Emission (mg/kg)</u>	<u>\pmUncertainty</u>	<u>Emission (mg/kg)</u>	<u>\pmUncertainty</u>	<u>PM2.5/PM10</u>
Cl-	187.5354	10.1262	197.2804	16.1480	0.95
NO3-	56.5558	3.0055	60.6256	4.7601	0.93
SO4=	228.7654	10.9758	267.6367	19.4817	0.85
NH4+	77.1462	3.8285	72.1093	5.3317	1.07
Na+	5.5186	0.6797	5.2648	0.8320	1.05
K+	275.2843	13.4449	293.3859	21.7910	0.94
C(org)	2838.5174	178.1399	2939.2905	279.2135	0.97
C(ohf)	2563.9793	253.3932	2453.2395	367.2831	1.05
C(e)	1404.5068	86.1229	1879.0205	175.1034	0.75
C(eht)	60.8445	24.1871	176.1292	105.8194	0.35
C	4243.0242	0.0000	4818.3109	0.0000	0.88
Al	3.3046	0.6903	3.9141	0.8320	0.84
Si	5.6252	1.3222	7.0006	1.5848	0.80
P	2.0992	2.9736	1.8910	3.3960	1.11
S	138.1383	6.4145	106.1580	7.4938	1.30
Cl	254.4480	11.7829	182.7275	12.8765	1.39
K	494.4228	22.7427	358.8625	25.1191	1.38
Ca	13.5793	1.6780	29.3645	2.6885	0.46
Ti	0.0000	1.4125	0.0632	1.6357	0.00
V	0.0000	0.6107	0.0000	0.7075	
Cr	0.0000	0.1381	0.0172	0.1585	0.00
Mn	0.0574	0.0956	0.2184	0.0736	0.26
Fe	0.4838	0.2390	1.8680	0.3056	0.26
Co	0.0000	0.0584	0.0057	0.0736	0.00
Ni	0.0000	0.0637	0.0000	0.0736	
Cu	0.0902	0.0425	0.0805	0.0509	1.12
Zn	9.7581	0.4514	6.9546	0.4924	1.40
Ga	0.0000	0.1221	0.0000	0.1358	
As	0.0656	0.2867	0.0000	0.3170	
Se	0.0656	0.0743	0.0460	0.0849	1.43
Br	2.3944	0.1221	1.6151	0.1302	1.48
Rb	0.5084	0.0531	0.3908	0.0566	1.30
Sr	0.1640	0.0478	0.3449	0.0566	0.48
Y	0.0000	0.0850	0.0000	0.0962	
Zr	0.0000	0.1009	0.0000	0.1189	
Mo	0.0000	0.1752	0.0000	0.1981	
Pd	0.0000	0.6000	0.0690	0.6792	0.00
Ag	0.2132	0.6903	0.0000	0.7754	
Cd	0.0000	0.7328	0.0000	0.8490	
In	0.0000	0.8284	0.0000	0.9509	
Sn	0.0000	1.0514	0.0172	1.2056	0.00
Sb	0.0000	1.1948	0.4311	1.3754	0.00
Ba	0.0000	4.1896	0.0000	4.7997	
La	0.0000	5.6392	0.0000	6.4581	
Au	0.0164	0.3027	0.0000	0.3453	
Hg	0.0000	0.1593	0.0000	0.1755	
Tl	0.0164	0.1646	0.0000	0.1811	
Pb	2.3042	0.1752	1.6381	0.1981	1.41
U	0.0000	0.1593	0.0000	0.1868	
Sum of measured species	5,310	200	5,660	311	0.94

Table 3.5.23. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Walnut
 Date: 12-Nov-92
 Time: 9:28
 Filter ID: AG-61

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	282,954	20,760	3,894
Na	60,107	8,049	13,795
Mg	52,302	7,693	5,383
Al	23,916	4,975	4,047
Si	14,546	3,756	3,346
P			3,376
S	116,448	7,115	3,646
Cl	376,805	20,140	3,879
K	747,311	38,121	2,426
Ca	80,158	9,106	1,733
Ti	1,565	589	1,509
V			1,309
Cr			1,077
Mn	2,273	578	991
Fe	7,922	913	992
Ni			696
Cu			703
Zn	11,571	794	629
As			645
Pb	5,699	1,605	1,751
Se			729
Br	3,845	541	776
Rb			1,210
Sr	2,956	845	1,281
Zr			2,060

Table 3.5.24. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Walnut
 Date: 12-Nov-92
 Time: 9:28
 Filter ID: AG-61

Fuel rate (g/s) 7.51
 Stack gas flow rate (m³/s) 2.79
 Stack Temperature (°C) 32.37
 Ambient Temperature (°C) 10.77

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	97.7	7.2
Na	20.8	2.8
Mg	18.1	2.7
Al	8.3	1.7
Si	5.0	1.3
P		
S	40.2	2.5
Cl	130.1	7.0
K	258.0	13.2
Ca	27.7	3.1
Ti	0.5	0.2
V		
Cr		
Mn	0.8	0.2
Fe	2.7	0.3
Ni		
Cu		
Zn	4.0	0.3
As		
Pb	2.0	0.6
Se		
Br	1.3	0.2
Rb		
Sr	1.0	0.3
Zr		

Table 3.5.25. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Walnut
 Date: 12-Nov-92
 Time: 11:12
 Filter ID: AG-62

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	389,888	26,090	4,329
Na	160,020	16,812	14,272
Mg	35,095	7,044	5,643
Al	40,271	4,414	4,284
Si			3,584
P			3,658
S	212,413	11,770	3,979
Cl	554,472	28,958	4,241
K	1,187,875	60,114	2,655
Ca	108,183	12,918	1,903
Ti			1,653
V	2,163	615	1,439
Cr			1,182
Mn			1,094
Fe	11,408	1,267	1,088
Ni			769
Cu			777
Zn	20,684	1,234	693
As			699
Pb			1,898
Se			792
Br	3,505	496	846
Rb			1,319
Sr			1,384
Zr	1,203	710	2,233

Table 3.5.26. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Walnut
 Date: 12-Nov-92
 Time: 11:12
 Filter ID: AG-62

Fuel rate (g/s) 12.66
 Stack gas flow rate (m³/s) 5.93
 Stack Temperature (°C) 50.04
 Ambient Temperature (°C) 18.14

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	164.6	11.0
Na	67.6	7.1
Mg	14.8	3.0
Al	17.0	1.9
Si		
P		
S	89.7	5.0
Cl	234.1	12.2
K	501.5	25.4
Ca	45.7	5.5
Ti		
V	0.9	0.3
Cr		
Mn		
Fe	4.8	0.5
Ni		
Cu		
Zn	8.7	0.5
As		
Pb		
Se		
Br	1.5	0.2
Rb		
Sr		
Zr	0.5	0.3

Table 3.5.27. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Walnut
 Date: 12-Nov-92
 Time: 11:30
 Filter ID: AG-63

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	445,191	31,807	4,604
Na	61,396	8,696	13,819
Mg	24,798	3,681	5,391
Al	21,167	3,485	4,057
Si	13,615	2,328	3,368
P	5,559	1,495	3,411
S	53,782	4,160	3,662
Cl	244,628	13,546	3,851
K	384,587	20,134	2,428
Ca	71,682	6,870	1,748
Ti	3,499	1,531	1,543
V			1,346
Cr			1,106
Mn			1,023
Fe	10,812	1,347	1,098
Ni			772
Cu			779
Zn	7,948	628	697
As			717
Pb	4,725	846	1,948
Se			809
Br	2,880	506	860
Rb			1,342
Sr			1,401
Zr			2,272

Table 3.5.28. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Walnut	
Date:	12-Nov-92	
Time:	11:30	
Filter ID:	AG-63	
Fuel rate (g/s)		12.66
Stack gas flow rate (m ³ /s)		5.93
Stack Temperature (°C)		50.04
Ambient Temperature (°C)		18.14
	Emission factor	±Uncertainty
Element	(mg/kg)	(mg/kg)
H	187.9	13.4
Na	25.9	3.7
Mg	10.5	1.6
Al	8.9	1.5
Si	5.7	1.0
P	2.3	0.6
S	22.7	1.8
Cl	103.3	5.7
K	162.4	8.5
Ca	30.3	2.9
Ti	1.5	0.6
V		
Cr		
Mn		
Fe	4.6	0.6
Ni		
Cu		
Zn	3.4	0.3
As		
Pb	2.0	0.4
Se		
Br	1.2	0.2
Rb		
Sr		
Zr		

Table 3.5.29. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Walnut
 Date: 12-Nov-92
 Time: 12:50
 Filter ID: AG-64

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	398,274	25,032	3,949
Na	73,828	17,313	13,741
Mg	57,441	12,977	5,282
Al			3,920
Si	27,538	3,561	3,219
P			3,222
S	55,017	4,146	3,410
Cl	198,331	11,236	3,526
K	344,123	18,130	2,204
Ca	59,703	7,400	1,607
Ti	1,621	577	1,438
V	1,334	506	1,255
Cr			1,031
Mn	1,924	477	953
Fe	9,617	937	1,033
Ni			730
Cu	1,828	340	736
Zn	7,183	560	656
As			669
Pb	4,060	1,036	1,818
Se	1,225	291	755
Br	3,109	483	802
Rb			1,251
Sr			1,313
Zr	2,402	854	2,121

Table 3.5.30. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Walnut
 Date: 12-Nov-92
 Time: 12:50
 Filter ID: AG-64

Fuel rate (g/s) 12.66
 Stack gas flow rate (m³/s) 5.93
 Stack Temperature (°C) 50.04
 Ambient Temperature (°C) 18.14

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	168.1	10.6
Na	31.2	7.3
Mg	24.2	5.5
Al		
Si	11.6	1.5
P		
S	23.2	1.8
Cl	83.7	4.7
K	145.3	7.7
Ca	25.2	3.1
Ti	0.7	0.2
V	0.6	0.2
Cr		
Mn	0.8	0.2
Fe	4.1	0.4
Ni		
Cu	0.8	0.1
Zn	3.0	0.2
As		
Pb	1.7	0.4
Se	0.5	0.1
Br	1.3	0.2
Rb		
Sr		
Zr	1.0	0.4

Table 3.5.31
VOC Concentrations (ppbv)

Date	12-Nov-92
Fuel	Walnut
Traverse	Traverse 2
Acetic acid	
Propanone (acetone)	7.64
Methyl ester acetic acid (methylacetate)	4.19
Butane	
Dimethyloxirane	
Pentene	
Methylbutanone (isopropylmethyl ketone)	5.57
Furancarboxaldehyde (furfural)	10.35
Benzene	11.63
Dimethylbutane	
Hexane	
Phenol	
Dimethylfuran	
2-methyl 2-cyclopenten-1-one	
2-chloro phenol	
Toluene	6.61
Benzonitrile	
Benzaldehyde	4.21
Methylphenol (hydroxy toluene)	
Styrene	3.7
Xylene	0.8
Trimethylpentane	
Benzofuran	
Methoxymethylphenol (creosol)	
Naphthalene	0.95
C10H12	
Alpha-pinene	
Camphene	
Δ 3-Carene	
Limonene	
No match r.t. (6.7)	
No match r.t. (8.51)	
No match r.t. (8.71)	
No match r.t. (8.73)	
No match r.t.(6.4)	
No match r.t.(8.5)	

Table 3.5.32
VOC Emission Factors (mg/kg)

Date	12-Nov-92
Fuel	Walnut
Traverse	Traverse 2
Fuel Consumption Rate (g/s d.b)	12.66
Stack Gas Mass Flow Rate* (kg/s)	6.49

Acetic acid	
Propanone (acetone)	8
Methyl ester acetic acid (methylacetate)	5
Butane	
Dimethyloxirane	
Pentene	
Methylbutanone (isopropylmethyl ketone)	8
Furancarboxaldehyde (furfural)	18
Benzene	16
Dimethylbutane	
Hexane	
Phenol	
Dimethylfuran	
2-methyl 2-cyclopenten-1-one	
2-chloro phenol	
Toluene	11
Benzonitrile	
Benzaldehyde	8
Methylphenol (hydroxy toluene)	
Styrene	7
Xylene	2
Trimethylpentane	
Benzofuran	
Methoxymethylphenol (creosol)	
Naphthalene	2
Unknown	
Alpha-pinene	
Camphene	
Δ^3 -Carene	
Limonene	

*uses stack gas flow rate from carbon balance

Table 3.5.33. PAH emission factors, walnut tree prunings, 12 November 1992, measured stack gas velocity (zero indicates not detected).

	Traverse 1 Filter	Traverse 2 Filter	Trap	Traverse 1 Sorbent	Traverse 2 Sorbent	Impinger Finsate	Total Traverse 1	Total Traverse 2	Total Average
µg/kg dry fuel									
Naphthalene	11	11	0	15,818	13,251	17	15,846	13,279	14,563
2-Methyl-naphthalene	10	8	0	2,189	1,747	4	2,203	1,757	1,980
Acenaphthylene	2	1	0	1,178	940	1	1,180	942	1,061
Acenaphthene	0	0	0	1,772	1,670	0	1,772	1,670	1,721
Fluorene	7	1	0	1,221	629	0	1,228	630	929
Phenanthrene	96	87	0	2,672	1,110	10	2,778	1,207	1,993
Anthracene	7	12	0	485	240	2	494	253	374
Fluoranthene	480	336	1	844	920	5	1,329	1,261	1,295
Pyrene	408	331	0	515	687	2	925	1,021	973
Benz[a]-anthracene	33	44	0	22	22	0	54	66	60
Chrysene	58	50	0	24	27	0	80	77	78
Benzo[b]-fluoranthene	0	0	0	0	0	0	0	0	0
Benzo[k]-fluoranthene	0	0	0	0	0	0	0	0	0
Benzo[a]pyrene	0	0	0	12	0	0	12	0	6
Benzo[e]pyrene	0	0	0	30	7	0	30	7	18
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	0	0	0	0	0	0	0	0	0
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	1,109	880	1	26,781	21,249	40	27,931	22,170	25,051

Table 3.5.34. PAH emission factors, walnut tree prunings, 12 November 1992, stack gas velocity from carbon balance.

	Traverse 1 Filter	Traverse 2 Filter	Trap	Traverse 1 Sorbent	Traverse 2 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 2	Total Average
µg/kg dry fuel									
Naphthalene	7	18	0	9,985	19,893	17	10,009	19,926	14,968
2-Methyl-naphthalene	6	9	0	1,382	2,623	4	1,392	2,636	2,014
Acenaphthylene	1	2	0	743	1,411	1	745	1,413	1,079
Acenaphthene	0	0	0	1,118	2,507	0	1,118	2,507	1,813
Fluorene	5	2	0	770	944	0	775	946	860
Phenanthrene	61	131	0	1,688	1,666	10	1,757	1,807	1,782
Anthracene	5	18	0	308	360	2	312	379	346
Fluoranthene	303	505	1	533	1,381	5	841	1,891	1,366
Pyrene	257	497	0	325	1,031	2	585	1,531	1,058
Benz[a]-anthracene	21	68	0	14	34	0	34	99	67
Chrysene	35	75	0	15	40	0	50	115	83
Benzo[b]-fluoranthene	0	1	0	0	0	0	0	1	0
Benzo[k]-fluoranthene	0	0	0	0	0	0	0	0	0
Benzo[a]pyrene	0	0	0	7	0	0	7	0	4
Benzo[e]pyrene	0	0	0	19	10	0	19	10	14
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	0	0	0	0	0	0	0	0	0
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	700	1,321	1	16,904	31,900	40	17,646	33,263	25,454

Figure 3.5.1. Ambient air conditions, 12 November 92.

Fuel Type: Walnut
Configuration: Pile

Test Date 12-Nov-92

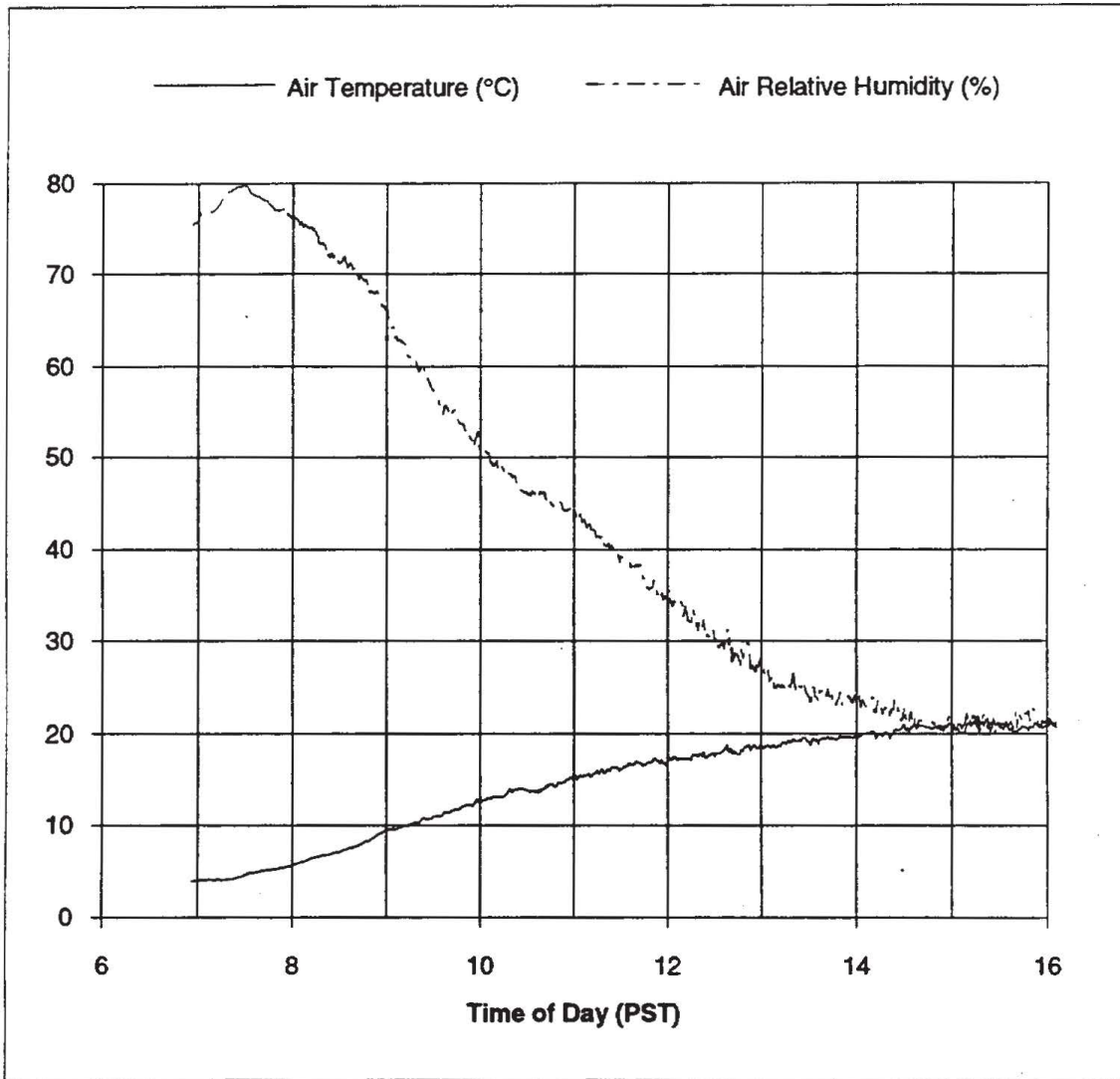


Figure 3.5.2. Air temperature and relative humidity from CIMIS station.

Fuel: Walnut Date of Test: 12-Nov-92

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

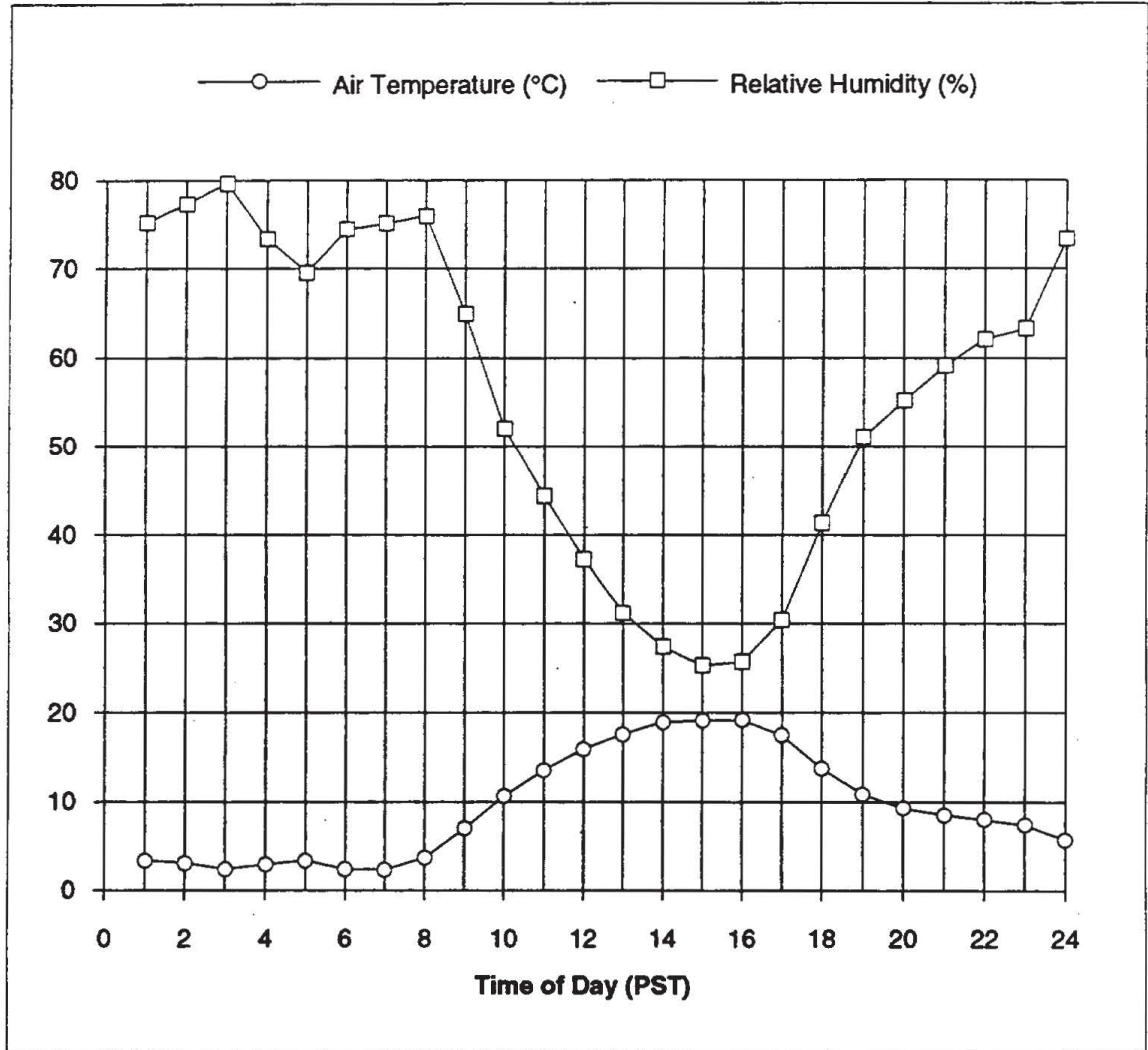


Figure 3.5.3. Wind speed from CIMIS station.

Fuel: Walnut

Date of Test: 12-Nov-92

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

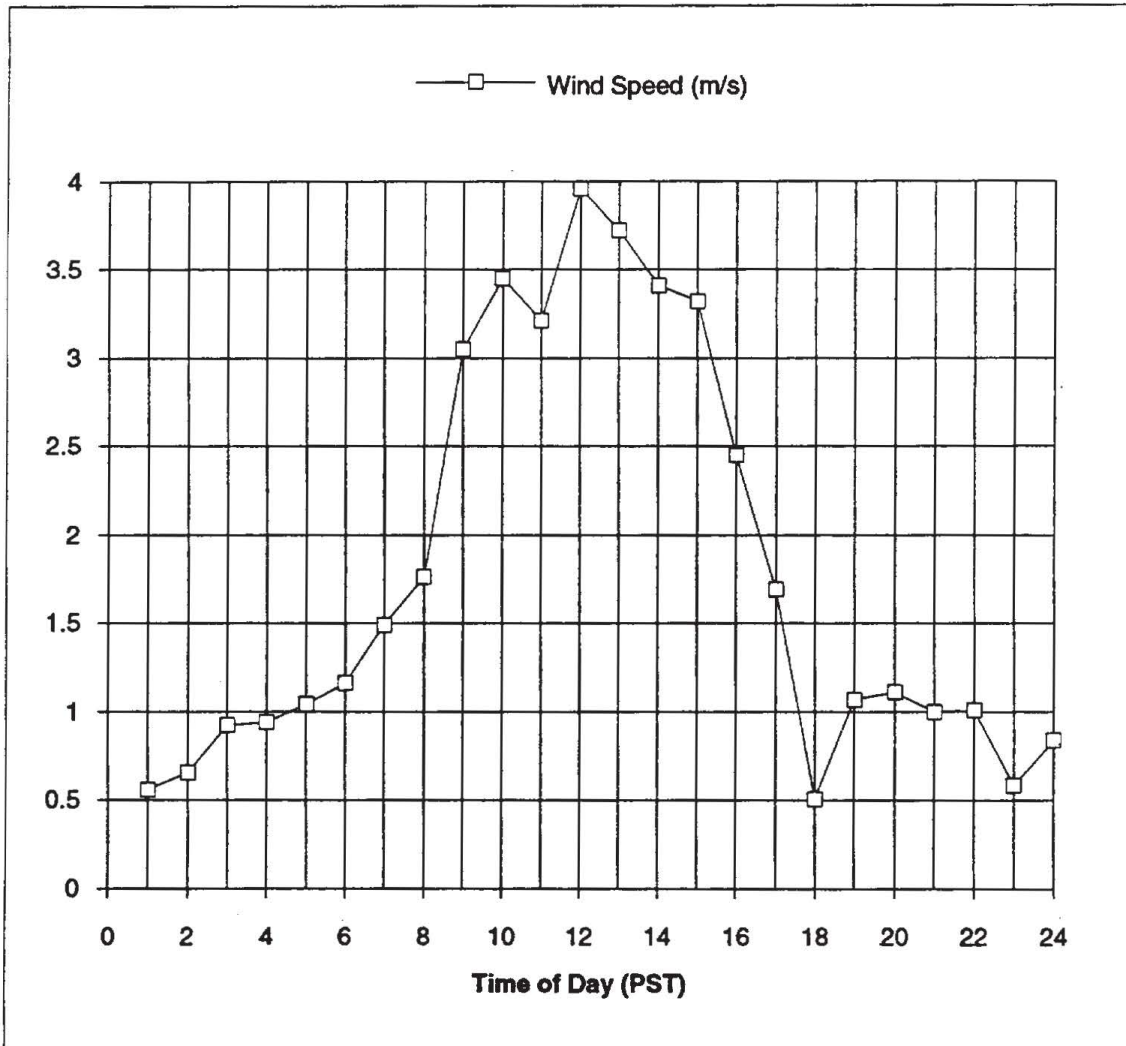


Figure 3.5.4. Wind direction and solar radiation from CIMIS station.

Fuel: Walnut Date of Test: 12-Nov-92

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

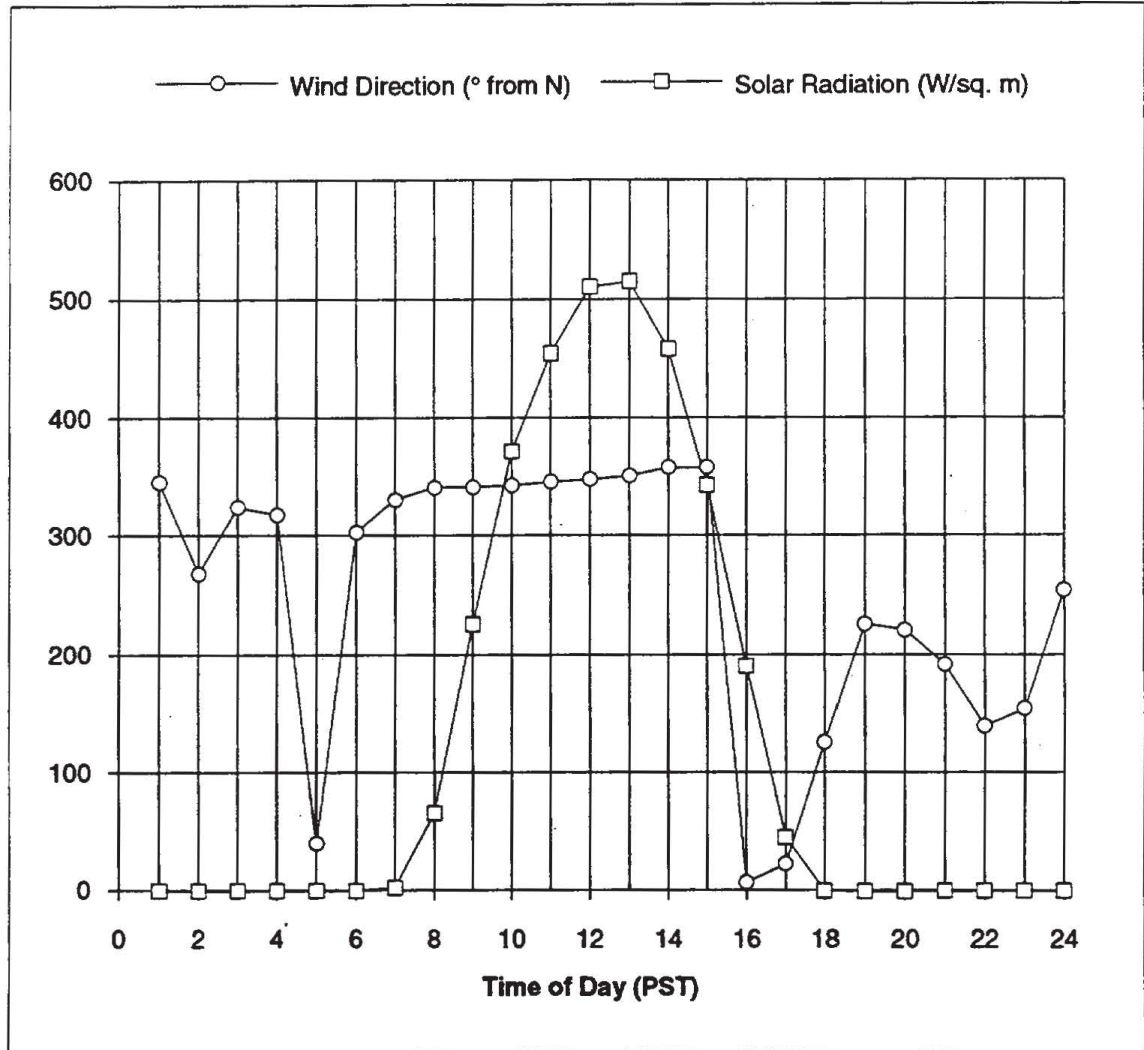


Figure 3.5.5. Inlet air, stack gas, and impinger temperatures, 12 November 92.

Fuel Type: Walnut
Configuration: Pile

Test Date 12-Nov-92

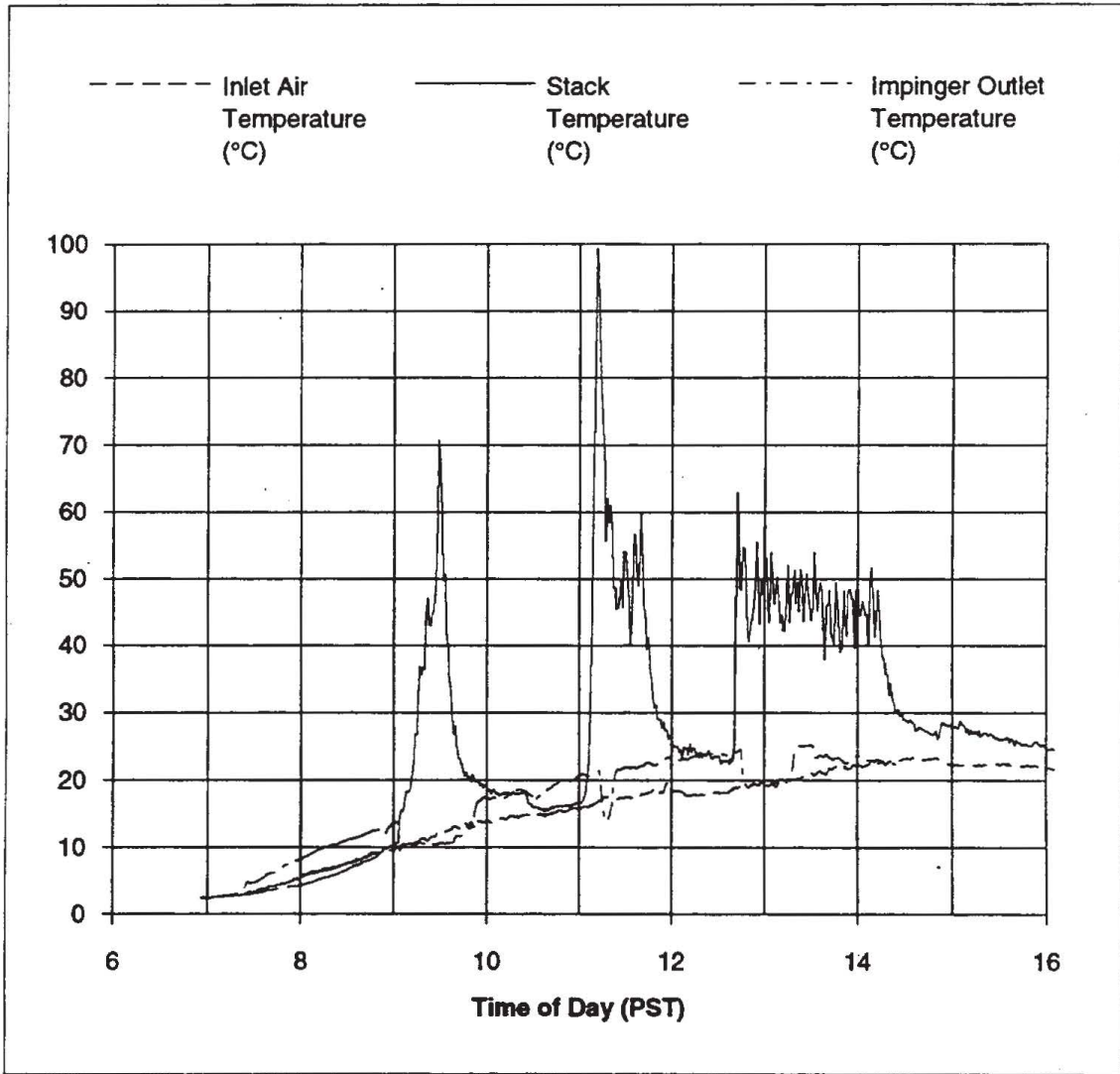


Figure 3.5.6. Stack gas velocity, 12 November 92.

Fuel Type: Walnut
Configuration: Pile

Test Date 12-Nov-92

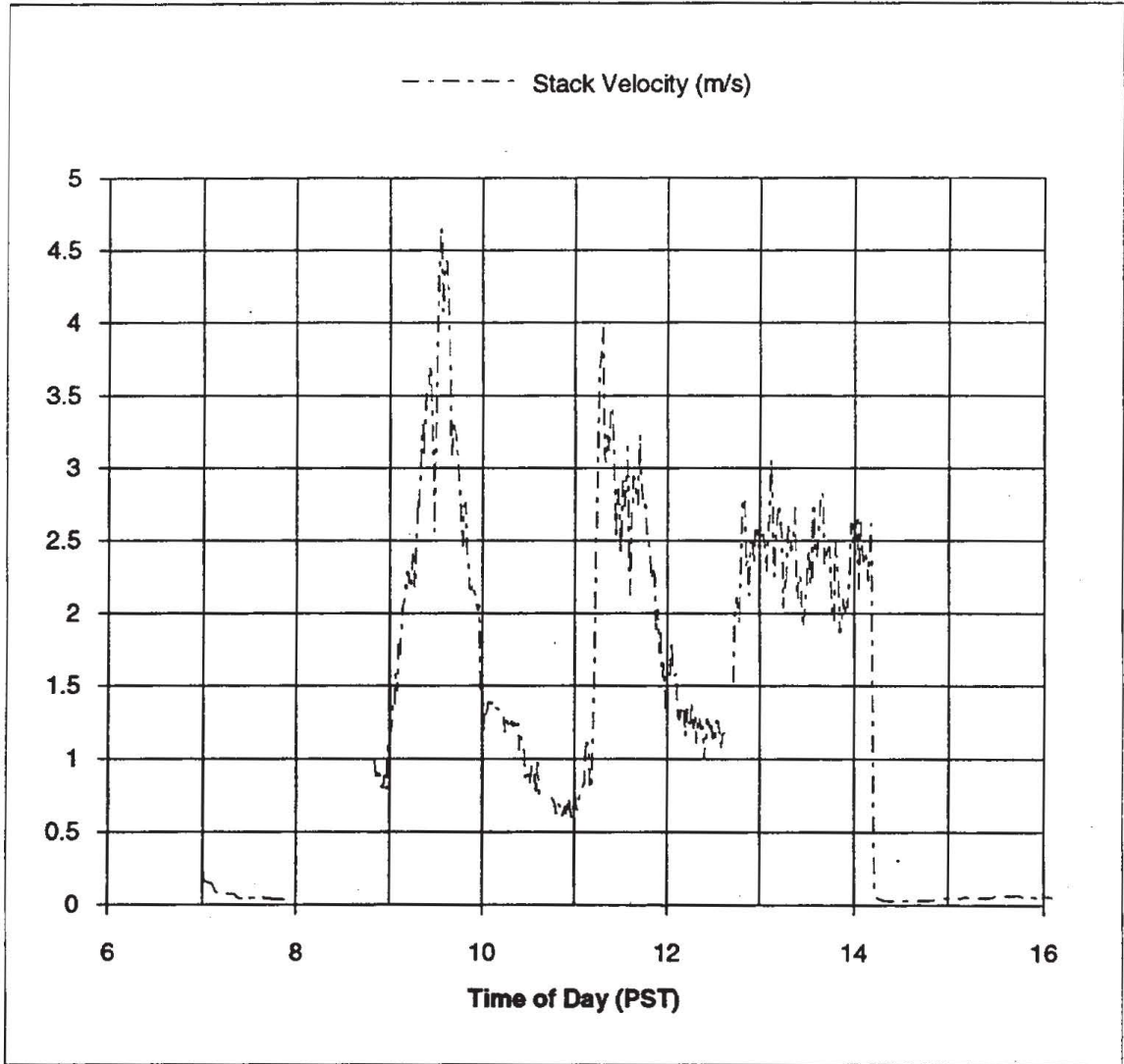


Figure 3.5.7. CO concentration in stack gas, 12 November 92.

Fuel Type: Walnut
Configuration: Pile

Test Date 12-Nov-92

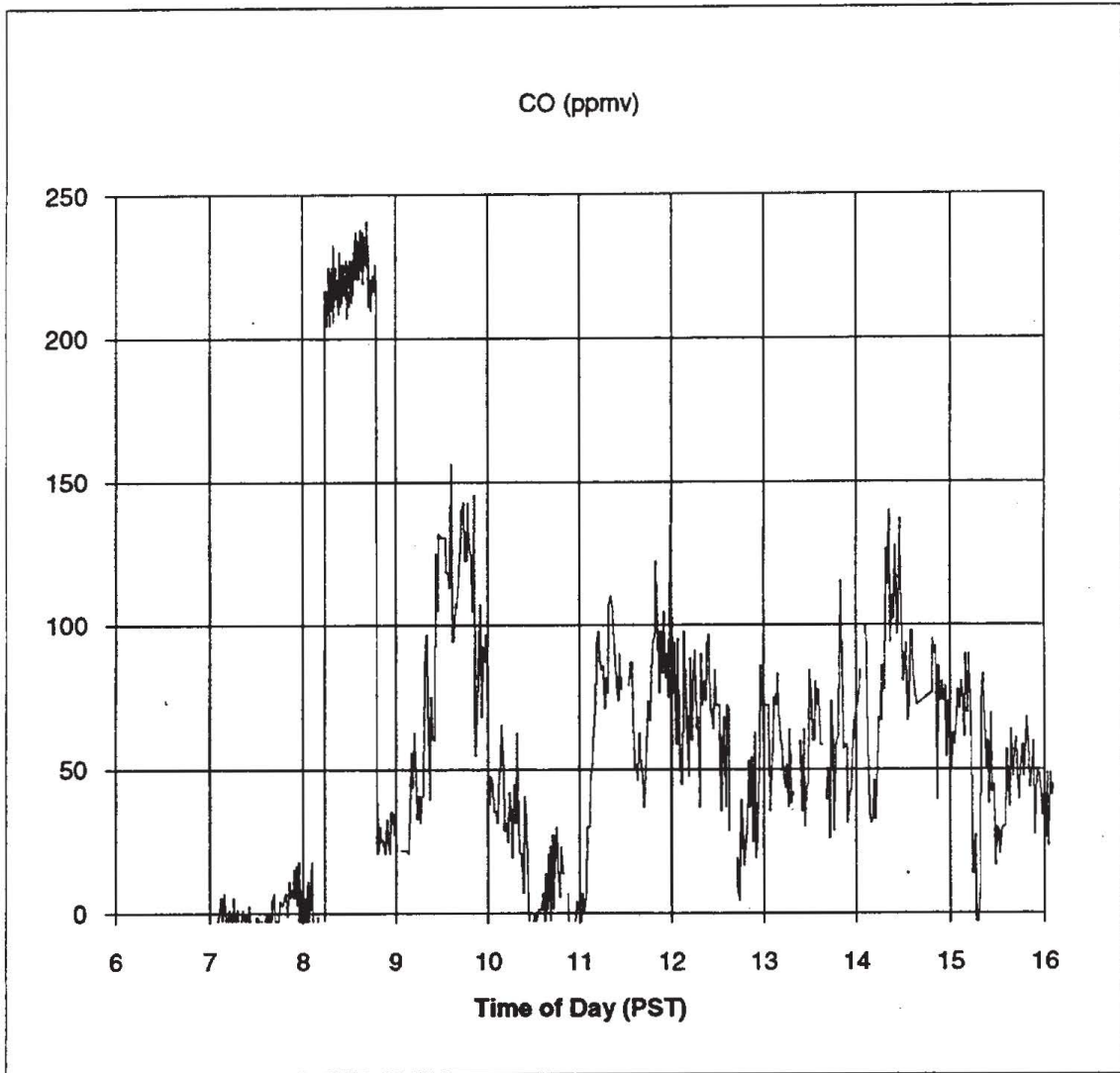


Figure 3.5.8. NO and NOx concentrations in stack gas, 12 November 92.

Fuel Type: Walnut
Configuration: Pile

Test Date 12-Nov-92

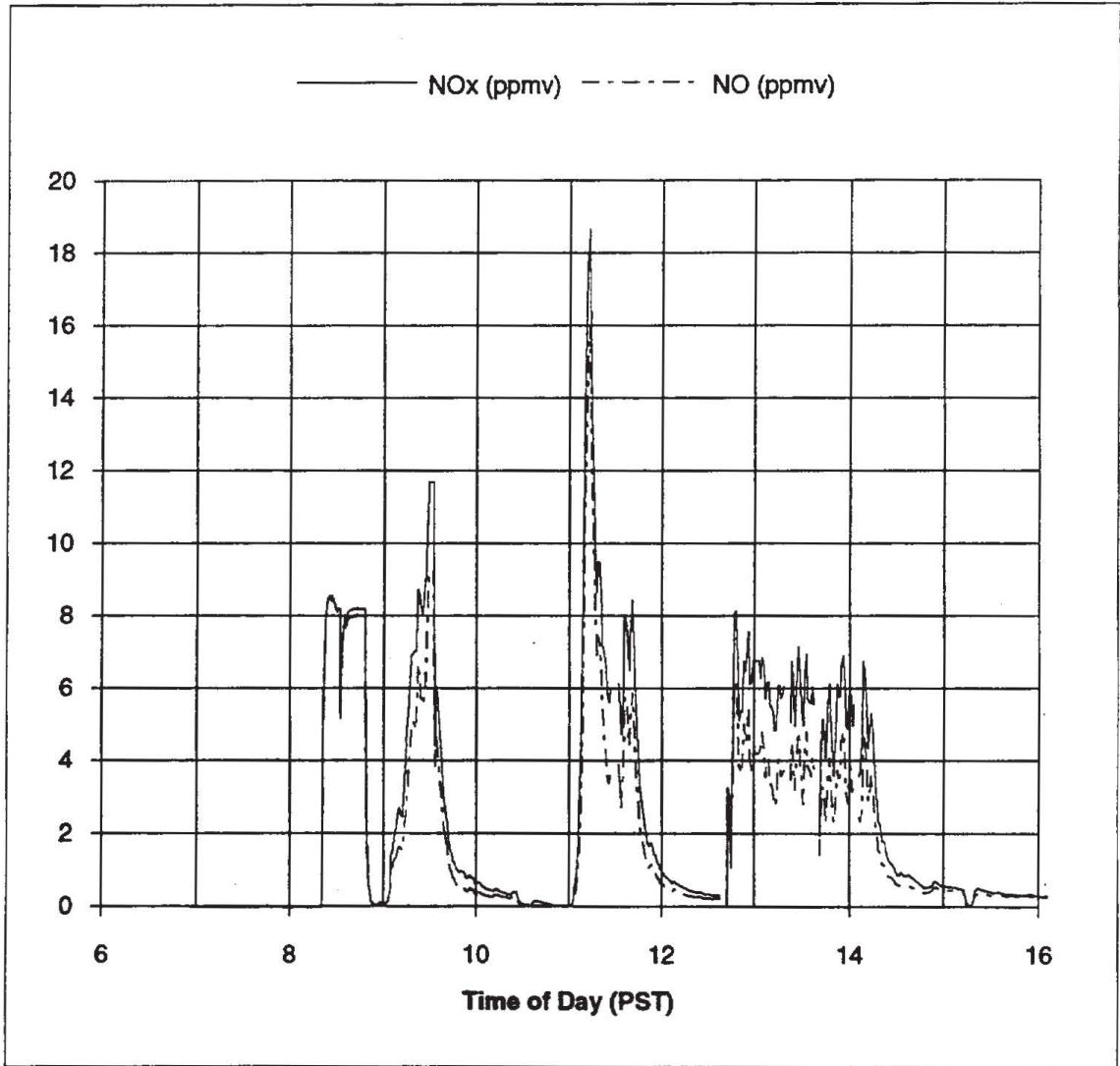


Figure 3.5.9. SO₂ concentration in stack gas, 12 November 92.

Fuel Type: Walnut
Configuration: Pile

Test Date 12-Nov-92

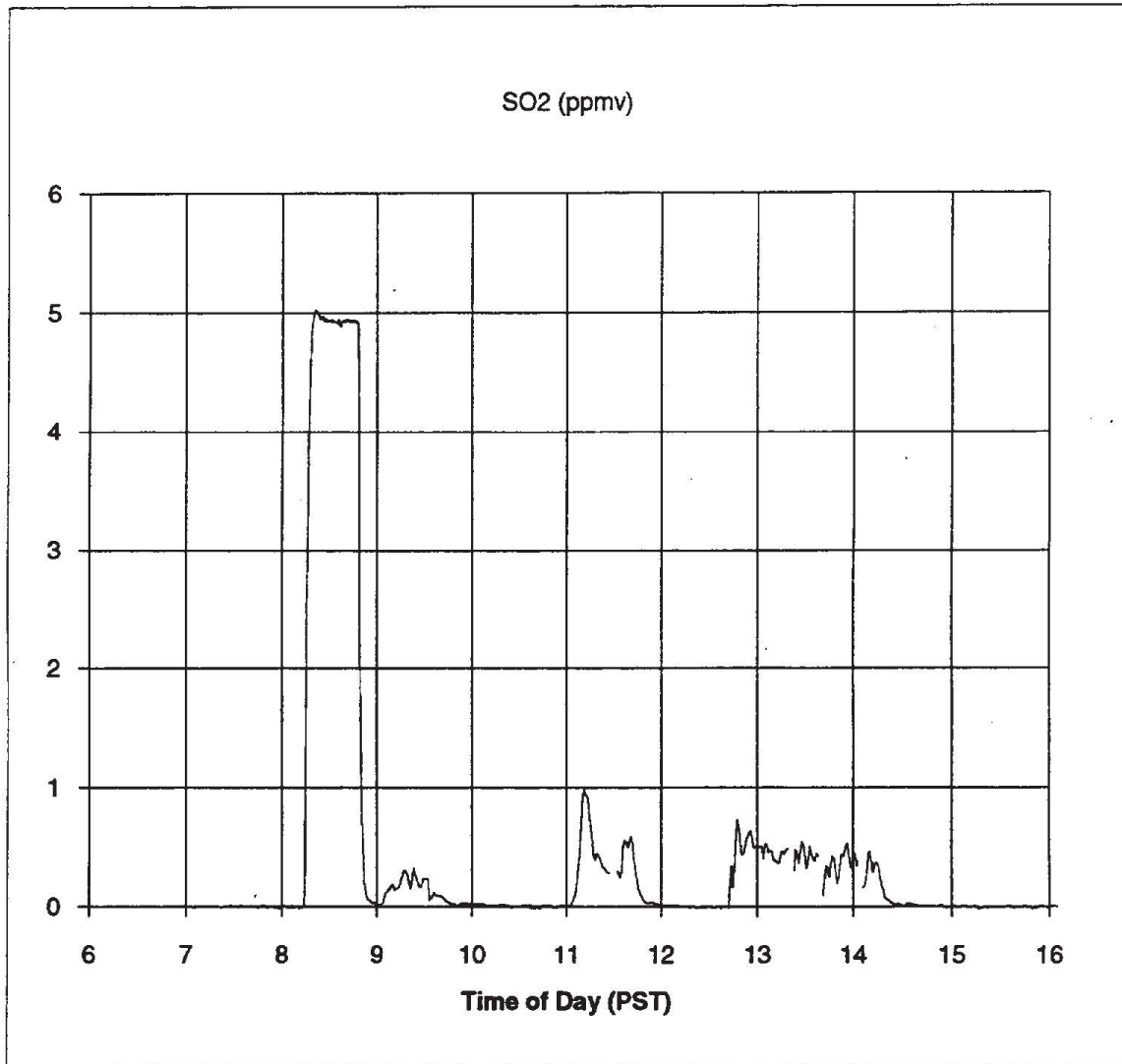


Figure 3.5.10. Total sulfur concentration in stack gas, 12 November 92.

Fuel Type: Walnut
Configuration: Pile

Test Date 12-Nov-92

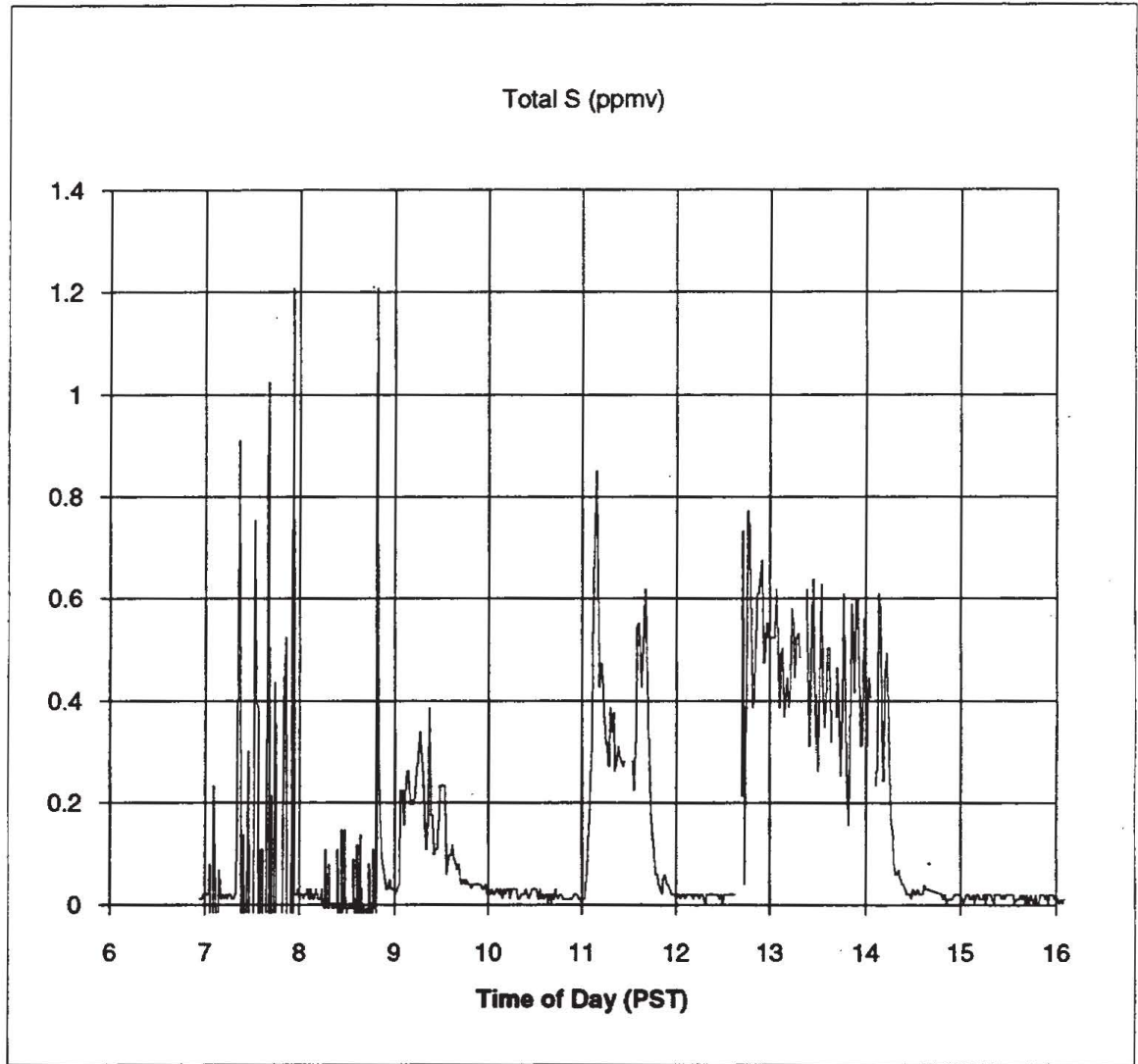


Figure 3.5.11. THC concentration in stack gas, 12 November 92.

Fuel Type: Walnut Test Date: 12-Nov-92
Configuration: Pile

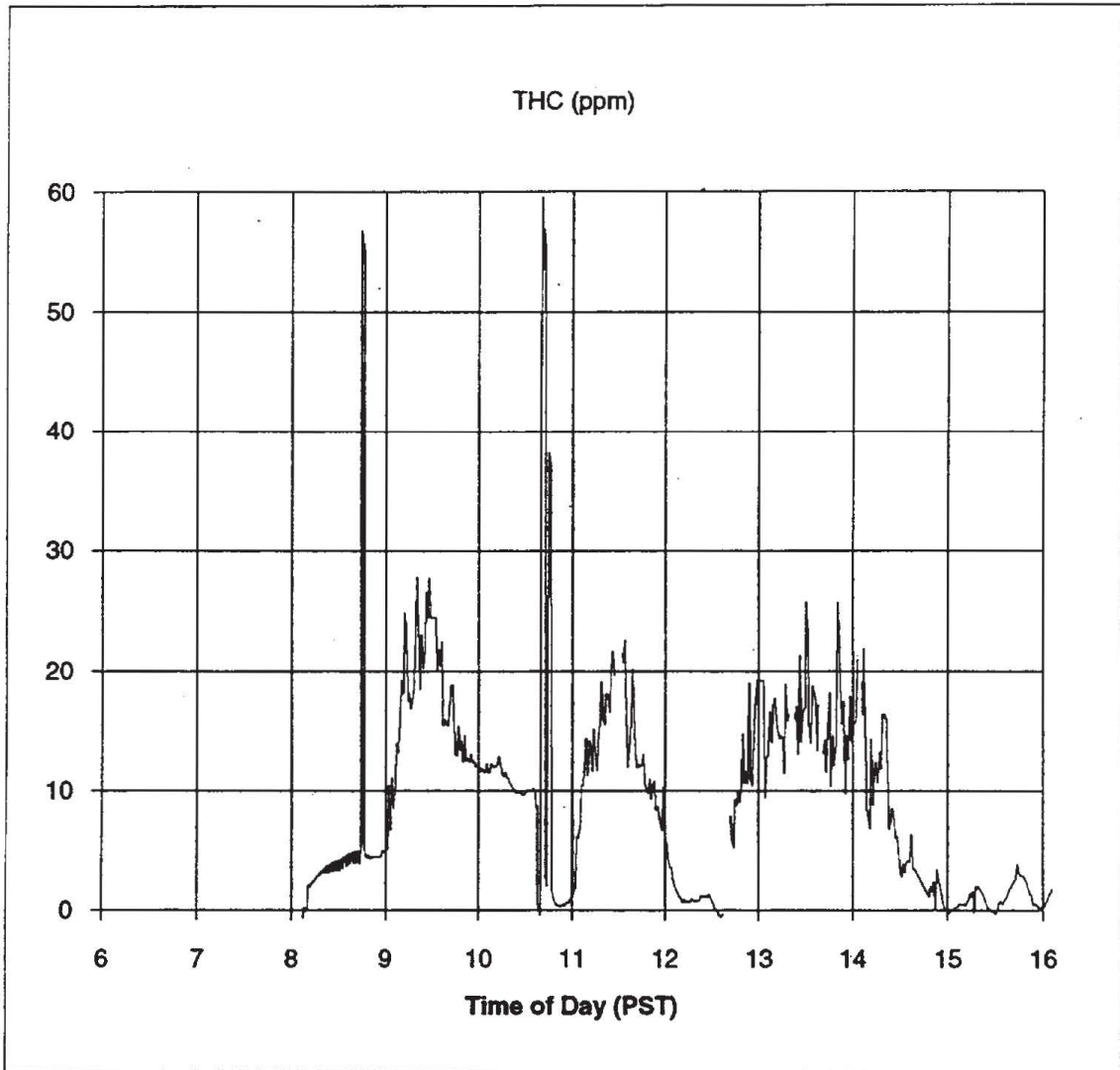


Figure 3.5.12. Particle size distribution, traverse 1, 12 November 92.

Fuel: Walnut Date of Test: 12-Nov-92
Configuration: Pile

Particle Size Distribution
Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.88	0.16	6.51	1.000
2	7.78	0.21	6.35	0.975
3	4.15	0.16	6.14	0.943
4	2.19	0.25	5.98	0.919
5	1.26	0.33	5.73	0.880
6	0.74	0.84	5.4	0.829
7	0.39	0.46	4.56	0.700
filter	0.00	4.1	4.1	0.630

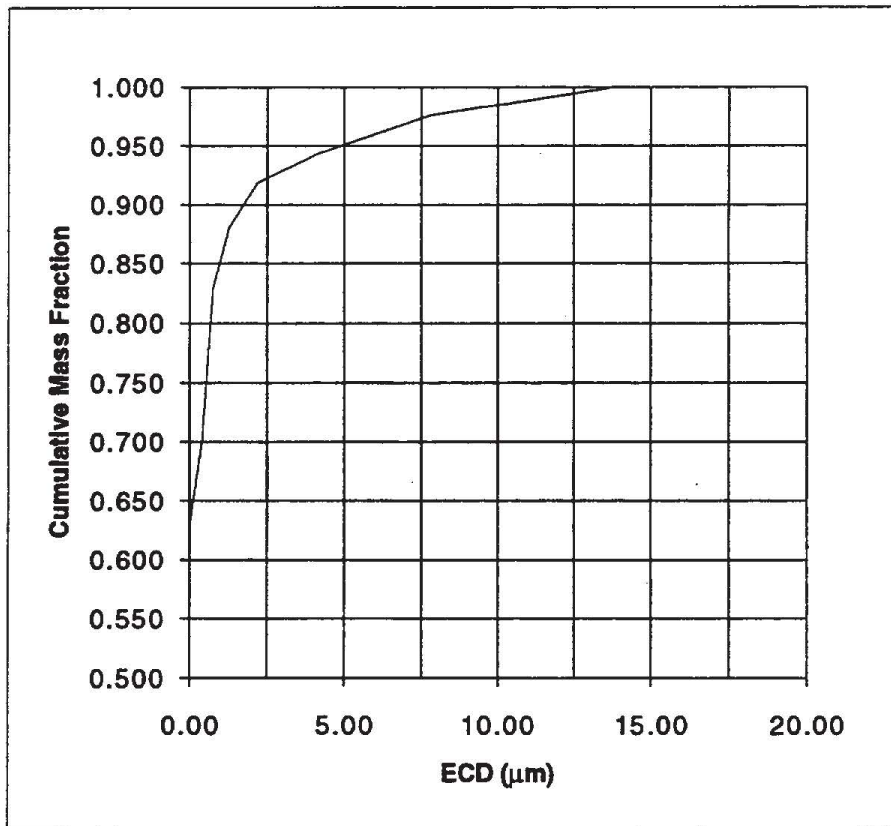


Figure 3.5.13. Particle size distribution, traverse 2, 12 November 92.

Fuel: Walnut Date of Test: 12-Nov-92
Configuration: Pile

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.92	0.11	4.26	1.000
2	7.80	0.12	4.15	0.974
3	4.16	0.12	4.03	0.946
4	2.20	0.14	3.91	0.918
5	1.27	0.08	3.77	0.885
6	0.74	0.34	3.69	0.866
7	0.39	0.45	3.35	0.786
filter	0.00	2.9	2.9	0.681

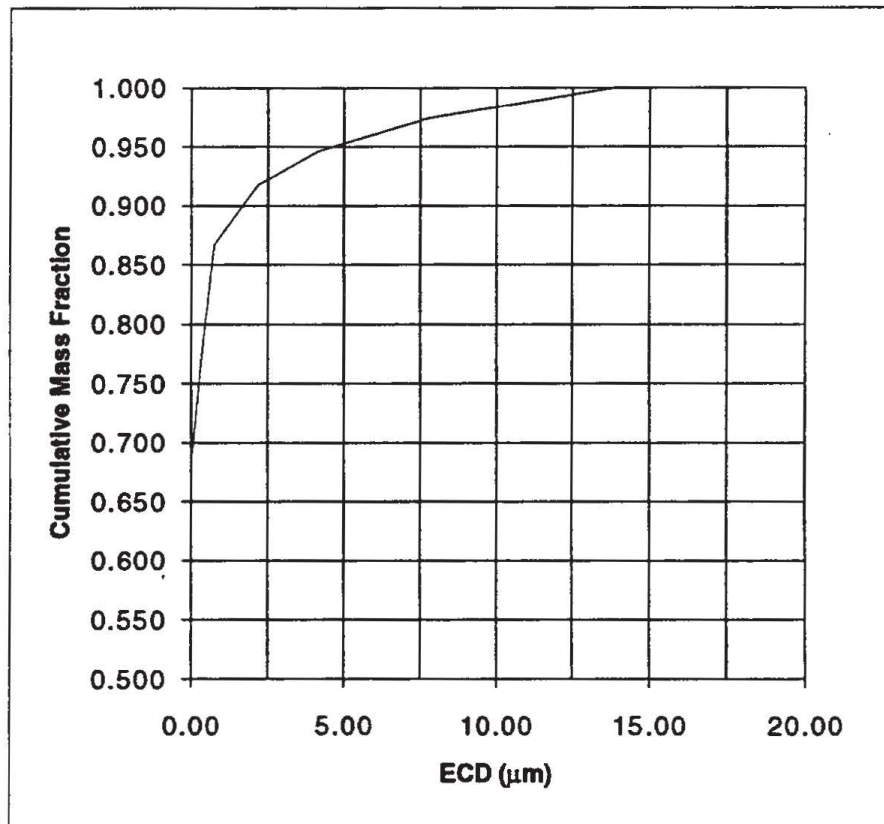


Figure 3.5.1.14. Results of grab sample analyses, 12 November 92.

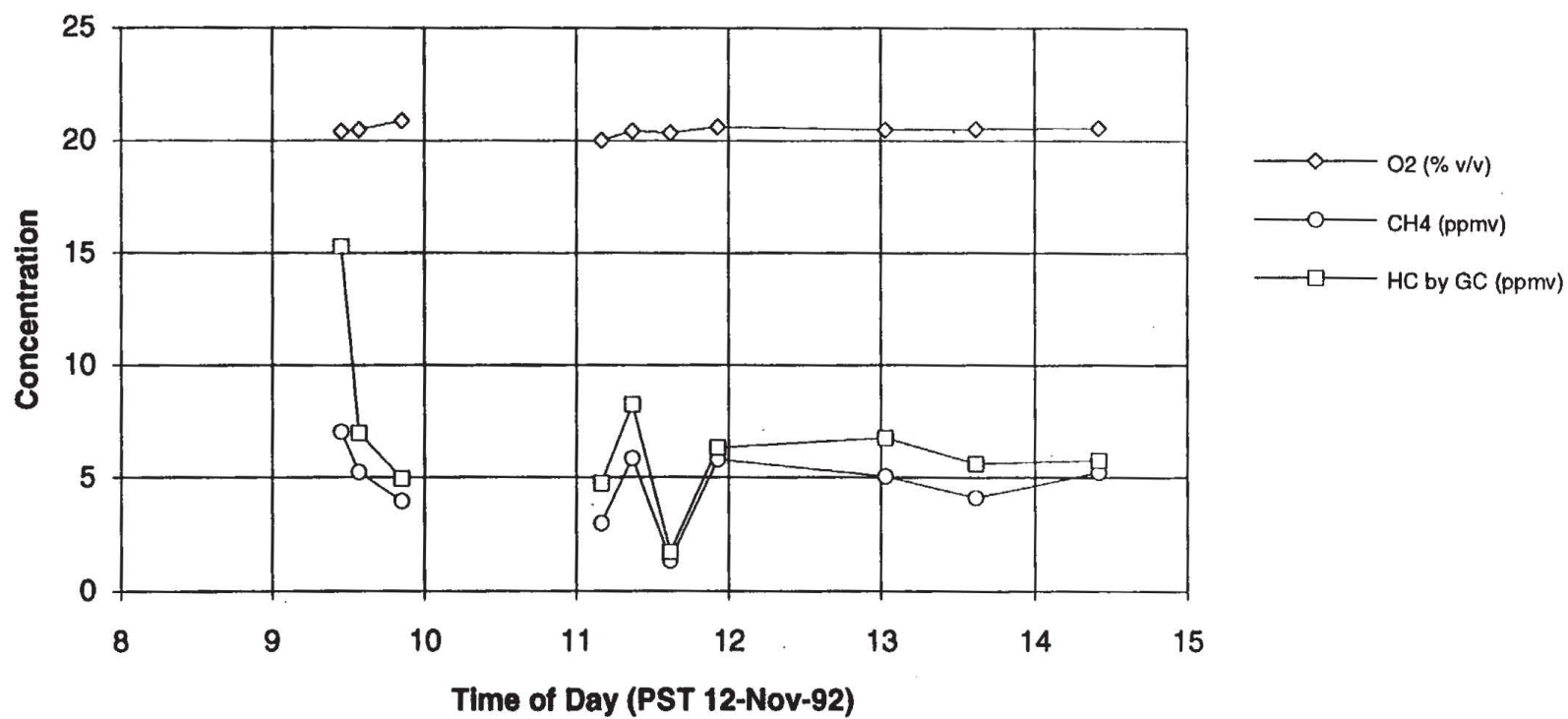


Figure 3.5.15. Results of grab sample analyses for CO₂, 12 November 92.

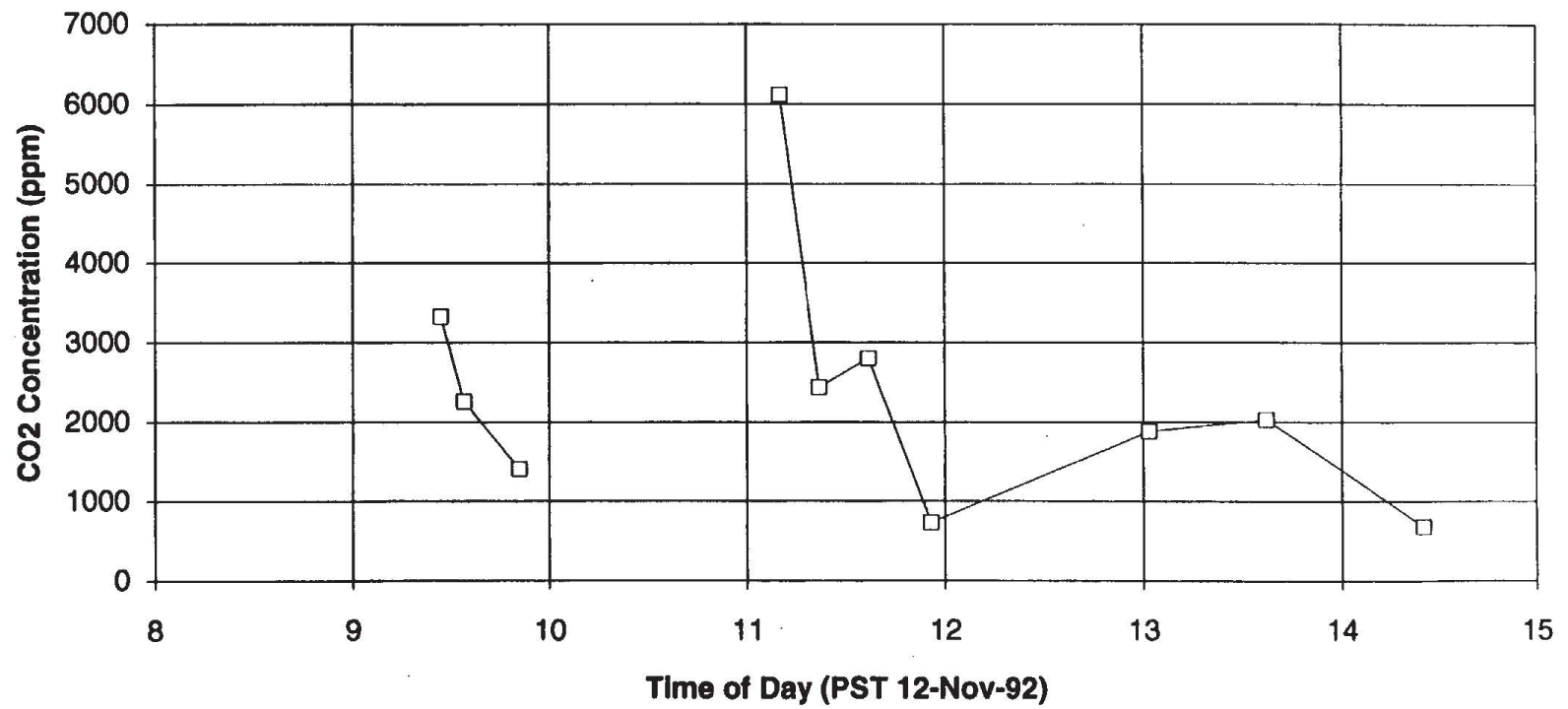


Figure 3.5.16. Nitrogen balance.

Date of Test:
Fuel

12-Nov-92
Walnut
Traverse 1

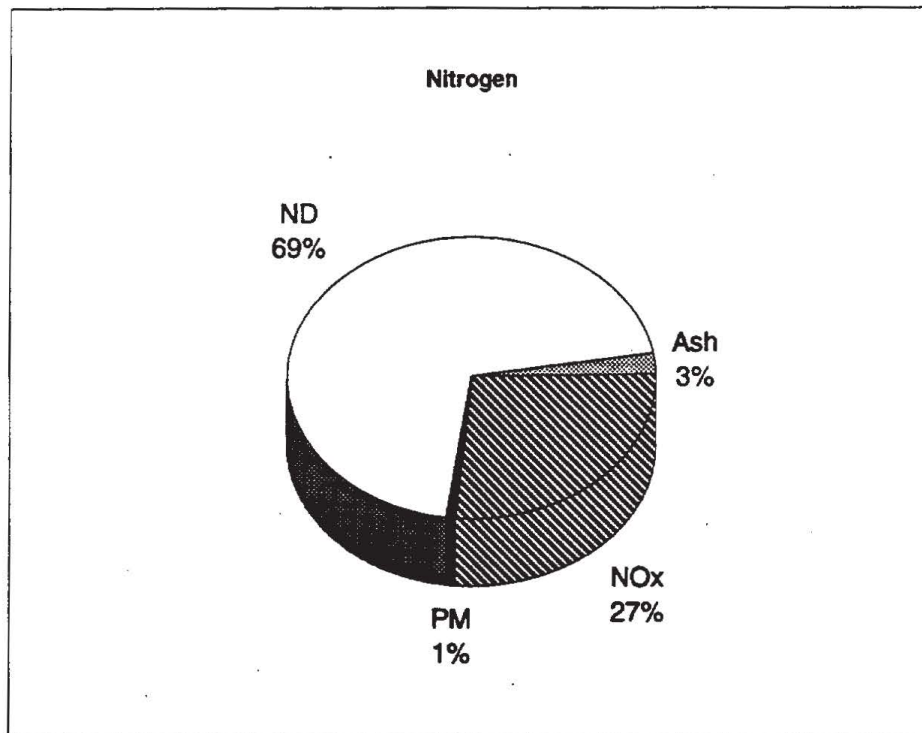


Figure 3.5.17. Nitrogen balance.
Date of Test:
Fuel

12-Nov-92
Walnut
Traverse 2

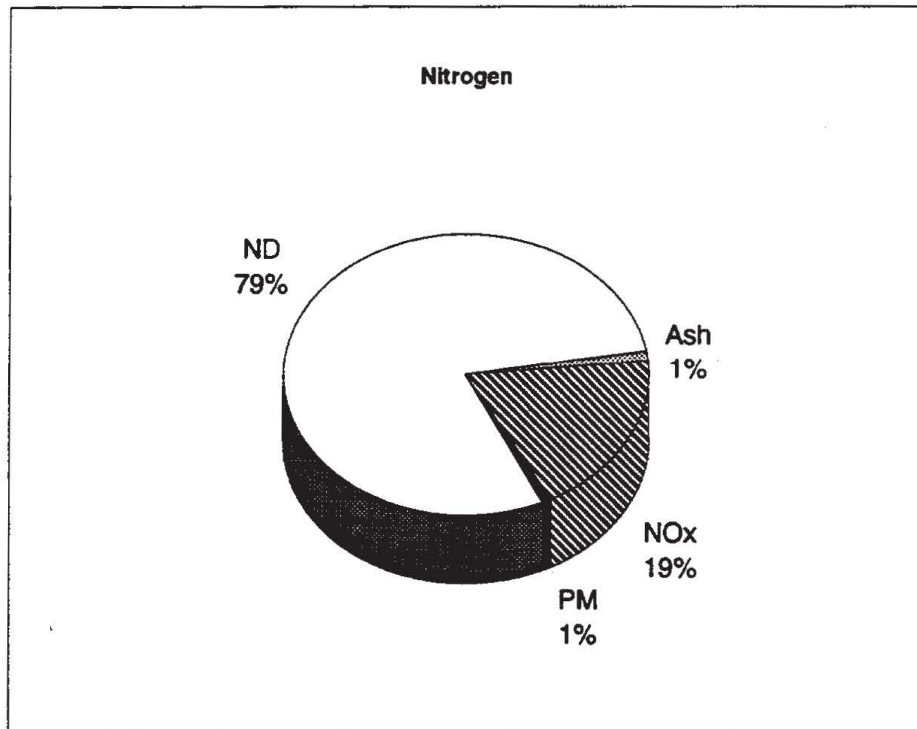


Figure 3.5.18. Nitrogen balance.
Date of Test:
Fuel

12-Nov-92
Walnut
Test 1

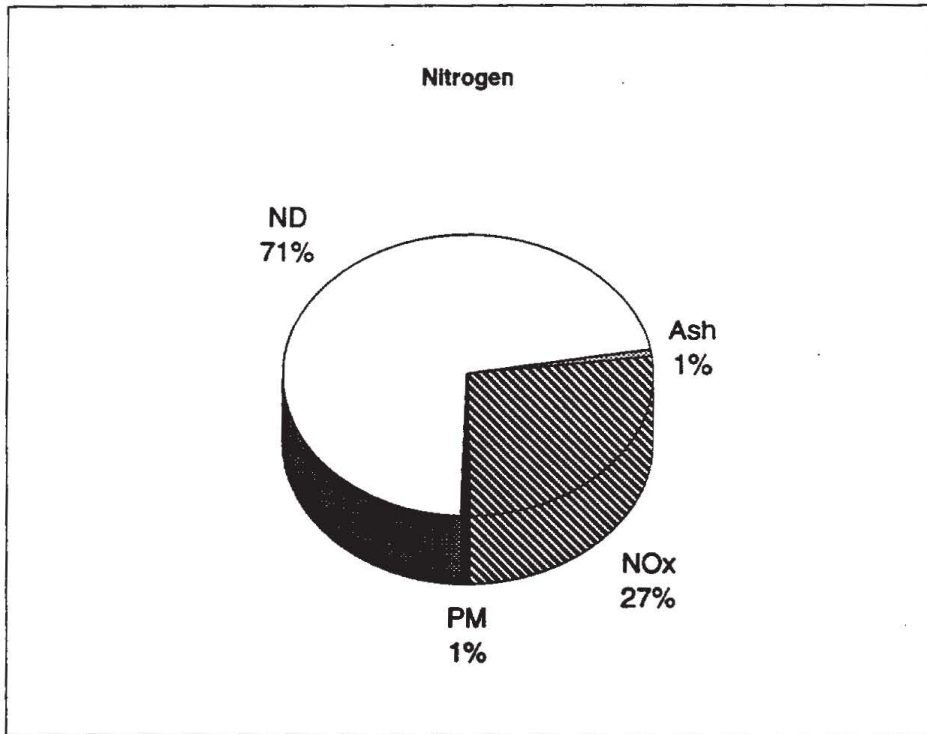


Figure 3.5.19. Sulfur balance.

Date of Test:
Fuel

12-Nov-92
Walnut
Traverse 1

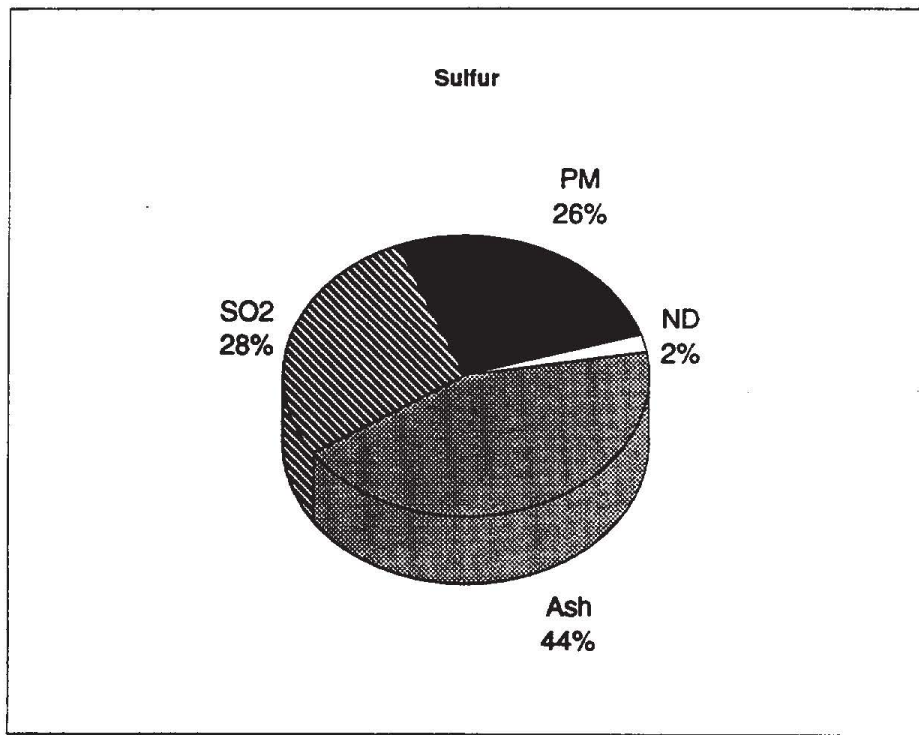


Figure 3.5.20. Sulfur balance.

Date of Test:
Fuel

12-Nov-92
Walnut
Traverse 2

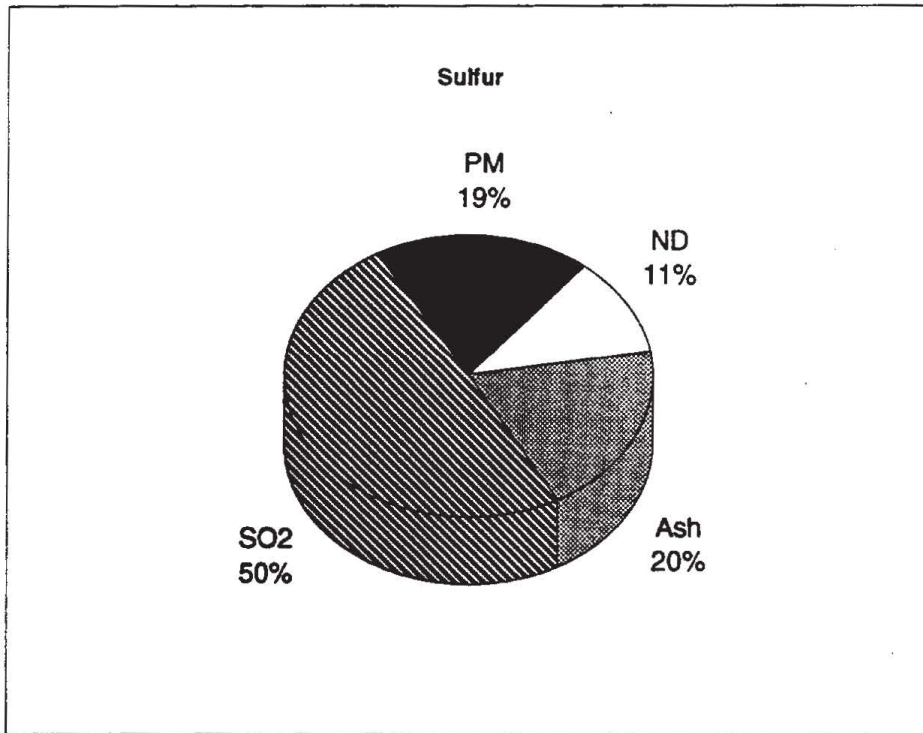
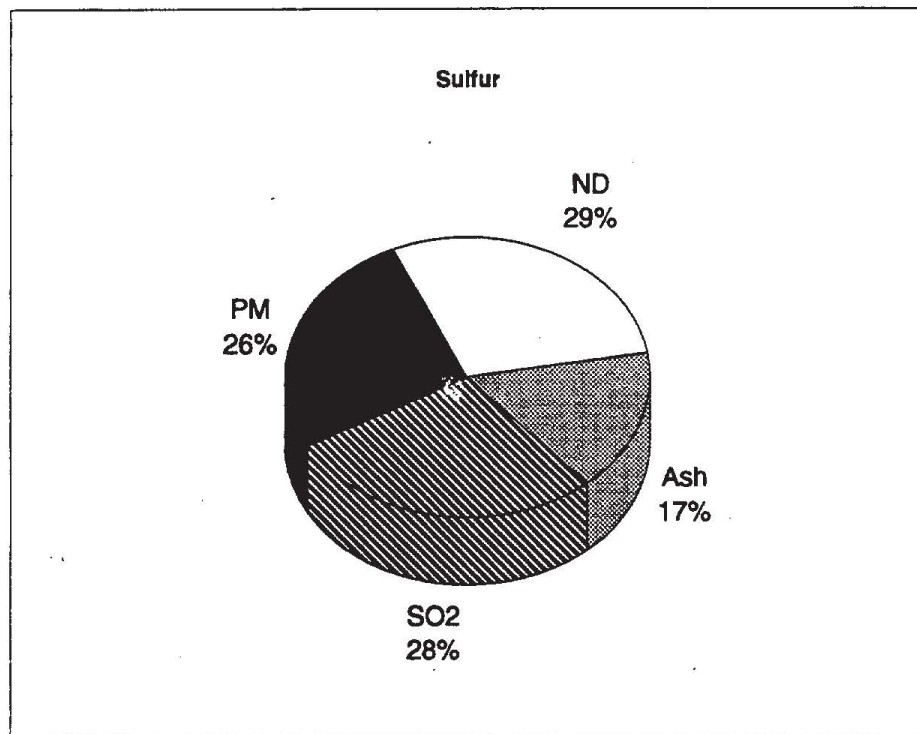


Figure 3.5.21. Sulfur balance.

Date of Test:
Fuel

12-Nov-92
Walnut
Test 1



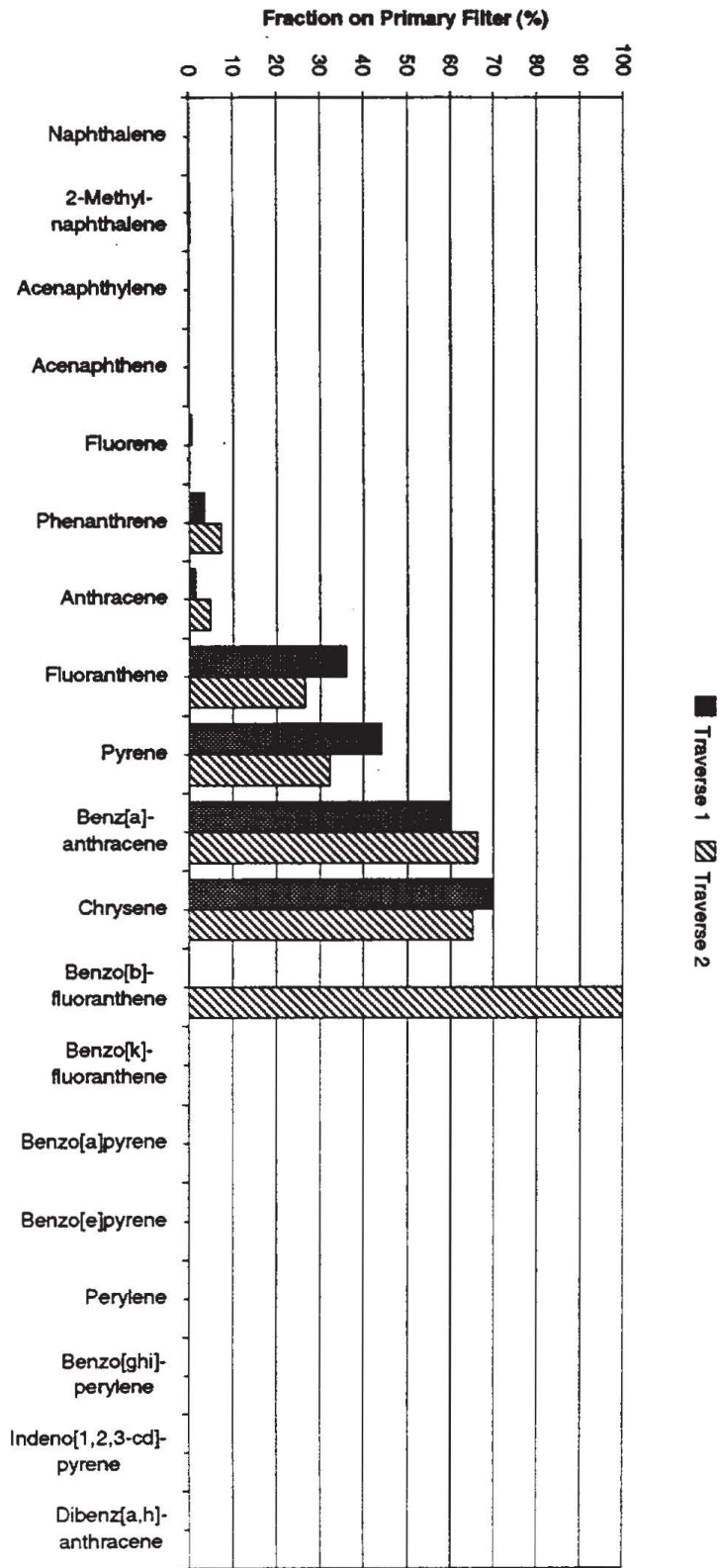


Figure 3.5.22. Mass fraction of PAH on primary filter samples, 12 November 1992, walnut tree prunings (measured stack gas velocity).

Table 3.6.1

Fuel and Ash Analyses

Run Date	6-Apr-93	6-Apr-93	6-Apr-93	6-Apr-93
Fuel Type	Almond	Almond	Almond	Almond
Sample Type	Fuel	Fuel	Ash	Ash
	Small Branch	Large Branch	Test #1	Test #2
Ultimate Analysis				
<u>(% dry weight)</u>				
C	49.23	49.04	7.49	7.46
H	6.28	6.17	0.34	0.24
N	0.10			
Elemental Analysis				
<u>(% by weight dry basis)</u>				
N	0.56	0.37	0.09	0.08
P	0.04	0.02	0.76	0.87
K	0.32	0.25	7.64	7.39
Ca	0.31	0.22	11.00	10.85
Mg	0.13	0.11	1.54	1.54
Na	0.0007	0.0010	0.38	0.38
Cl	0.03	0.04	0.08	0.05
<u>(mg/kg dry weight)</u>				
S	246	145	1,270	1,180
B	17	11	715	685
Zn	16	17	548	544
Mn	9	17	336	342
Fe	90	3,350	1,040	300
Cu	4	4	160	182
Si	425	429	16,100	22,600
Total (% dry weight)	56.98	56.62	31.34	31.45
Proximate Analysis				
<u>(% dry weight)</u>				
Ash	1.37	1.25	90.38	91.21
Volatiles	82.16	82.47	19.34	19.04
Fixed Carbon	16.47	16.28	-9.73	-10.25
Higher Heating Value				
<u>(MJ/kg dry weight)</u>				
	19.5880	19.2718	-0.2469	0.0035

Table 3.6.2

Fuel: Almond
Date of Test: 6-Apr-93

Fuel Properties

	Large Branch	Small Branch	Total
Diameter (mm)	> 50	<50	
Mass Fraction (% wet weight)	40.3	59.7	100.0
Moisture (% wet weight)	22.95	15.23	18.34
Mass Fraction (% dry weight)	38	62	100
Carbon (% dry weight)	49.04	49.23	49.16
Nitrogen (% dry weight)	0.37	0.56	0.49
Sulfur (mg/kg dry weight)	145	246	208
Ash (% dry weight)	1.25	1.37	1.32
Heating Value (MJ/kg dry weight)	19.27	19.59	19.47

Table 3.6.3. Operating conditions, almond tree prunings, 6 April 93.

Fuel: Almond tree prunings Date of Test: 6-Apr-93
 Configuration: Pile

	Test 1	Test 2
Total Fuel Consumption (kg w.b.)	35.4	54.9
Total Ash (kg w.b.)	1.6	1.7
Ash Fraction (w.b.)	0.05	0.03

	Traverse 1	Traverse 2	Test 1	Test 2-Final
Mean Values				
Air Temperature (°C)	12	17	12	18
Air Relative Humidity (%)	69	60	70	55
Inlet Air Temperature (°C)	17.54	20.51	17.93	21.99
Stack Temperature (°C)	36.90	58.31	29.71	29.48
Impinger Outlet Temperature (°C)	14.15	15.93	16.48	21.14
Stack Gas Velocity (m/s)	3.66	5.33	3.55	2.92
Total Duration (minutes)	48	24	93	210

Table 3.6.4. Concentrations, almond tree prunings, 6 April 93

Fuel: Almond tree prunings Date of Test: 6-Apr-93
Configuration: Pile

<u>Gas and PM Concentrations (less background)</u>	<u>Traverse 1</u>	<u>Traverse 2</u>	<u>Test 1</u>	<u>Test 2-Final</u>
CO (ppmv)	62.29	73.91	44.47	37.37
NO (ppmv)	2.66	5.21	1.46	0.41
NOx (ppmv)	3.72	7.20	2.08	0.67
SO2 (ppmv)	0.05	0.14	0.03	0.01
THC (ppmv as CH4)	18.41	28.14	17.49	10.02
HC (ppmv as CH4 by GC)	8.01	4.54		
CH4 (ppmv by GC)	3.49	1.70		
NMHC (ppmv as CH4)	14.92	26.44		
NMHC (ppmv as CH4 by GC)	4.52	2.84		
CO2 (ppmv)	1,861	3,158	1,130	426
Total S (ppmv as SO2)	0.05	0.09	0.03	0.04
PM (mg/cu.m)	8.83	11.83		
PM10 (mg/cu.m)	8.70	11.60		
PM2.5 (mg/cu.m)	8.30	10.89		

Table 3.6.5. Mass balance, almond tree prunings, 6 April 93

Fuel: Almond tree prunings Date of Test: 6-Apr-93
Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Test 1	Test 2-Final
Fuel Moisture Content (% w.b.)	18.3	18.3	18.3	0.0
Fuel Consumption (g w.b.)	32,526	23,300	35,443	17,312
Fuel Consumption (g d.b.)	26,560	19,026	28,941	17,312
Ash (g)	352	252	1,610	1,699
Fuel Vaporized (g)	32,174	23,048	33,833	15,613
Average Burning Rate (g/s w.b.)	11.29	16.18	6.35	1.37
Average Burning Rate (g/s d.b.)	9.22	13.21	5.19	1.37
Fuel Vaporization Rate (g/s)	11.17	16.01	6.06	1.24
Stack Gas Density (kg/cu.m)	1.1399	1.0663	1.1670	1.1679
Stack Gas Flow Rate (cu.m/s)	5.43	7.92	5.27	4.34
Stack Gas Mass Flow Rate (kg/s)	6.19	8.44	6.15	5.07
Inlet Air Mass Flow Rate (kg/s)	6.18	8.43	6.15	5.06
Overall Air-Fuel Ratio (w.b.)	547	521	967	3,686
Overall Air-Fuel Ratio (d.b.)	670	638	1,185	3,686

Table 3.6.6. Emission factors, almond tree prunings, 6 April 93 (Integrated basis).

Fuel: Almond tree prunings Date of Test: 6-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Test 1	Test 2-Final
CO	4.201	4.604	5.300	15.780
NO	0.195	0.343	0.188	0.214
NOx (as NO2)	0.411	0.728	0.407	0.514
SO2	0.007	0.020	0.006	0.014
THC (as CH4)	0.688	1.001	1.221	2.526
HC (as CH4 by GC)	0.297	0.160		
CH4 (by GC)	0.129	0.060		
NMHC (as CH4)	0.559	0.941		
NMHC (as CH4 by GC)	0.168	0.100		
CO2	218.594	334.582	263.946	508.855
Total S (as SO2)	0.006	0.013	0.008	
SO2/Total S	1.05	1.51	0.83	
PM	0.482	0.618		
PM10	0.475	0.606		
PM2.5	0.453	0.569		
MMAD	0.158	0.143		
σ	5.038	5.366		

Table 3.6.7. Emission factors, almond tree prunings, 6 April 93 (average basis).

Fuel: Almond tree prunings Date of Test: 6-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Test 1	Test 2-Final
CO	4.039	4.560	5.093	13.304
NO	0.185	0.344	0.179	0.157
NOx (as NO2)	0.397	0.730	0.392	0.390
SO2	0.007	0.020	0.007	0.012
THC (as CH4)	0.682	0.992	1.144	2.039
HC (as CH4 by GC)	0.297	0.160		
CH4 (by GC)	0.129	0.060		
NMHC (as CH4)	0.553	0.932		
NMHC (as CH4 by GC)	0.168	0.100		
CO2	189.653	306.110	203.312	238.165
Total S (as SO2)	0.007	0.013	0.009	
SO2/Total S	1.04	1.51	0.80	
PM	0.482	0.618		
PM10	0.475	0.606		
PM2.5	0.453	0.569		
MMAD	0.158	0.143		
σ	5.038	5.366		

Table 3.6.8. Carbon balance.

Date of Test:	6-Apr-93			
	Almond tree prunings			
Fuel:	Traverse 1	Traverse 2	Test 1	Test 2-Final
<u>Carbon Balance</u>				
Dry Fuel Consumption Rate (g/s)	9.22	13.21	5.19	1.37
Ash Generation Rate (g/s)	0.12	0.17	0.29	0.13
Ash Fraction (% dry basis)	1.32	1.32	5.56	9.81
Fuel Carbon Concentration* (%)	49.16	49.16	49.16	90.92
Residual Ash Carbon Concentration (%)	0.00	0.00	7.49	7.46
Carbon released to stack (g/s)	4.53	6.49	2.53	1.24
Maximum CO2 emission factor (%)	180.25	180.25	178.73	330.69
Stack Gas Density (kg/cubic meter)	1.14	1.07	1.17	1.17
Average CO2 concentration (ppmv)	1,861	3,158	1,130	426
Average CO concentration (ppmv)	62.29	73.91	44.47	37.37
Average THC concentration (ppmv as CH4)	18.41	28.14	17.49	10.02
PM Concentration (mg/cubic meter)	8.83	11.83	4.56	
PM Carbon Concentration (%)	66.63	69.82	66.63	
PM Carbon (mg/cubic meter)	5.88	8.26	3.04	0.00
Stack Gas Temperature (°C)	36.90	58.31	29.71	29.48
Impinger Temperature (°C)	14.15	15.93	16.48	21.14
PM molar concentration (ppm)	11.56	16.33	6.01	
Estimated Average Stack Gas Velocity (m/s)	3.31	3.02	2.94	3.64
Emission Factors (% Average Basis):				
CO2	189.653	306.110	203.312	238.165
CO	4.039	4.560	5.093	13.304
THC (as CH4)	0.682	0.992	1.144	2.039
PM	0.482	0.618	0.482	
Emission Factors (% Integrated Basis):				
CO2	218.594	334.582	263.946	508.855
CO	4.201	4.604	5.300	15.780
THC (as CH4)	0.688	1.001	1.221	2.526
PM	0.482	0.618	0.482	
Closure (% Average Basis)	110	176	121	80
Closure (% Integrated Basis)	126	191	154	163

*computed for Test 2- final.

Table 3.6.9. Nitrogen balance

Date of Test:

6-Apr-93

Fuel:

Almond tree prunings

	Traverse 1	Traverse 2	Test 1	Test 2-Final
Nitrogen Balance				
Fuel Nitrogen Concentration (% dry weight)	0.49	0.49	0.49	0.49
Ash Nitrogen Concentration (% weight)	0.09	0.08	0.09	0.09
Emission Factors (% Average Basis):				
NOx (as NO ₂)	0.397	0.730	0.392	0.390
PM	0.482	0.618	0.482	
Emission Factors (% Integrated Basis):				
NOx (as NO ₂)	0.411	0.728	0.407	0.514
NO ₃ - Concentration of PM (% weight)	0.739	0.989	0.739	
NH ₄ + Concentration of PM (% weight)	0.293	0.725	0.293	
Nitrogen Concentration of PM (%)	0.395	0.787	0.395	
Fuel Nitrogen (mg/s)	45.18	64.73	25.43	6.71
Ash Nitrogen (mg/s)	0.11	0.14	0.26	0.12
Nitrogen as NOx (mg/s Average Basis)	11.14	29.35	6.19	1.63
Nitrogen as NOx (mg/s Integrated Basis)	11.53	29.27	6.43	2.14
Nitrogen as PM (mg/s Average Basis)	0.18	0.64	0.10	0.00
Nitrogen as NOx+PM (mg/s Average Basis)	11.32	29.99	6.29	1.63
Nitrogen as NOx+PM (mg/s Integrated Basis)	11.71	29.91	6.53	2.14
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.250	0.463	0.247	0.242
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.259	0.462	0.257	0.319
Ash Nitrogen/Fuel Nitrogen	0.002	0.002	0.010	0.018
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.253	0.466	0.258	0.260
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.262	0.464	0.267	0.337

Table 3.6.10. Sulfur balance.

Date of Test:

6-Apr-93

Fuel:

Almond tree prunings

	Traverse 1	Traverse 2	Test 1	Test 2-Final
Sulfur Balance				
Fuel Sulfur Concentration (mg/kg dry weight)	208	208	208	208
Ash Sulfur Concentration (mg/kg weight)	1,270	1,180	1,270	1,180
Emission Factors (% Average Basis)				
SO ₂	0.007	0.020	0.007	0.012
PM	0.482	0.618	0.482	
Emission Factors (% Integrated Basis)				
SO ₂	0.007	0.020	0.006	0.014
Sulfur Concentration of PM (% weight)				
Fuel Sulfur (mg/s)	1.92	2.75	1.08	0.28
Ash Sulfur (mg/s)	0.15	0.21	0.37	0.16
Sulfur as SO ₂ (mg/s Average Basis)	0.32	1.32	0.18	0.08
Sulfur as SO ₂ (mg/s Integrated Basis)	0.32	1.32	0.16	0.10
Sulfur as PM (mg/s Average Basis)	0.93	0.95	0.52	0.00
Sulfur as SO ₂ +PM (mg/s Average Basis)	1.26	2.27	0.71	0.08
Sulfur as SO ₂ +PM (mg/s Integrated Basis)	1.26	2.27	0.68	0.10
SO ₂ +PM Sulfur/Fuel Sulfur (Average Basis)	0.655	0.827	0.655	0.288
SO ₂ +PM Sulfur/Fuel Sulfur (Integrated Basis)	0.655	0.827	0.630	0.337
Ash Sulfur/Fuel Sulfur	0.081	0.075	0.339	0.557
Closure (% Average Basis)	74	90	99	84
Closure (% Integrated Basis)	74	90	97	89

Table 3.6.11. Water balance.

Estimated Stack Humidity			
Fuel	Almond		
Configuration	Pile		
Date of Test	6-Apr-93		
	Traverse 1	Traverse 2	
Ambient Air Temperature (°C)	12	17	
Ambient Air Relative Humidity (%)	69	60	
Air Temperature (K)	285	290	
Saturation Pressure (Pa)	1,403	1,938	
Vapor Pressure (Pa)	968	1,163	
Air Dew Point Temperature (°C)	6.5	9.2	
Ambient Volume Fraction Water Vapor	0.0096	0.0115	
Ambient Mass Fraction Water Vapor	0.0059	0.0071	
Fuel Burning Rate (g/s wet basis)	11.29	16.18	
Fuel Moisture Content (%)	18.3	18.3	
Ash Fraction (wet basis)	0.05	0.03	
Fuel Hydrogen Content (%)	6.24	6.24	
Ash Hydrogen Content* (%)	0.00	0.00	
Moisture Evaporated (g/s)	2.07	2.96	
Water of Combustion (g/s)	5.18	7.42	
Total Fuel Water Added (g/s)	7.25	10.38	
Inlet Air Mass Flowrate (g/s)	6,180	8,430	
Inlet Air Water Vapor Flowrate (g/s)	37	60	
Total Stack Water Vapor Flowrate (g/s)	44	70	
Stack Gas Mass Flowrate (g/s)	6,191	8,446	
Mass Fraction Water Vapor in Stack	0.0071	0.0083	
Volume Fraction Water Vapor in Stack	0.0114	0.0134	
Stack Vapor Pressure (Pa)	1,157	1,361	
Stack Temperature (°C)	37	58	
Stack Temperature (K)	310	331	
Stack Saturation Pressure (Pa)	6,247	18,435	
Stack Relative Humidity (%)	19	7	
Stack Dew Point Temperature (°C)	9.1	11.6	
Impinger Outlet Temperature (°C)	14.2	15.9	
Volume Stack Gas Sampled for PM (L)	533	363	
Estimated Impinger/Desiccant Weight Gain (g)	4.6	3.7	
Totals:			
	Estimated	Measured	
Total Impinger/Desiccant Weight Gain (g)	8.3	11.4	
Estimated/Measured Weight Gain		0.73	

*assumes complete fuel conversion

Table 3.6.12. Power balance, Almond tree prunings.

Date of Test: Fuel	6-Apr-93 Almond			
	Traverse 1	Traverse 2	Test 1	Test 2-Final
Power Balance				
Fuel Heating Value* (MJ/kg dry weight)	19.47	19.47	19.47	32
Ash Heating Value** (MJ/kg dry weight)	0	0.0035	0	0.0035
Average Energy Release Rate (kW)	179.5	257.2	101.0	43.8
Products of Incomplete Combustion (kW)				
CO	3.4	3.5	2.2	1.8
THC (as CH ₄)	3.2	4.1	2.7	1.6
PM	0.9	1.1	0.5	0.0
Heat Release Rate (kW)	172.1	248.6	95.6	40.4
Stack Gas Flow (kg/s)	5.61	4.79	5.1	5.07
Stack Gas Temperature (°C)	36.90	58.31	29.71	29.48
Ambient Temperature (°C)	12	17	12	18
Sensible Power at Top of Stack (kW)	140.5	199.1	90.9	58.6
Tunnel Dissipation (kW)	31.5	49.5	4.8	-18.1

*Estimated for Test 2-Final.

**Negative values assumed to be zero.

†stack flow from carbon balance for traverses 1 and 2 and test 1.

Table 3.6.13. Operating conditions, Almond tree prunings*.

Fuel: Almond Date of Test: 6-Apr-93
 Configuration: Pile

	Test 1	Test 2
Total Fuel Consumption (kg w.b.)	35.4	54.9
Total Ash (kg w.b.)	1.6	1.7
Ash Fraction (w.b.)	0.05	0.03

	Traverse 1	Traverse 2	Test 1	Test 2-Final
Mean Values				
Air Temperature (°C)	12	17	12	18
Air Relative Humidity (%)	69	60	70	55
Inlet Air Temperature (°C)	17.54	20.51	17.93	21.99
Stack Temperature (°C)	36.90	58.31	29.71	29.48
Impinger Outlet Temperature (°C)	14.15	15.93	16.48	21.14
Stack Gas Velocity (m/s)	3.31	3.02	2.94	3.64
Total Duration (minutes)	48	24	93	210

*stack gas velocity from carbon balance.

Table 3.6.14. Mass balance, Almond tree prunings*.

Fuel: Almond Date of Test: 6-Apr-93
 Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Test 1	Test 2-Final
Fuel Moisture Content (% w.b.)	18.3	18.3	18.3	0.0
Fuel Consumption (g w.b.)	32,526	23,300	35,443	17,312
Fuel Consumption (g d.b.)	26,560	19,026	28,941	17,312
Ash (g)	352	252	1,610	1,699
Fuel Vaporized (g)	32,174	23,048	33,833	15,613
Average Burning Rate (g/s w.b.)	11.29	16.18	6.35	1.37
Average Burning Rate (g/s d.b.)	9.22	13.21	5.19	1.37
Fuel Vaporization Rate (g/s)	11.17	16.01	6.06	1.24
Stack Gas Density (kg/cu.m)	1.1399	1.0663	1.1670	1.1679
Stack Gas Flow Rate (cu.m/s)	4.92	4.49	4.37	5.41
Stack Gas Mass Flow Rate (kg/s)	5.61	4.79	5.10	6.32
Inlet Air Mass Flow Rate (kg/s)	5.60	4.77	5.09	6.32
Overall Air-Fuel Ratio (w.b.)	496	295	802	4,598
Overall Air-Fuel Ratio (d.b.)	607	361	982	4,598

*stack gas velocity from carbon balance.

Table 3.6.15. Emission factors, Almond tree prunings (integrated basis)*.

Fuel: Almond Date of Test: 6-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Test 1	Test 2-Final
CO	3.082	0.629	3.193	6.961
NO	0.183	-0.466	0.171	0.554
NOx (as NO2)	0.385	-1.235	0.362	1.507
SO2	0.007	-0.076	0.006	0.030
THC (as CH4)	0.477	-1.880	0.562	14.991
HC (as CH4 by GC)	0.269	0.091		
CH4 (by GC)	0.117	0.034		
NMHC (as CH4)	0.360	-1.914		
NMHC (as CH4 by GC)	0.152	0.057		
CO2	184.944	-78.722	183.282	1766.407
Total S (as SO2)	0.005	-0.041	0.005	
SO2/Total S	1.23	1.86	1.13	
PM	0.436	0.351		
PM10	0.430	0.344		
PM2.5	0.410	0.323		
MMAD	0.158	0.143		
σ	5.038	5.366		

*stack gas velocity from carbon balance.

Table 3.6.16. Emission factors, Almond tree prunings (average basis)*.

Fuel: Almond Date of Test: 6-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Test 1	Test 2-Final
CO	3.657	2.585	4.222	16.593
NO	0.168	0.195	0.148	0.196
NOx (as NO2)	0.359	0.414	0.325	0.486
SO2	0.006	0.011	0.006	0.015
THC (as CH4)	0.618	0.562	0.949	2.543
HC (as CH4 by GC)	0.269	0.091		
CH4 (by GC)	0.117	0.034		
NMHC (as CH4)	0.501	0.528		
NMHC (as CH4 by GC)	0.152	0.057		
CO2	171.712	173.549	168.550	297.042
Total S (as SO2)	0.006	0.008	0.007	
SO2/Total S	1.04	1.51	0.80	
PM	0.436	0.351		
PM10	0.430	0.344		
PM2.5	0.410	0.323		
MMAD	0.158	0.143		
σ	5.038	5.366		

*stack gas velocity from carbon balance.

Table 3.6.17. Carbon balance, Almond tree prunings*.

Fuel: Almond Date of Test: 6-Apr-93
 Configuration: Pile

Carbon Balance

	Traverse 1	Traverse 2	Test 1	Test 2-Final
Dry Fuel Consumption Rate (g/s)	9.22	13.21	5.19	1.37
Ash Fraction (%)	1.32	1.32	5.56	9.81
Ash Generation Rate (g/s)	0.12	0.17	0.29	0.13
Fuel Carbon Concentration** (%)	49.16	49.16	49.16	90.92
Residual Ash Carbon Concentration (%)	0.00	0.00	7.49	7.46
Carbon released to stack (g/s)	4.53	6.49	2.53	1.24
Maximum CO ₂ emission factor (%)	180.24	180.24	178.72	330.68
Average CO ₂ concentration (ppmv)	1,861	3,158	1,130	426
Average CO concentration (ppmv)	62.29	73.91	44.47	37.37
Average THC concentration (ppmv)	18.41	28.14	17.49	10.02
PM Concentration (mg/cubic meter)	8.83	11.83	8.83	
PM Carbon Concentration (%)	66.60	66.60	66.60	
PM Carbon (mg/cubic meter)	5.88	7.88	5.88	
PM molar concentration (ppm)	11.55	15.58	11.65	
Estimated Average Stack Gas Velocity (m/s)	3.31	3.02	2.93	3.65
Closure (% , Average Basis)	100	100	100	100
Closure (% , Integrated Basis)	107	-46	106	550

*stack gas velocity from carbon balance. Closure forced.

**Computed for Test 2-Final.

Table 3.6.18. Mass concentrations (%) from DRI filter samples.

Date	6-Apr-93		6-Apr-93		
Fuel	Almond Prunings		Almond Prunings		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT052		ABTT053		
Quartz Filter ID	ABTQ052		ABTQ053		
Teflon Field Sample Flag					
Quartz field sample field					
Teflon mass sample flag					
Quartz mass sample flag					
Anions sample flag					
Ammonium analysis flag					
Sodium ion analysis flag					
Magnesium ion analysis flag					
Potassium ion analysis flag					
Carbon analysis flag					
XRF analysis flag					
	\pm Uncertainty		\pm Uncertainty		
Teflon sample volume (m ³)	0.30	0.02	0.30	0.02	
Quartz sample volume (m ³)	0.30	0.02	0.30	0.02	
Teflon mass concentration (μ g/m ³)	5,233	267	5,480	279	
	Concentration (%)	\pm Uncertainty	Concentration (%)	\pm Uncertainty	PM2.5/PM10
Cl-	1.2187	0.1075	1.2040	0.1058	1.01
NO3-	0.7586	0.0704	0.7391	0.0680	1.03
SO4=	3.3282	0.2490	3.1966	0.2390	1.04
NH4+	0.3029	0.0500	0.2933	0.0478	1.03
Na+	0.1263	0.0219	0.1764	0.0237	0.72
K+	5.5575	0.4214	5.4558	0.4133	1.02
C(org)	43.7361	4.2828	43.3732	4.2412	1.01
C(ohf)	38.4061	5.9131	36.8415	5.6674	1.04
C(e)	23.8981	2.2713	23.2543	2.2072	1.03
C(eht)	0.4522	0.2873	0.5474	0.3455	0.83
C	67.6342		66.6275		1.02
Al	0.0166	0.0385	0.0330	0.0383	0.50
Si	0.0119	0.0561	0.0510	0.0351	0.23
P	0.0200	0.0537	0.0265	0.0532	0.75
S	1.9219	0.1379	1.9053	0.1365	1.01
Cl	1.3243	0.0985	1.3071	0.0971	1.01
K	6.4657	0.4623	6.3772	0.4556	1.01
Ca	0.0738	0.0943	0.1400	0.0331	0.53
Ti	0.0000	0.0418	0.0000	0.0407	
V	0.0000	0.0181	0.0013	0.0177	0.00
Cr	0.0000	0.0041	0.0000	0.0040	
Mn	0.0000	0.0028	0.0006	0.0028	0.00
Fe	0.0077	0.0075	0.0185	0.0072	0.42
Co	0.0000	0.0018	0.0000	0.0017	
Ni	0.0000	0.0019	0.0000	0.0019	
Cu	0.0045	0.0014	0.0030	0.0014	1.50
Zn	0.5403	0.0387	0.5253	0.0376	1.03
Ga	0.0000	0.0037	0.0000	0.0035	
As	0.0009	0.0043	0.0000	0.0041	
Se	0.0005	0.0022	0.0002	0.0021	2.50
Br	0.0092	0.0016	0.0100	0.0015	0.92
Pb	0.0066	0.0014	0.0058	0.0013	1.14
Sr	0.0013	0.0021	0.0022	0.0014	0.59
Y	0.0000	0.0025	0.0001	0.0024	0.00
Zr	0.0000	0.0030	0.0004	0.0029	0.00
Mo	0.0000	0.0052	0.0000	0.0049	
Pd	0.0000	0.0178	0.0000	0.0172	
Ag	0.0119	0.0206	0.0031	0.0200	3.84
Cd	0.0009	0.0218	0.0025	0.0211	0.36
In	0.0000	0.0247	0.0047	0.0239	0.00
Sn	0.0000	0.0315	0.0000	0.0303	
Sb	0.0000	0.0362	0.0000	0.0348	
Ba	0.0368	0.1261	0.0000	0.1215	
La	0.0281	0.1686	0.0000	0.1631	
Au	0.0000	0.0195	0.0000	0.0194	
Hg	0.0000	0.0047	0.0000	0.0045	
Tl	0.0000	0.0045	0.0000	0.0043	
Pb	0.0060	0.0041	0.0072	0.0039	0.83
U	0.0002	0.0046	0.0002	0.0044	1.00
Sum of measured species	79.3109	4.8806	78.2616	4.8124	1.01

Table 3.6.19. Element ratios from DRI filter samples.

Date	6-Apr-93		6-Apr-93	
Fuel	Almond Prunings		Almond Prunings	
Configuration	Pile		Pile	
Size Fraction	PM2.5		PM10	PM2.5/PM10
Teflon Filter ID	ABTT052		ABTT053	
Quartz Filter ID	ABTQ052		ABTQ053	
Cl-/Cl	0.92		0.92	1.00
K+/K	0.86		0.86	1.00
Sulfate S/Total S	0.58		0.56	1.03
C(org)/C	0.65		0.65	0.99
Cl/K	0.20		0.20	1.00
Cl-/K+	0.22		0.22	0.99
Cl-/Na+	9.65		6.83	1.41
S/K	0.30		0.30	0.99
S/Na+	15.22		10.80	1.41
Al/Si	1.39		0.65	2.16

Table 3.6.20. Emission factors (mg/kg) from DRI filter samples.

Date	6-Apr-93		6-Apr-93		
Fuel	Almond Prunings		Almond Prunings		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT052		ABTT053		
Quartz Filter ID	ABTQ052		ABTQ053		
Start Time	10:06				
Stop Time	13:36				
Start Time					
End Time					
Elapsed Time (minutes)	30				Traverse 1
PM (mg/m ³ by total filter)					8.830
PM10 (by total filter/impactor)					8.700
PM2.5 (by total filter/impactor)					8.300
PM emission factor (%)					0.437
PM10 emission factor (%)					0.430
PM2.5 emission factor (%)					0.410
		\pm Uncertainty		\pm Uncertainty	
Teflon sample volume (m ³)	0.30	0.02	0.30	0.02	
Quartz sample volume (m ³)	0.30	0.02	0.30	0.02	
Teflon mass concentration (mg/m ³)	5.233	0.267	5.480	0.279	
Teflon mass/Total mass	0.631		0.630		
	<u>Emission (mg/kg)</u>	<u>\pmUncertainty</u>	<u>Emission (mg/kg)</u>	<u>\pmUncertainty</u>	<u>PM2.5/PM10</u>
Cl-	63.0011	4.4075	66.1525	4.5494	0.95
NO3-	39.2160	2.8864	40.6091	2.9240	0.97
SO4=	172.0523	10.2090	175.6338	10.2770	0.98
NH4+	15.6585	2.0500	16.1151	2.0554	0.97
Na+	6.5291	0.8979	9.6921	1.0191	0.67
K+	287.2966	17.2774	299.7631	17.7719	0.96
C(org)	2260.9504	175.5948	2383.0941	182.3716	0.95
C(oh)	1985.4145	242.4371	2024.2169	243.6982	0.98
C(e)	1235.4192	93.1233	1277.6827	94.9096	0.97
C(eht)	23.3766	11.7793	30.0763	14.8565	0.78
C	3496.3696	0.0000	3660.7768	0.0000	0.96
Al	0.8581	1.5785	1.8131	1.6469	0.47
Si	0.6152	2.3001	2.8021	1.5093	0.22
P	1.0339	2.2017	1.4560	2.2876	0.71
S	99.3532	5.6539	104.6847	5.8695	0.95
Cl	68.4601	4.0385	71.8172	4.1753	0.95
K	334.2462	18.9543	350.3884	19.5908	0.95
Ca	3.8151	3.8663	7.6922	1.4233	0.50
Ti	0.0000	1.7138	0.0000	1.7501	
V	0.0000	0.7421	0.0714	0.7611	0.00
Cr	0.0000	0.1681	0.0000	0.1720	
Mn	0.0000	0.1148	0.0330	0.1204	0.00
Fe	0.3981	0.3075	1.0165	0.3096	0.39
Co	0.0000	0.0738	0.0000	0.0731	
Ni	0.0000	0.0779	0.0000	0.0817	
Cu	0.2326	0.0574	0.1648	0.0602	1.41
Zn	27.9310	1.5867	28.8620	1.6168	0.97
Ga	0.0000	0.1517	0.0000	0.1505	
As	0.0465	0.1763	0.0000	0.1763	
Se	0.0258	0.0902	0.0110	0.0903	2.35
Br	0.4756	0.0656	0.5494	0.0645	0.87
Rb	0.3412	0.0574	0.3187	0.0559	1.07
Sr	0.0672	0.0861	0.1209	0.0602	0.56
Y	0.0000	0.1025	0.0055	0.1032	0.00
Zr	0.0000	0.1230	0.0220	0.1247	0.00
Mo	0.0000	0.2132	0.0000	0.2107	
Pd	0.0000	0.7298	0.0000	0.7396	
Ag	0.6152	0.8446	0.1703	0.8600	3.61
Cd	0.0465	0.8938	0.1374	0.9073	0.34
In	0.0000	1.0127	0.2582	1.0277	0.00
Sn	0.0000	1.2915	0.0000	1.3029	
Sb	0.0000	1.4842	0.0000	1.4964	
Ba	1.9024	5.1701	0.0000	5.2245	
La	1.4526	6.9126	0.0000	7.0133	
Au	0.0000	0.7995	0.0000	0.8342	
Hg	0.0000	0.1927	0.0000	0.1935	
Tl	0.0000	0.1845	0.0000	0.1849	
Pb	0.3102	0.1681	0.3956	0.1677	0.78
U	0.0103	0.1886	0.0110	0.1892	0.94
Sum of measured species	4.100	200	4.300	197	0.95

Table 3.6.21. Mass concentrations (%) from DRI filter samples.

Date	6-Apr-93		6-Apr-93		
Fuel	Almond Prunings		Almond Prunings		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT054		ABTT055		
Quartz Filter ID	ABTQ054		ABTQ055		
Teflon Field Sample Flag					
Quartz field sample field					
Teflon mass sample flag					
Quartz mass sample flag					
Anions sample flag					
Ammonium analysis flag					
Sodium ion analysis flag					
Magnesium ion analysis flag					
Potassium ion analysis flag					
Carbon analysis flag					
XRF analysis flag					
	\pm Uncertainty		\pm Uncertainty		
Teflon sample volume (m ³)	0.30	0.02	0.30	0.02	
Quartz sample volume (m ³)	0.30	0.02	0.30	0.02	
Teflon mass concentration (μ g/m ³)	8,467	426	8,390	423	
	Concentration (%)	\pm Uncertainty	Concentration (%)	\pm Uncertainty	PM2.5/PM10
Cl-	1.6663	0.1400	1.7566	0.1474	0.95
NO3-	0.9827	0.0784	0.9893	0.0789	0.99
SO4=	3.5395	0.2618	3.5611	0.2635	0.99
NH4+	0.6719	0.0552	0.7250	0.0586	0.93
Na+	0.1751	0.0192	0.2200	0.0224	0.80
K+	5.5580	0.4190	5.5118	0.4155	1.01
C(org)	47.5573	4.5891	43.2760	4.1818	1.10
C(oh)	40.3691	6.1370	34.8023	5.3052	1.16
C(e)	20.3898	1.9298	26.5435	2.5120	0.77
C(eht)	0.6024	0.3720	0.8224	0.5026	0.73
C	67.9471		69.8195		0.97
Al	0.0040	0.0351	0.0200	0.0369	0.20
Si	0.0268	0.0502	0.0473	0.0528	0.57
P	0.0112	0.0556	0.0196	0.0587	0.57
S	1.9827	0.1413	2.0983	0.1495	0.94
Cl	1.7252	0.1250	1.8001	0.1304	0.96
K	6.3550	0.4515	6.4955	0.4615	0.98
Ca	0.0543	0.0917	0.1477	0.0332	0.37
Ti	0.0000	0.0269	0.0000	0.0259	
V	0.0000	0.0117	0.0000	0.0113	
Cr	0.0000	0.0027	0.0000	0.0026	
Mn	0.0000	0.0019	0.0008	0.0019	0.00
Fe	0.0048	0.0046	0.0177	0.0048	0.27
Co	0.0000	0.0012	0.0000	0.0012	
Ni	0.0000	0.0014	0.0000	0.0013	
Cu	0.0053	0.0010	0.0044	0.0010	1.20
Zn	0.7440	0.0529	0.7579	0.0539	0.98
Ga	0.0000	0.0026	0.0000	0.0026	
As	0.0000	0.0034	0.0000	0.0035	
Se	0.0001	0.0014	0.0000	0.0014	
Br	0.0146	0.0014	0.0148	0.0014	0.99
Pb	0.0061	0.0009	0.0067	0.0010	0.91
Sr	0.0006	0.0013	0.0021	0.0009	0.29
Y	0.0006	0.0017	0.0003	0.0016	2.00
Zr	0.0000	0.0020	0.0002	0.0019	0.00
Mo	0.0000	0.0034	0.0000	0.0032	
Pd	0.0000	0.0116	0.0000	0.0113	
Ag	0.0000	0.0133	0.0000	0.0130	
Cd	0.0000	0.0143	0.0001	0.0139	0.00
In	0.0000	0.0161	0.0000	0.0153	
Sn	0.0070	0.0201	0.0092	0.0197	0.76
Sb	0.0003	0.0232	0.0058	0.0225	0.05
Ba	0.0000	0.0804	0.0000	0.0783	
La	0.0000	0.1075	0.0186	0.1043	0.00
Au	0.0000	0.0258	0.0000	0.0263	
Hg	0.0000	0.0031	0.0000	0.0029	
Tl	0.0000	0.0030	0.0000	0.0028	
Pb	0.0114	0.0027	0.0134	0.0028	0.85
U	0.0000	0.0031	0.0000	0.0029	
Sum of measured species	80.7308	5.0072	83.2339	4.9084	0.97

Table 3.6.22. Element ratios from DRI filter samples.

Date	6-Apr-93		6-Apr-93
Fuel	Almond Prunings		Almond Prunings
Configuration	Pile		Pile
Size Fraction	PM2.5	PM10	PM2.5/PM10
Teflon Filter ID	ABTT054	ABTT055	
Quartz Filter ID	ABTQ054	ABTQ055	
Cl-/Cl	0.97	0.98	0.99
K+/K	0.87	0.85	1.03
Sulfate S/Total S	0.60	0.57	1.05
C(org)/C	0.70	0.62	1.13
Cl/K	0.27	0.28	0.98
Cl-/K+	0.30	0.32	0.94
Cl-/Na+	9.52	7.98	1.19
S/K	0.31	0.32	0.97
S/Na+	11.32	9.54	1.19
Al/Si	0.15	0.42	0.35

Table 3.6.23. Emission factors (mg/kg) from DRI filter samples.

Date	6-Apr-93		6-Apr-93		
Fuel	Almond Prunings		Almond Prunings		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT054		ABTT055		
Quartz Filter ID	ABTQ054		ABTQ055		
Start Time	11:52				
Stop Time	12:22				
Start Time					
End Time					
Elapsed Time (minutes)	30				Traverse 2
PM (mg/m ³ by total filter)					11.830
PM10 (by total filter/impactor)					11.600
PM2.5 (by total filter/impactor)					10.890
PM emission factor (%)					0.351
PM10 emission factor (%)					0.344
PM2.5 emission factor (%)					0.323
		<u>±Uncertainty</u>		<u>±Uncertainty</u>	
Teflon sample volume (m ³)	0.30	0.02	0.30	0.02	
Quartz sample volume (m ³)	0.30	0.02	0.30	0.02	
Teflon mass concentration (mg/m ³)	8.467	0.426	8.390	0.423	
Teflon mass/Total mass	0.777		0.723		
	<u>Emission (mg/kg)</u>	<u>±Uncertainty</u>	<u>Emission (mg/kg)</u>	<u>±Uncertainty</u>	<u>PM2.5/PM10</u>
Cl-	66.6679	4.5220	72.5991	5.0706	0.92
NO3-	39.3173	2.5323	40.8871	2.7142	0.96
SO4=	141.6137	8.4561	147.1778	9.0644	0.96
NH4+	26.8824	1.7830	29.9638	2.0158	0.90
Na+	7.0057	0.6202	9.0924	0.7706	0.77
K+	222.3729	13.5337	227.7989	14.2932	0.98
C(org)	1902.7444	148.2279	1788.5674	143.8539	1.06
C(oh)	1615.1480	198.2251	1438.3552	182.4989	1.12
C(e)	815.7860	62.3325	1097.0246	86.4128	0.74
C(eht)	24.1017	12.0156	33.9892	17.2894	0.71
C	2718.5304	0.0000	2885.5920	0.0000	0.94
Al	0.1600	1.1337	0.8266	1.2694	0.19
Si	1.0723	1.6215	1.9549	1.8163	0.55
P	0.4481	1.7959	0.8101	2.0193	0.55
S	79.3269	4.5640	86.7213	5.1428	0.91
Cl	69.0244	4.0375	74.3969	4.4858	0.93
K	254.2605	14.5835	268.4546	15.8756	0.95
Ca	2.1725	2.9619	6.1043	1.1421	0.36
Ti	0.0000	0.8689	0.0000	0.8910	
V	0.0000	0.3779	0.0000	0.3887	
Cr	0.0000	0.0872	0.0000	0.0894	
Mn	0.0000	0.0614	0.0331	0.0654	0.00
Fe	0.1920	0.1486	0.7315	0.1651	0.26
Co	0.0000	0.0388	0.0000	0.0413	
Ni	0.0000	0.0452	0.0000	0.0447	
Cu	0.2121	0.0323	0.1818	0.0344	1.17
Zn	29.7671	1.7087	31.3235	1.8542	0.95
Ga	0.0000	0.0840	0.0000	0.0894	
As	0.0000	0.1098	0.0000	0.1204	
Se	0.0040	0.0452	0.0000	0.0482	
Br	0.5841	0.0452	0.6117	0.0482	0.95
Rb	0.2441	0.0291	0.2769	0.0344	0.88
Sr	0.0240	0.0420	0.0868	0.0310	0.28
Y	0.0240	0.0549	0.0124	0.0550	1.94
Zr	0.0000	0.0646	0.0083	0.0654	0.00
Mo	0.0000	0.1098	0.0000	0.1101	
Pd	0.0000	0.3747	0.0000	0.3887	
Ag	0.0000	0.4296	0.0000	0.4472	
Cd	0.0000	0.4619	0.0041	0.4782	0.00
In	0.0000	0.5200	0.0000	0.5263	
Sn	0.2801	0.6492	0.3802	0.6777	0.74
Sb	0.0120	0.7494	0.2397	0.7740	0.05
Ba	0.0000	2.5969	0.0000	2.6935	
La	0.0000	3.4723	0.7687	3.5879	0.00
Au	0.0000	0.8333	0.0000	0.9047	
Hg	0.0000	0.1001	0.0000	0.0998	
Tl	0.0000	0.0969	0.0000	0.0963	
Pb	0.4561	0.0872	0.5538	0.0963	0.82
U	0.0000	0.1001	0.0000	0.0998	
Sum of measured species	3,230	162	3,440	159	0.94

Table 3.6.24. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 10:05
 Filter ID: AG-67

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	551,717	36,510	4,210
Na	159,867	29,558	14,081
Mg			5,528
Al	30,799	3,339	4,166
Si			3,468
P			3,520
S	217,125	11,983	3,801
Cl	300,722	16,340	4,020
K	1,022,498	51,946	2,498
Ca	60,088	9,698	1,784
Ti	2,018	721	1,567
V			1,367
Cr	1,385	463	1,126
Mn	5,881	1,061	1,037
Fe	11,157	1,069	1,040
Ni			747
Cu			760
Zn	99,320	5,159	688
As			668
Pb			1,815
Se			735
Br	2,645	495	783
Rb			1,224
Sr	2,565	744	1,287
Zr			2,069

Table 3.6.25. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 10:05
 Filter ID: AG-67

Fuel rate (g/s) 9.22
 Stack gas flow rate (m³/s) 4.92
 Stack Temperature (°C) 36.90
 Ambient Temperature (°C) 12.00

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	270.8	17.9
Na	78.5	14.5
Mg		
Al	15.1	1.6
Si		
P		
S	106.6	5.9
Cl	147.6	8.0
K	501.8	25.5
Ca	29.5	4.8
Ti	1.0	0.4
V		
Cr	0.7	0.2
Mn	2.9	0.5
Fe	5.5	0.5
Ni		
Cu		
Zn	48.7	2.5
As		
Pb		
Se		
Br	1.3	0.2
Rb		
Sr	1.3	0.4
Zr		

Table 3.6.26. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 10:16
 Filter ID: AG-68

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	269,437	18,026	3,329
Na	22,259	5,532	13,070
Mg	14,588	2,652	4,929
Al	26,873	5,418	3,603
Si	25,096	5,016	2,912
P			2,876
S	49,480	3,759	2,989
Cl	71,749	4,941	3,036
K	336,044	17,612	1,882
Ca	30,106	4,227	1,379
Ti			1,276
V			1,113
Cr	625	339	917
Mn	1,251	477	841
Fe	3,860	1,189	879
Ni	665	210	619
Cu			625
Zn	19,028	1,135	559
As			573
Pb			1,556
Se			648
Br			692
Rb			1,076
Sr			1,139
Zr			1,821

Table 3.6.27. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 10:16
 Filter ID: AG-68

Fuel rate (g/s) 9.22
 Stack gas flow rate (m³/s) 4.92
 Stack Temperature (°C) 36.90
 Ambient Temperature (°C) 12.00

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	132.2	8.8
Na	10.9	2.7
Mg	7.2	1.3
Al	13.2	2.7
Si	12.3	2.5
P		
S	24.3	1.8
Cl	35.2	2.4
K	164.9	8.6
Ca	14.8	2.1
Ti		
V		
Cr	0.3	0.2
Mn	0.6	0.2
Fe	1.9	0.6
Ni	0.3	0.1
Cu		
Zn	9.3	0.6
As		
Pb		
Se		
Br		
Rb		
Sr		
Zr		

Table 3.6.28. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 11:54
 Filter ID: AG-69

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	451,055	30,105	4,256
Na	73,832	10,585	13,974
Mg	28,264	4,626	5,425
Al	40,514	8,381	4,065
Si			3,346
P			3,380
S	123,721	7,450	3,594
Cl	224,555	12,564	3,736
K	711,955	36,493	2,307
Ca	52,504	7,826	1,663
Ti	1,419	630	1,489
V	2,322	619	1,299
Cr			1,066
Mn	2,496	628	986
Fe			1,037
Ni			736
Cu			744
Zn	66,809	3,539	669
As			665
Pb			1,806
Se			754
Br			803
Rb			1,258
Sr			1,323
Zr			2,128

Table 3.6.29. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 11:54
 Filter ID: AG-69

Fuel rate (g/s) 13.21
 Stack gas flow rate (m³/s) 4.49
 Stack Temperature (°C) 58.31
 Ambient Temperature (°C) 17.00

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	134.2	9.0
Na	22.0	3.1
Mg	8.4	1.4
Al	12.1	2.5
Si		
P		
S	36.8	2.2
Cl	66.8	3.7
K	211.8	10.9
Ca	15.6	2.3
Ti	0.4	0.2
V	0.7	0.2
Cr		
Mn	0.7	0.2
Fe		
Ni		
Cu		
Zn	19.9	1.1
As		
Pb		
Se		
Br		
Rb		
Sr		
Zr		

Table 3.6.30. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 12:12
 Filter ID: AG-70

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	480,207	41,324	4,874
Na	103,683	13,509	15,833
Mg			6,185
Al	21,153	3,625	4,652
Si	9,054	2,285	3,854
P			3,914
S	99,910	6,586	4,186
Cl	221,493	12,800	4,402
K	646,483	33,302	2,762
Ca	36,527	6,700	1,985
Ti			1,779
V	1,866	736	1,551
Cr			1,278
Mn			1,180
Fe	11,335	1,220	1,142
Ni			809
Cu			819
Zn	76,035	4,040	733
As			729
Pb	4,671	1,245	1,981
Se			827
Br	2,228	433	884
Rb			1,382
Sr			1,449
Zr			2,345

Table 3.6.31. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Almond
 Date: 6-Apr-92
 Time: 12:12
 Filter ID: AG-70

Fuel rate (g/s) 13.21
 Stack gas flow rate (m³/s) 4.49
 Stack Temperature (°C) 58.31
 Ambient Temperature (°C) 17.00

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	142.9	12.3
Na	30.8	4.0
Mg		
Al	6.3	1.1
Si	2.7	0.7
P		
S	29.7	2.0
Cl	65.9	3.8
K	192.4	9.9
Ca	10.9	2.0
Ti		
V	0.6	0.2
Cr		
Mn		
Fe	3.4	0.4
Ni		
Cu		
Zn	22.6	1.2
As		
Pb	1.4	0.4
Se		
Br	0.7	0.1
Rb		
Sr		
Zr		

Table 3.6.32
VOC Concentrations (ppbv)

Date	6-Apr-93	6-Apr-93
Fuel	Almond	Almond
Traverse	Traverse 1	Traverse 2
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)	8.5	15.1
Benzene	18.1	30.9
Dimethylbutane		
Hexane		
Phenol	5.2	9.6
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	9.8	17.2
Benzonitrile		
Benzaldehyde	3	7.2
Methylphenol (hydroxy toluene)	3.9	
Styrene	5.1	6.2
Xylene	1	2.6
Trimethylpentane		
Benzofuran	1.9	4
Methoxymethylphenol (creosol)		
Naphthalene	3.7	6.6
C10H12		
Alpha-pinene		
Camphene		
Δ3-Carene		
Limonene		
No match r.t. (6.7)		
No match r.t. (8.51)		
No match r.t. (8.71)		
No match r.t. (8.73)		
No match r.t.(6.4)		
No match r.t.(8.5)		

Table 3.6.33
VOC Emission Factors (mg/kg)

Date	6-Apr-93	6-Apr-93
Fuel	Almond	Almond
Traverse	Traverse 1	Traverse 2
Fuel Consumption Rate (g/s d.b)	9.22	13.21
Stack Gas Mass Flow Rate* (kg/s)	5.61	4.79
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane*		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)	17	18
Benzene	30	30
Dimethylbutane		
Hexane		
Phenol	10	11
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	19	20
Benzonitrile		
Benzaldehyde	7	10
Methylphenol (hydroxy toluene)	9	
Styrene	11	8
Xylene	2	3
Trimethylpentane		
Benzofuran	5	6
Methoxymethylphenol (creosol)		
Naphthalene	10	11
Unknown		
Alpha-pinene		
Camphene		
Δ3-Carene		
Limonene		

*uses stack gas flow rate from carbon balance

Table 3.6.34. PAH emission factors, almond tree prunings, 6 April 1993, measured stack gas velocity (zero indicates not detected).

	Traverse 1 Filter	Traverse 2 Filter	Trap	Traverse 1 Sorbent	Traverse 2 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 2	Total Average
µg/kg dry fuel									
Naphthalene	93	113	1	8,753	11,493	12	8,859	11,619	10,239
2-Methyl-naphthalene	15	19	0	161	205	1	178	225	202
Acenaphthylene	9	0	0	3,375	4,000	0	3,384	4,001	3,692
Acenaphthene	0	0	0	217	281	0	217	281	249
Fluorene	0	0	0	81	32	0	82	32	57
Phenanthrene	129	133	0	2,572	2,731	5	2,706	2,869	2,788
Anthracene	24	29	0	468	307	1	493	338	416
Fluoranthene	262	291	0	437	440	0	700	731	715
Pyrene	239	281	0	333	382	0	572	664	618
Benzo[a]-anthracene	169	161	0	100	165	0	269	326	297
Chrysene	102	280	1	79	177	0	182	438	310
Benzo[b]-fluoranthene	44	30	0	22	17	0	65	47	56
Benzo[k]-fluoranthene	39	54	0	22	25	0	62	80	71
Benzo[a]pyrene	14	4	0	27	27	0	42	31	37
Benzo[e]pyrene	9	0	0	17	18	0	26	18	22
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	3	0	0	0	0	0	3	0	2
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	1,152	1,376	1	16,665	20,302	21	17,839	21,699	19,769

Table 3.6.35. PAH emission factors, almond tree prunings, 6 April 1993, stack gas velocity from carbon balance.

	Traverse 1 Filter	Traverse 2 Filter	Trap	Traverse 1 Sorbent	Traverse 2 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 2	Total Average
µg/kg dry fuel									
Naphthalene	84	64	0	7,931	6,516	10	8,025	6,590	7,307
2-Methyl-naphthalene	14	11	0	146	116	1	161	128	145
Acenaphthylene	8	0	0	3,058	2,268	0	3,066	2,268	2,667
Acenaphthene	0	0	0	197	159	0	197	159	178
Fluorene	0	0	0	74	18	0	74	18	46
Phenanthrene	117	75	0	2,330	1,548	4	2,451	1,627	2,039
Anthracene	22	17	0	424	174	1	447	192	319
Fluoranthene	238	185	0	396	250	0	634	415	524
Pyrene	216	160	0	302	217	0	518	376	447
Benzo[a]-anthracene	153	91	0	90	94	0	243	185	214
Chrysene	92	148	0	72	100	0	165	248	206
Benzo[b]-fluoranthene	40	17	0	20	10	0	59	27	43
Benzo[k]-fluoranthene	36	31	0	20	14	0	56	45	50
Benzo[a]pyrene	13	2	0	25	15	0	38	18	28
Benzo[e]pyrene	8	0	0	16	10	0	24	10	17
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	3	0	0	0	0	0	3	0	3
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	1,044	780	1	15,100	11,509	16	16,161	12,306	14,235

Figure 3.6.1. Air temperature and relative humidity from CIMIS station.

Fuel:

Almond

Date of Test:

6-Apr-93

Configuration:

Pile

Hourly Average CIMIS Data for Davis, California

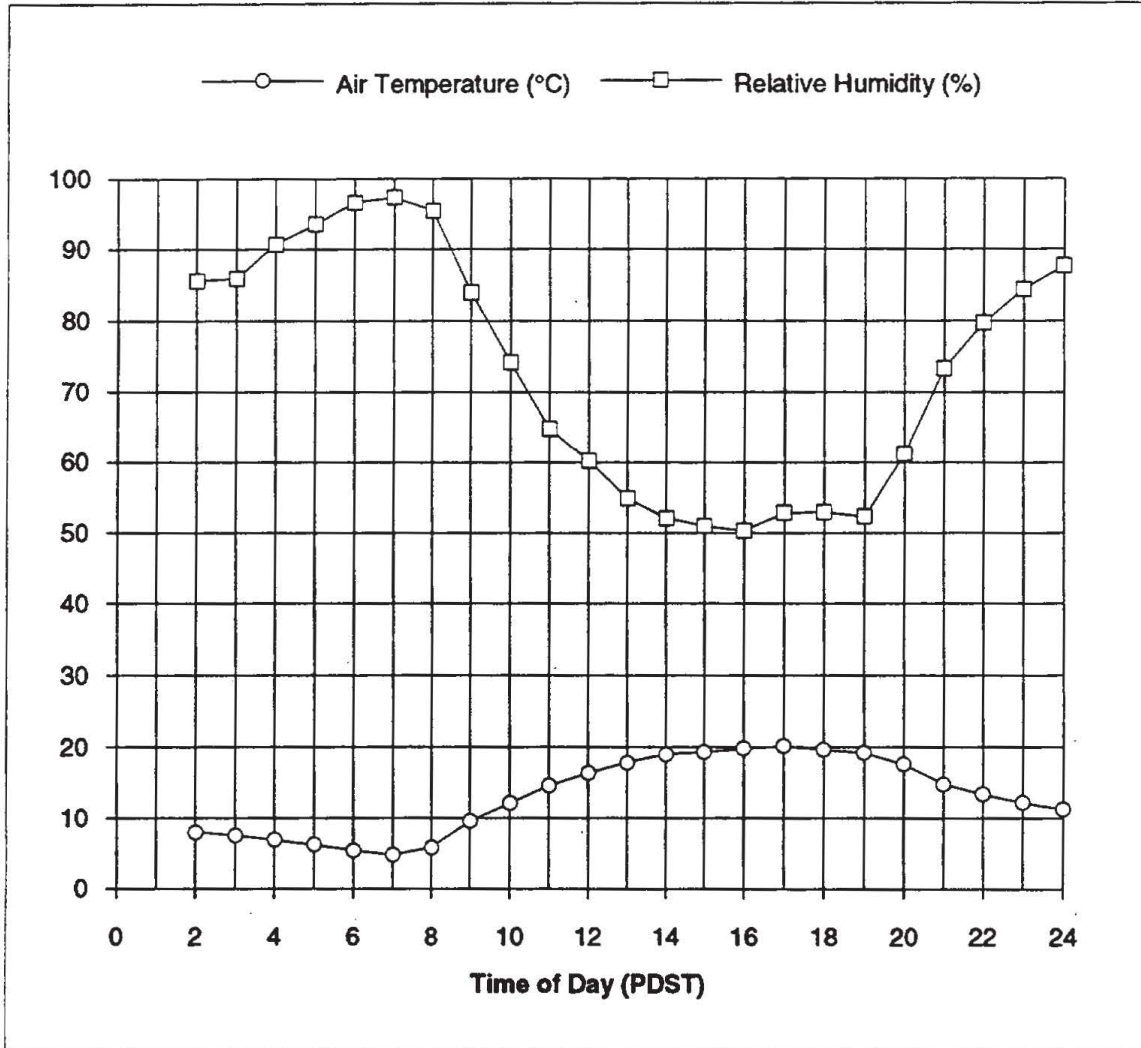


Figure 3.6.2. Wind speed from CIMIS station.

Fuel: Almond
Configuration: Pile

Date of Test: 6-Apr-93

Hourly Average CIMIS Data for Davis, California

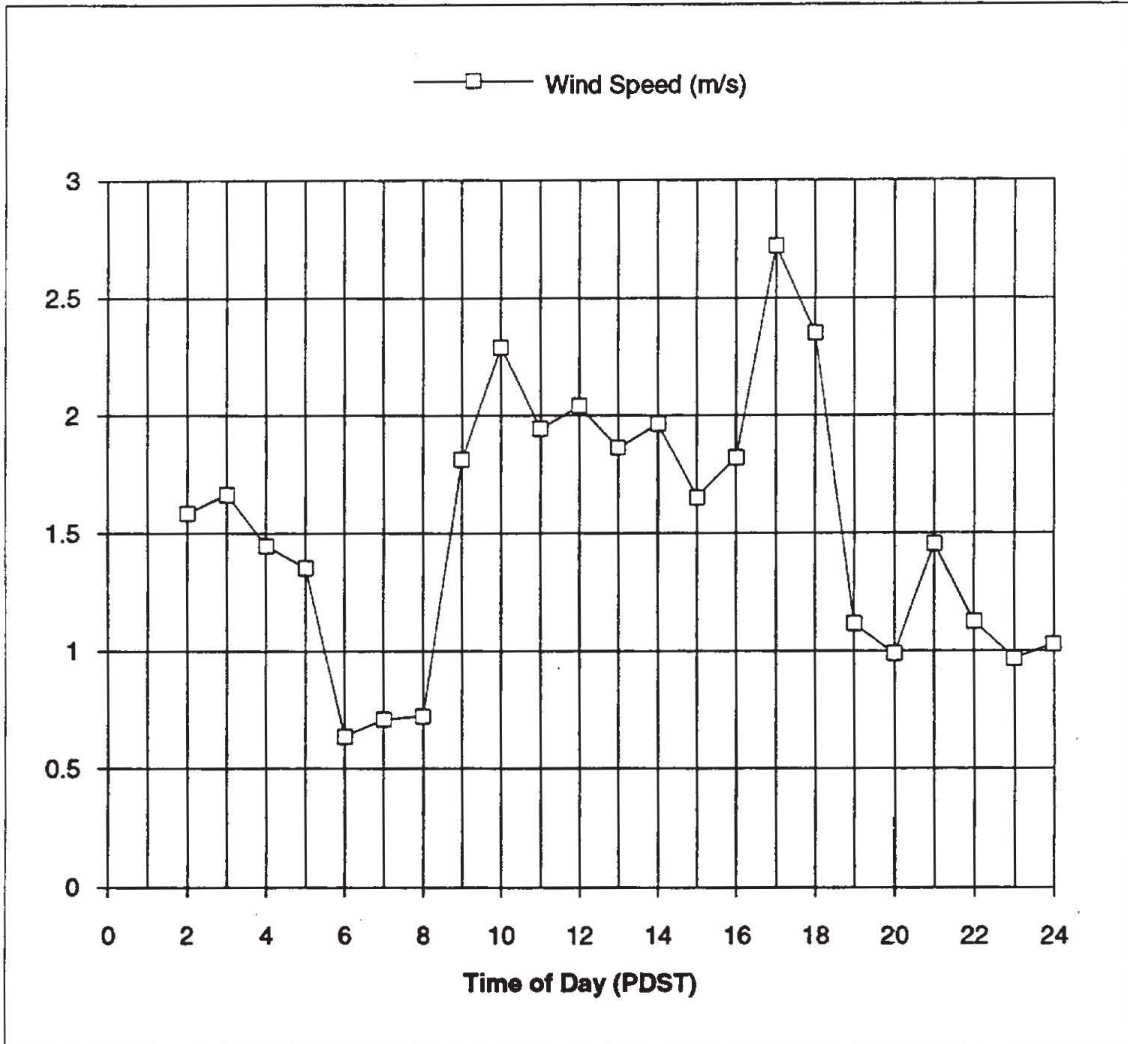


Figure 3.6.3. Wind direction and solar radiation from CIMIS station.

Fuel: Almond Date of Test: 6-Apr-93
Configuration: Pile
Hourly Average CIMIS Data for Davis, California

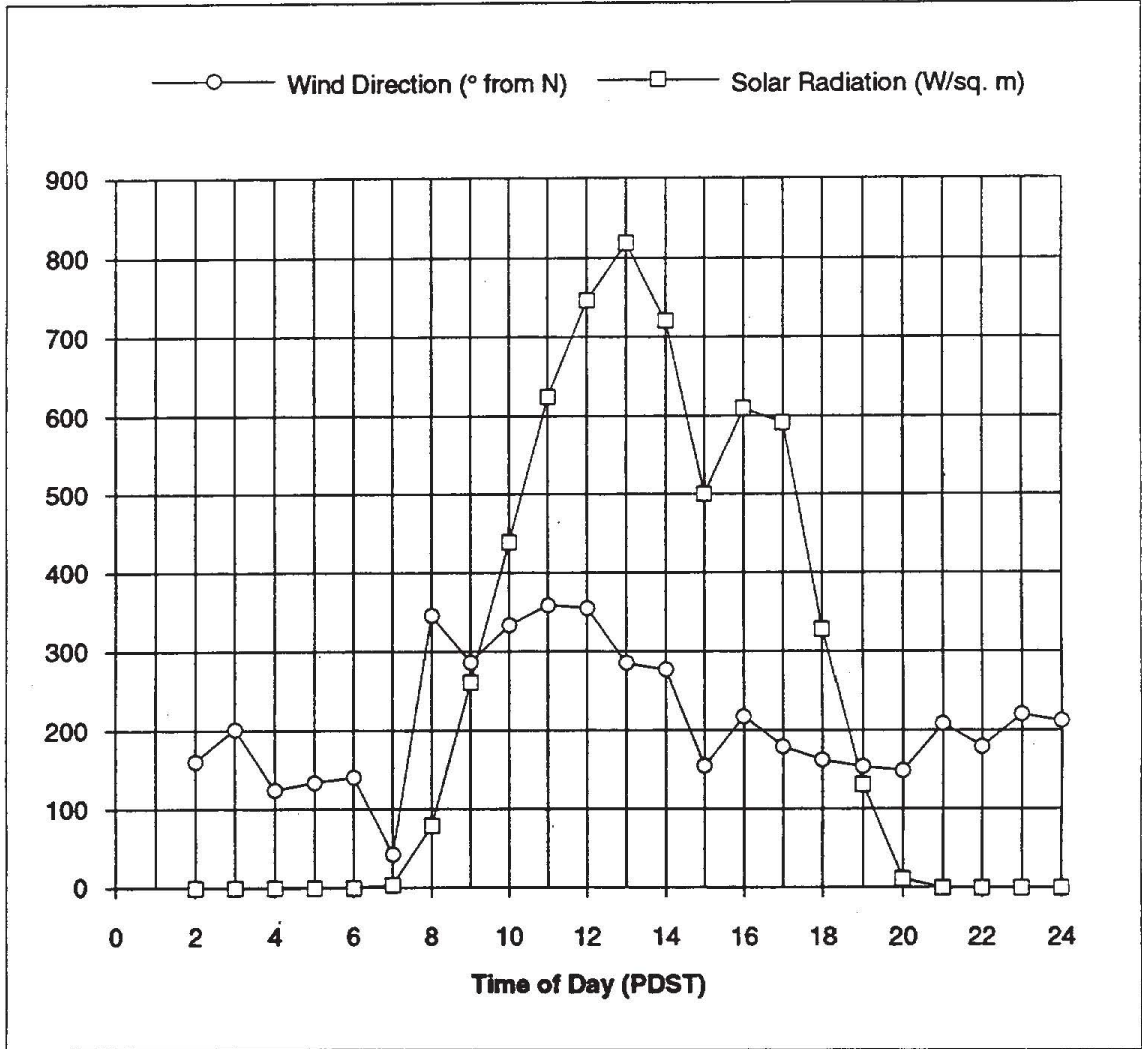


Figure 3.6.4. Inlet air, stack gas, and impinger temperatures, 6 April 93.

Fuel Type: Almond
Configuration: Pile

Test Date: 6-Apr-93

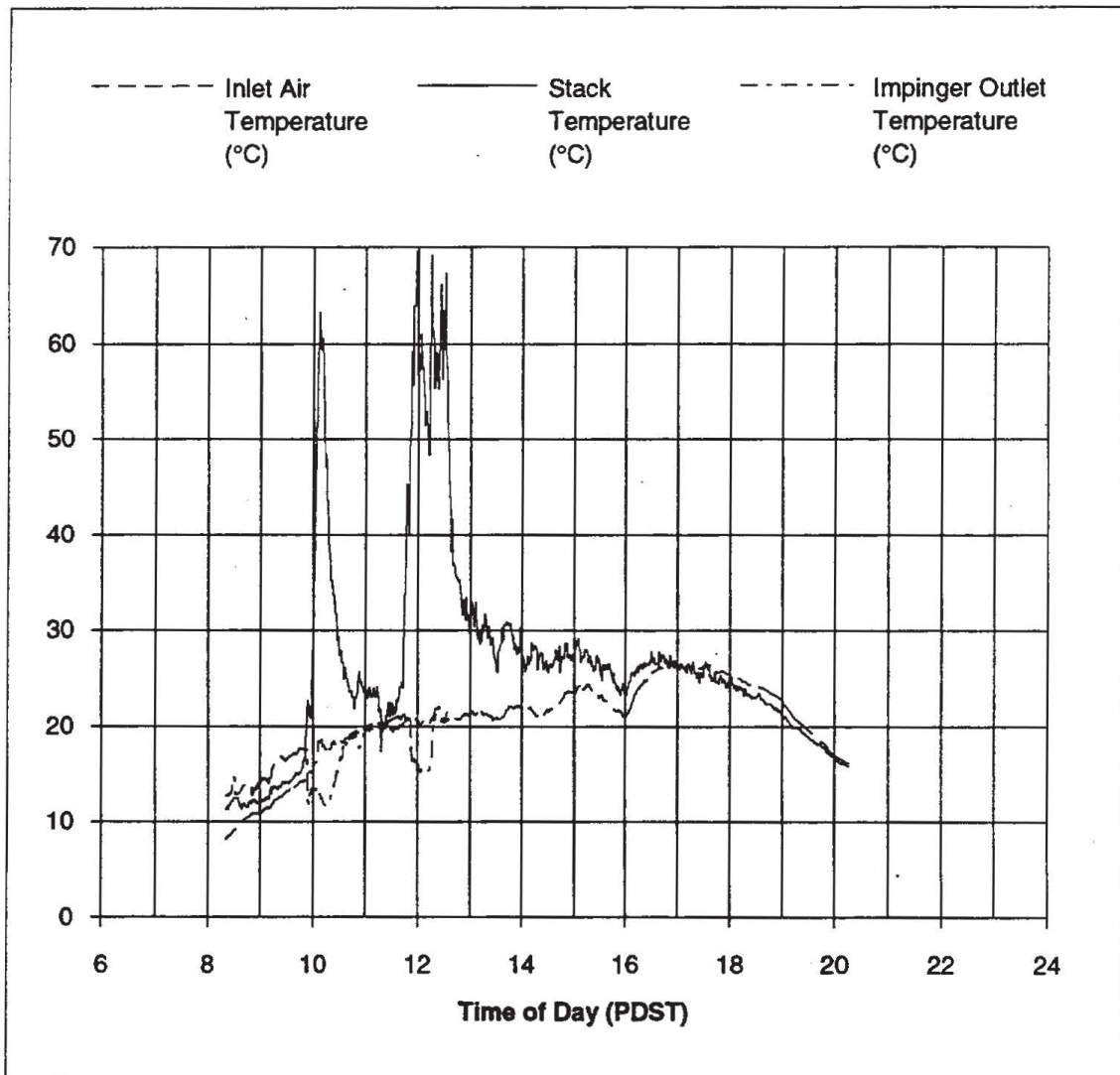


Figure 3.6.5. Stack gas velocity, 6 April 93.

Fuel Type: Almond
Configuration: Pile

Test Date 6-Apr-93

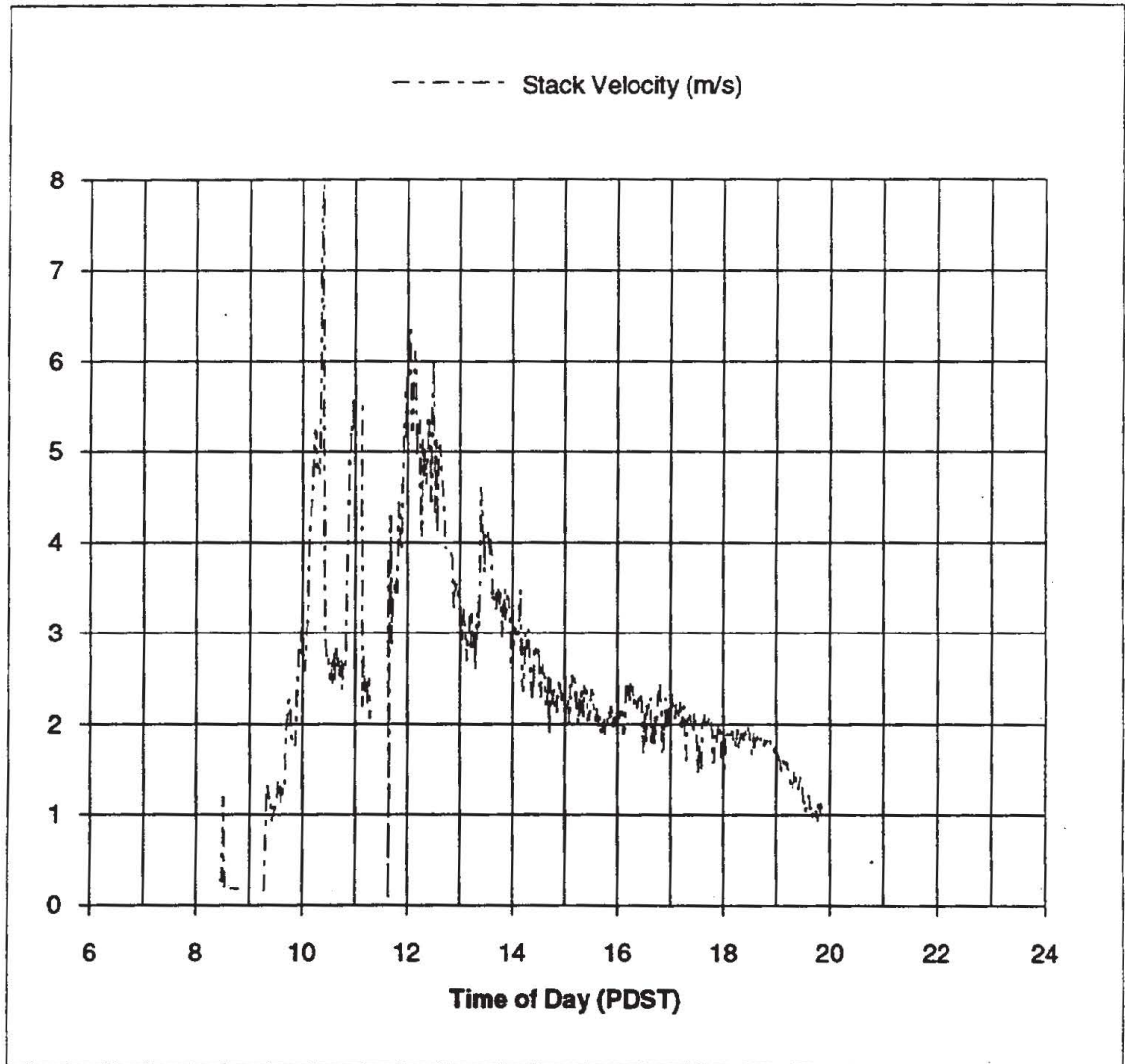


Figure 3.6.6. CO concentration in stack gas, 6 April 93.

Fuel Type: Almond
Configuration: Pile

Test Date 6-Apr-93

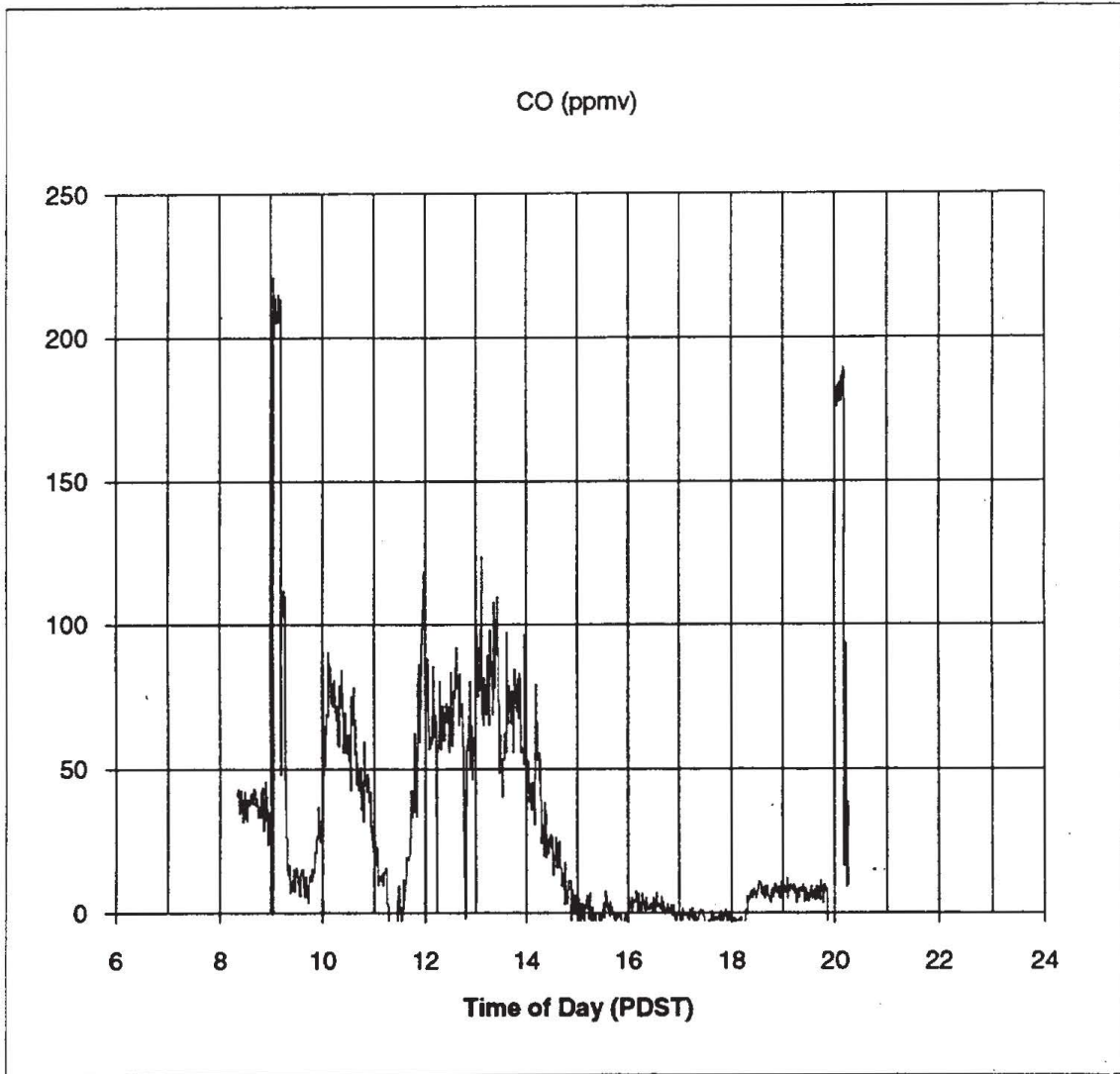


Figure 3.6.7. NO and NOx concentrations in stack gas, 6 April 93.

Fuel Type: Almond Test Date: 6-Apr-93
Configuration: Pile

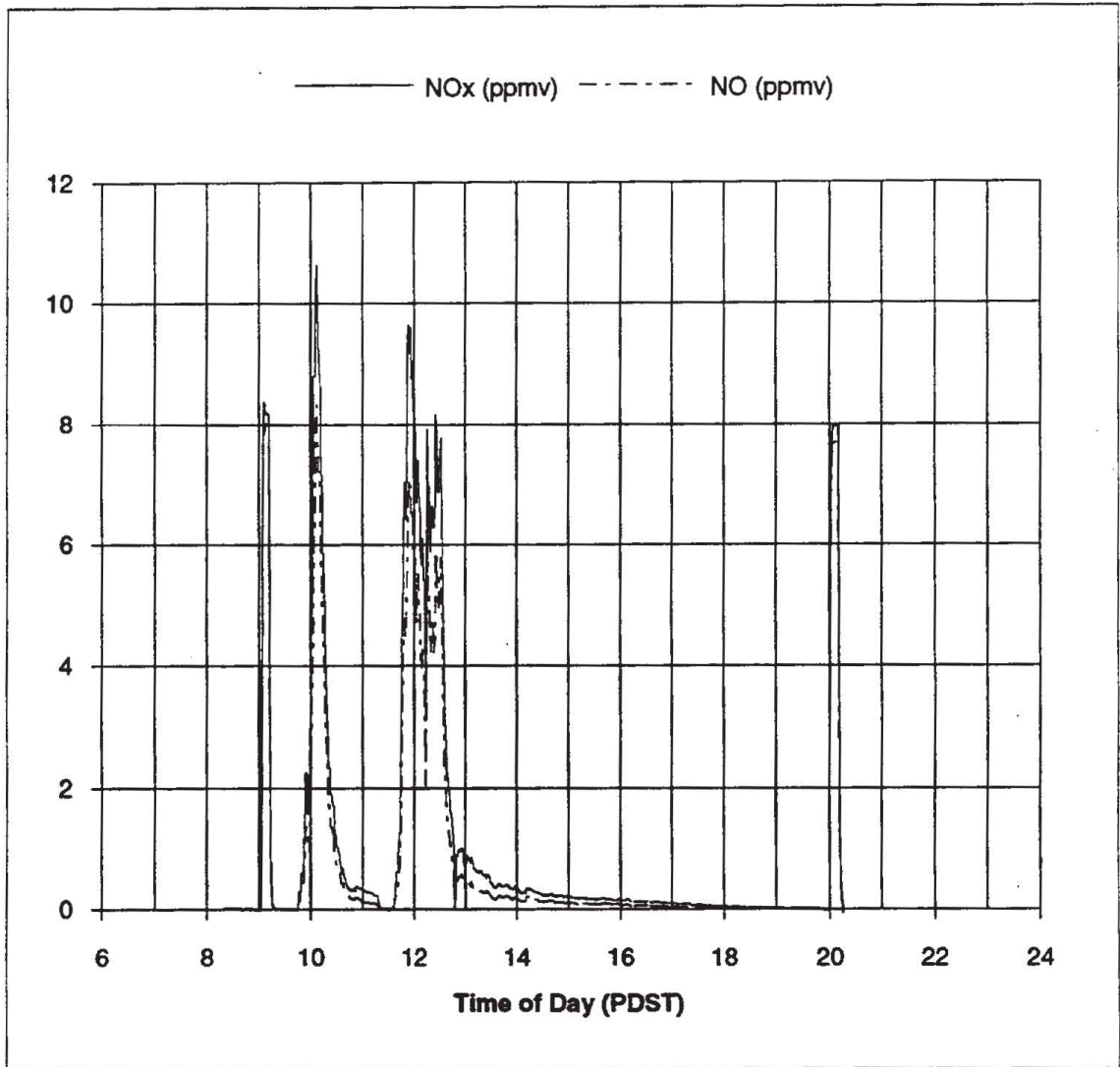


Figure 3.6.8. SO2 concentration in stack gas, 6 April 93.

Fuel Type: Almond
Configuration: Pile

Test Date 6-Apr-93

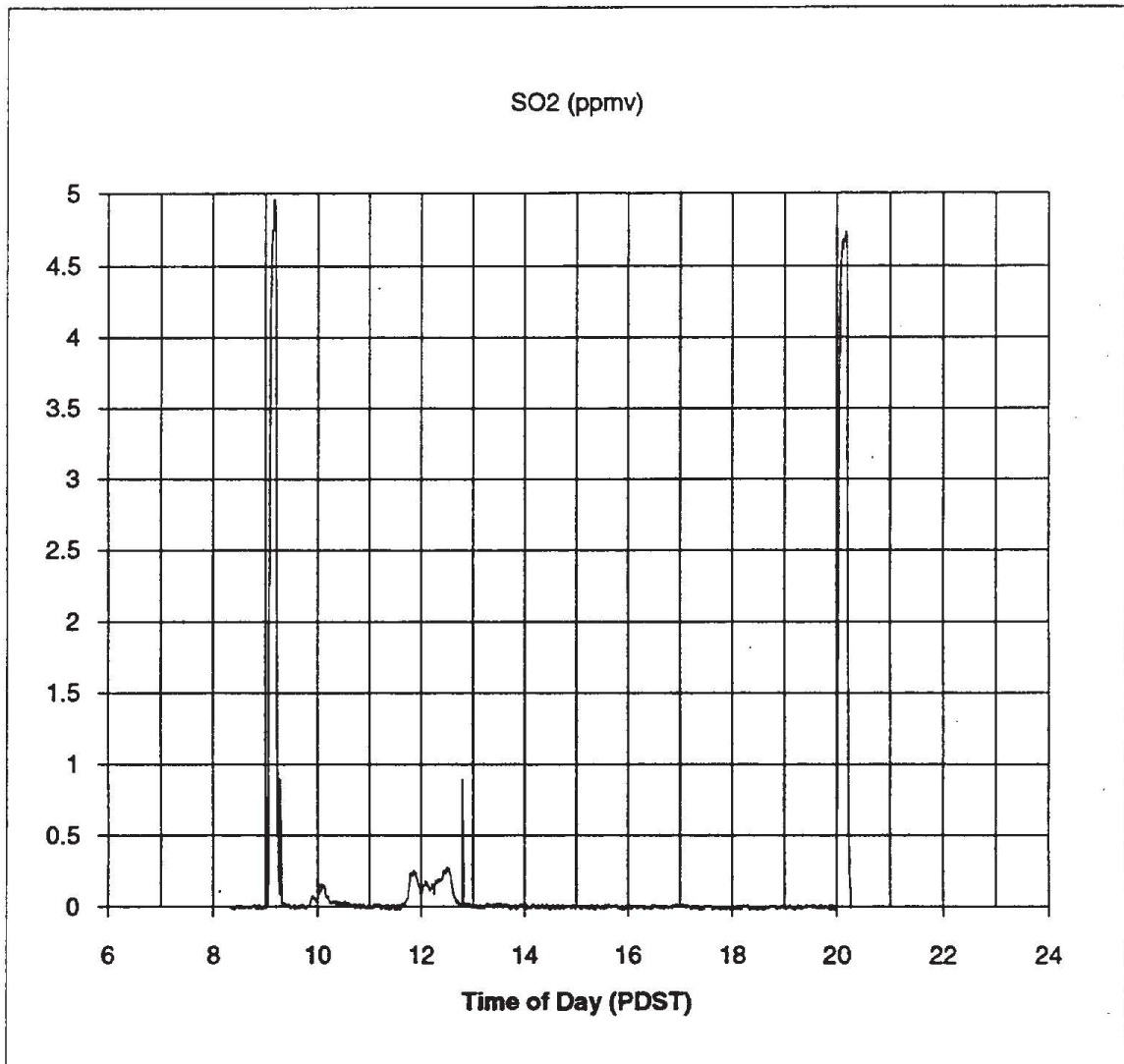


Figure 3.6.9. Total sulfur concentration in stack gas, 6 April 93.

Fuel Type: Almond
Configuration: Pile

Test Date

6-Apr-93

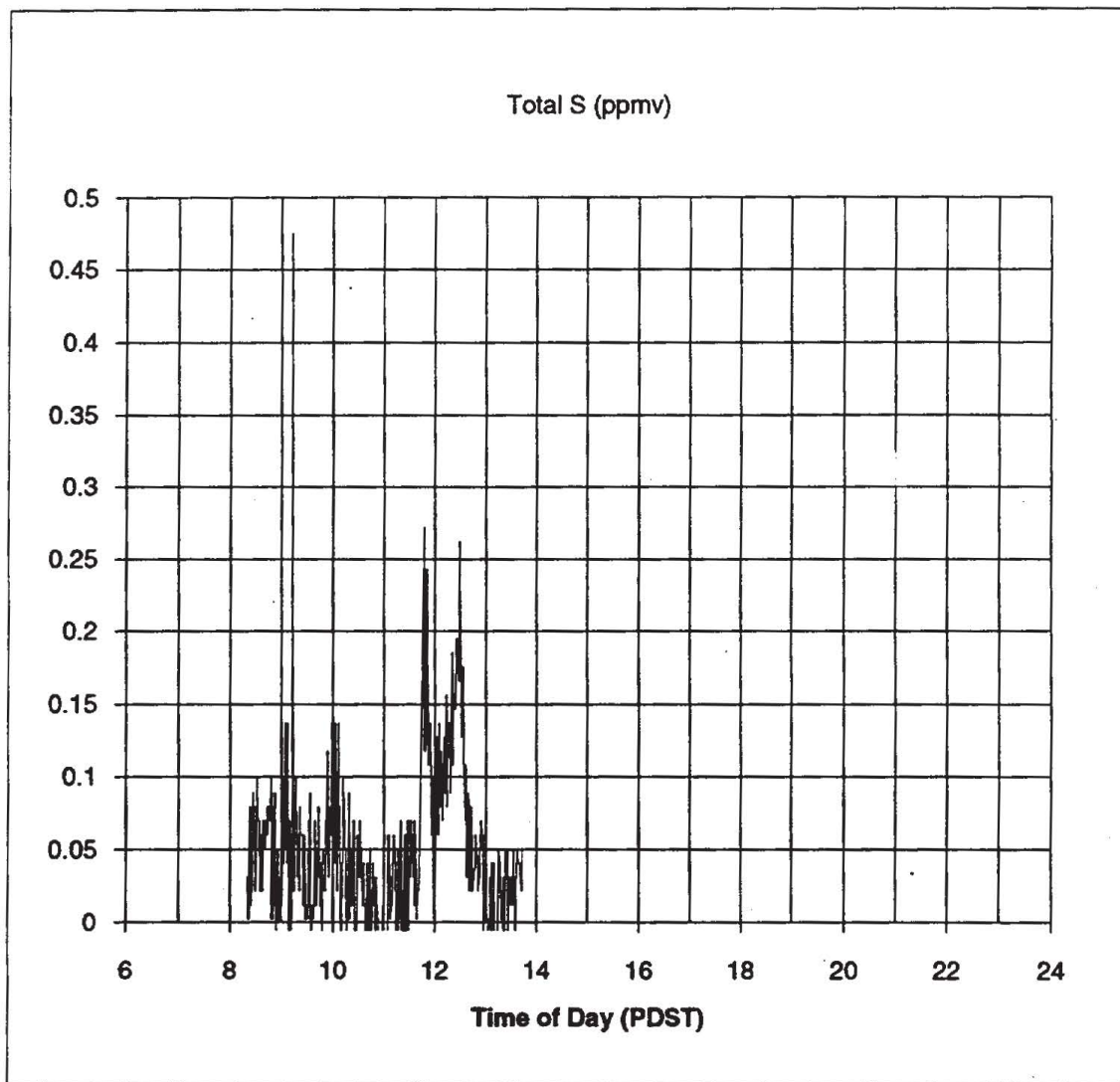


Figure 3.6.10. THC concentration in stack gas, 6 April 93.

Fuel Type: Almond
Configuration: Pile

Test Date 6-Apr-93

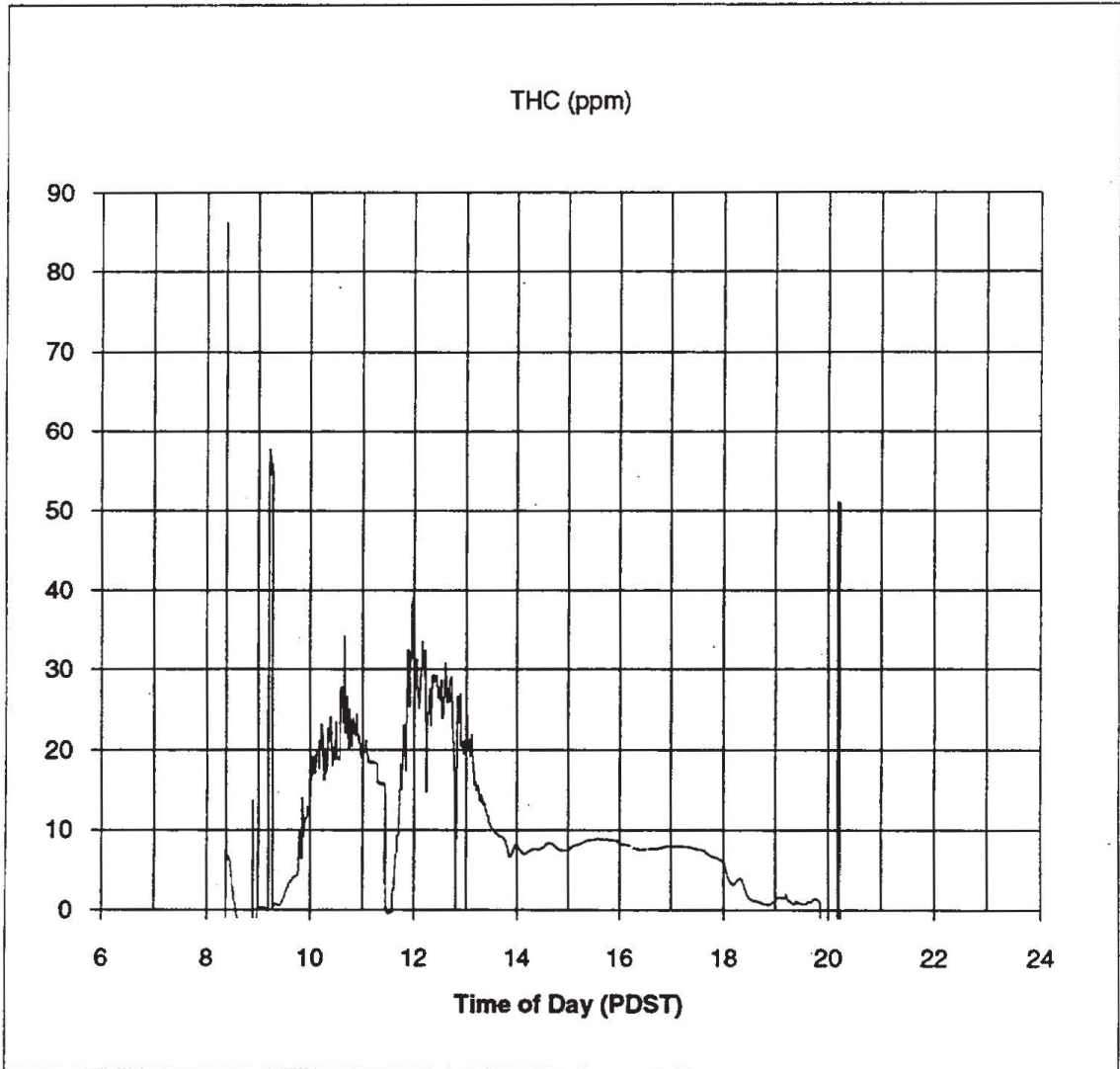


Figure 3.6.11. CO2 concentration in stack gas, 6 April 93.

Fuel Type: Almond
Configuration: Pile

Test Date

6-Apr-93

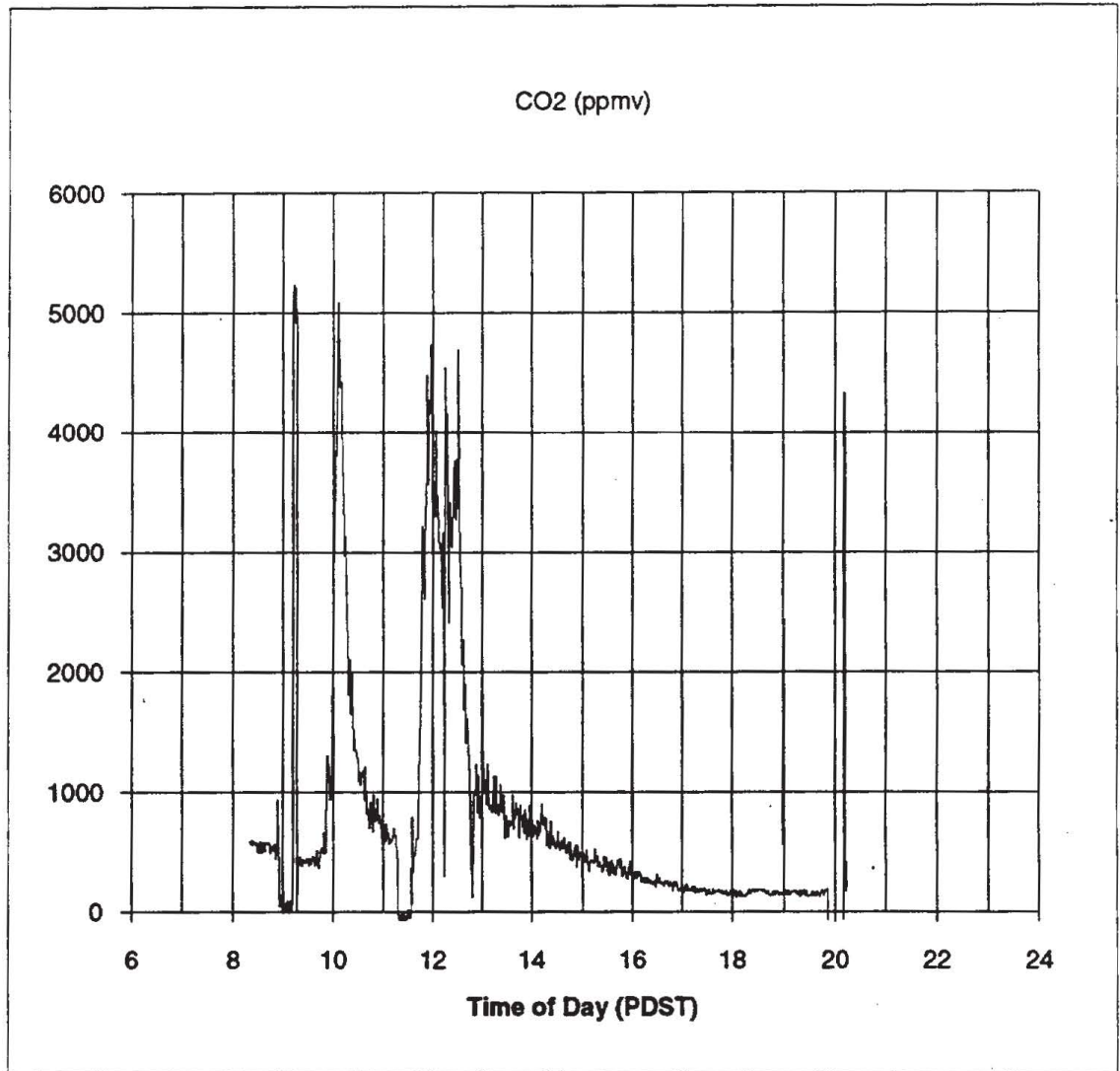


Figure 3.6.12. Particle size distribution, traverse 1, 12 November 92.

Fuel: Almond Date of Test: 6-Apr-93
Configuration: Pile

Particle Size Distribution
Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.74	0.11	5.88	1.000
2	7.70	0.13	5.77	0.981
3	4.10	0.15	5.64	0.959
4	2.17	0.18	5.49	0.934
5	1.25	0.27	5.31	0.903
6	0.73	0.5	5.04	0.857
7	0.38	0.63	4.54	0.772
filter	0.00	3.91	3.91	0.665

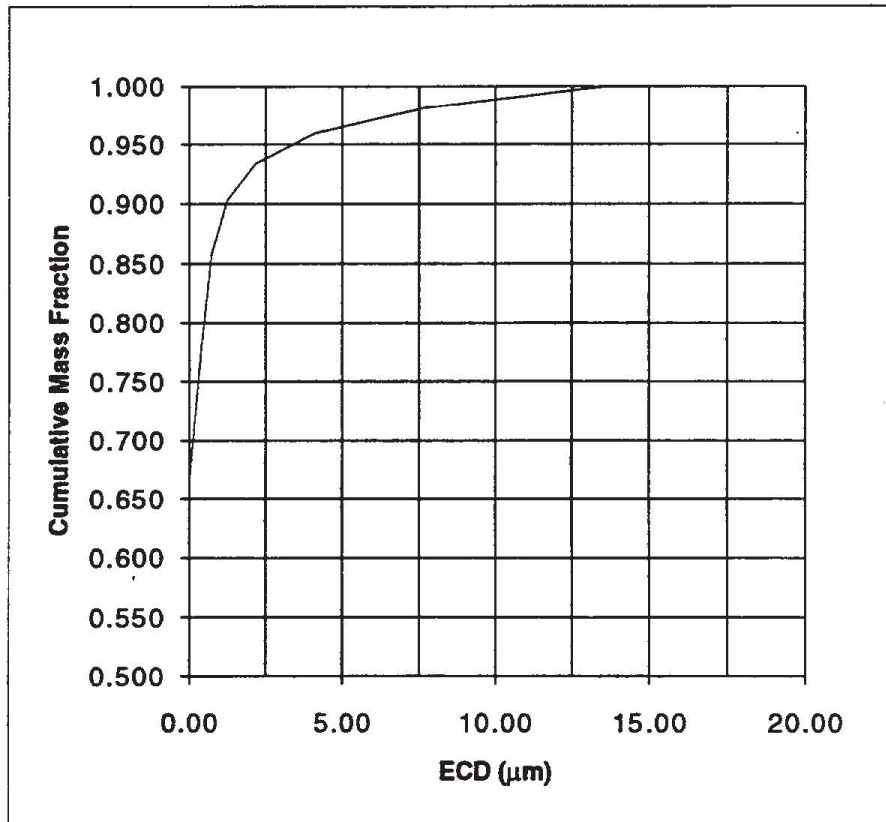


Figure 3.6.13. Particle size distribution, traverse 2, 12 November 92.

Fuel: Almond Date of Test: 6-Apr-93
Configuration: Pile

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.92	0.14	4.59	1.000
2	7.80	0.11	4.45	0.969
3	4.16	0.15	4.34	0.946
4	2.20	0.15	4.19	0.913
5	1.27	0.19	4.04	0.880
6	0.74	0.36	3.85	0.839
7	0.39	0.44	3.49	0.760
filter	0.00	3.05	3.05	0.664

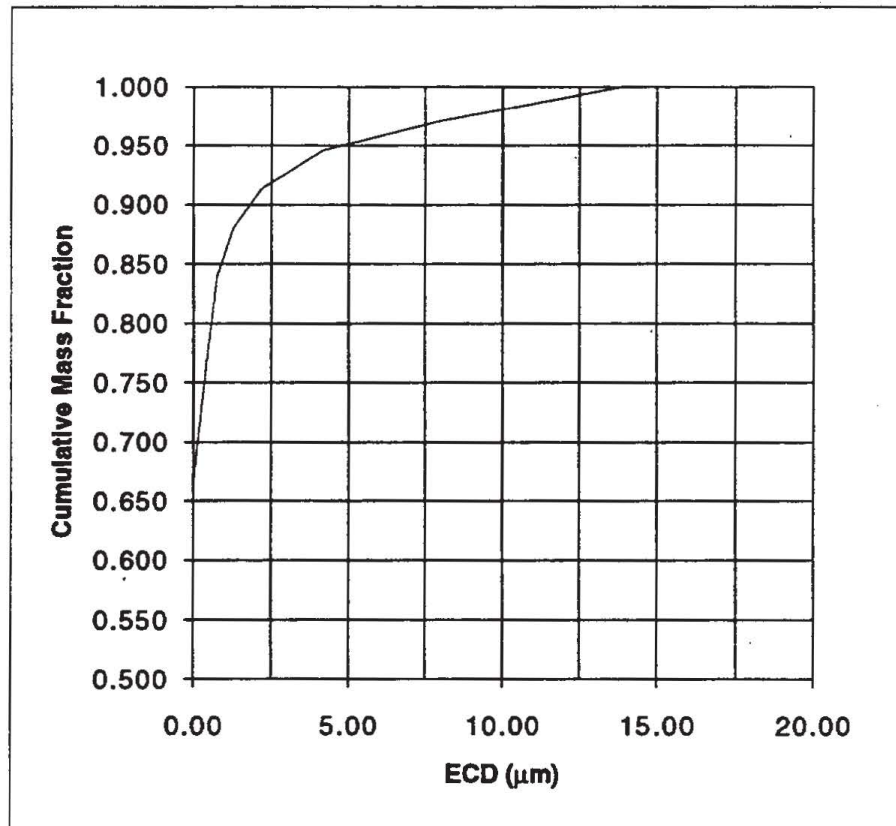


Figure 3.6.14. Weight on burning platform, almond tree prunings

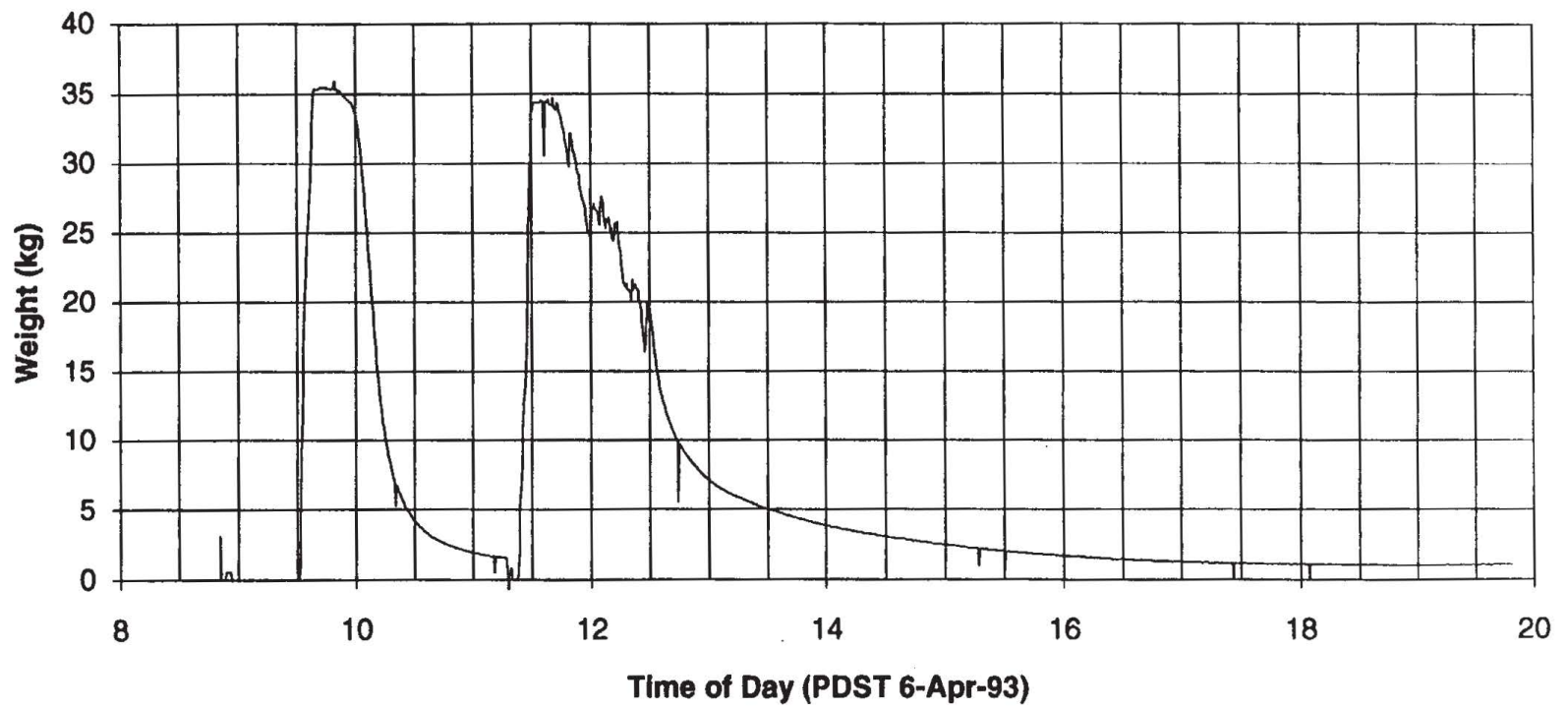


Figure 3.6.15. Residual weight profiles, almond tree prunings.

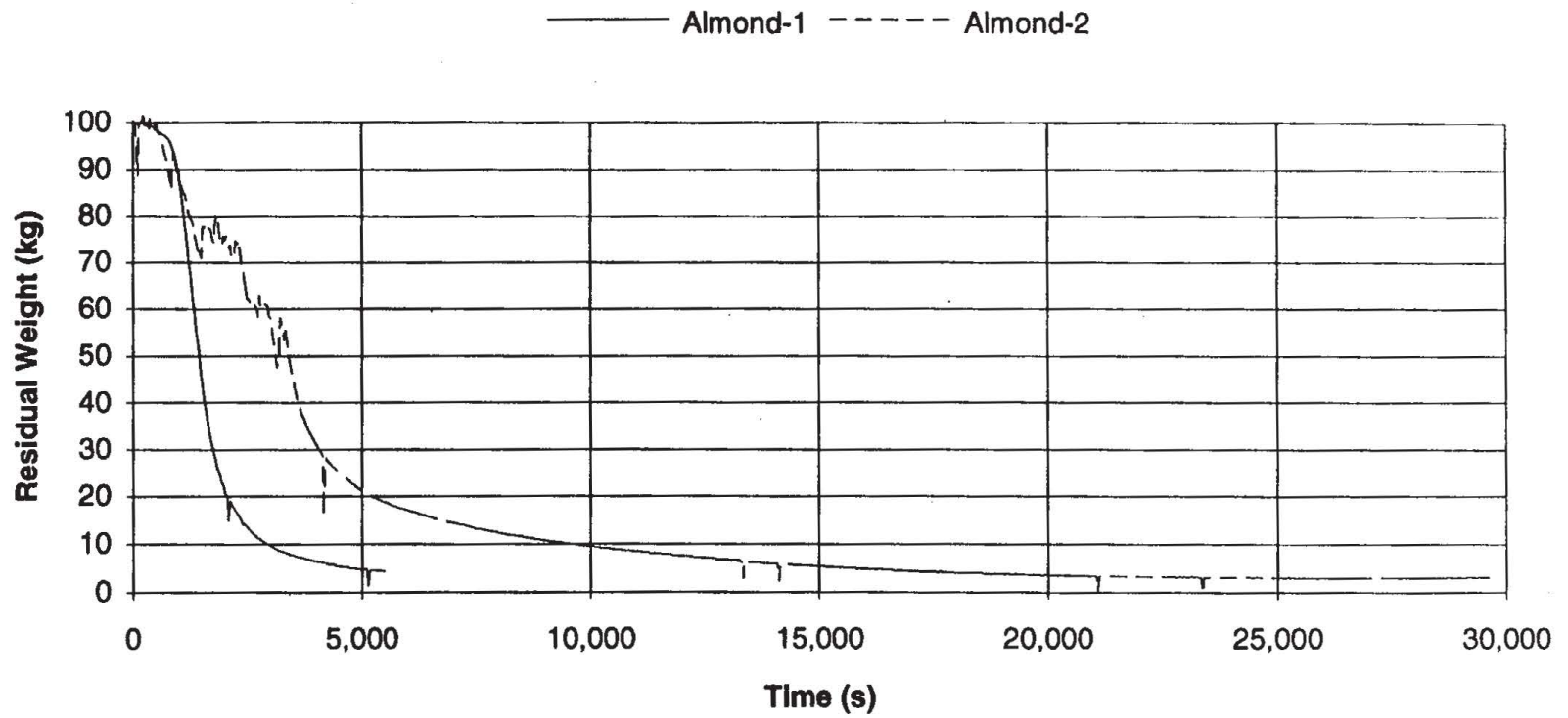


Figure 3.6.16. Rate of weight loss, first test, almond tree prunings.

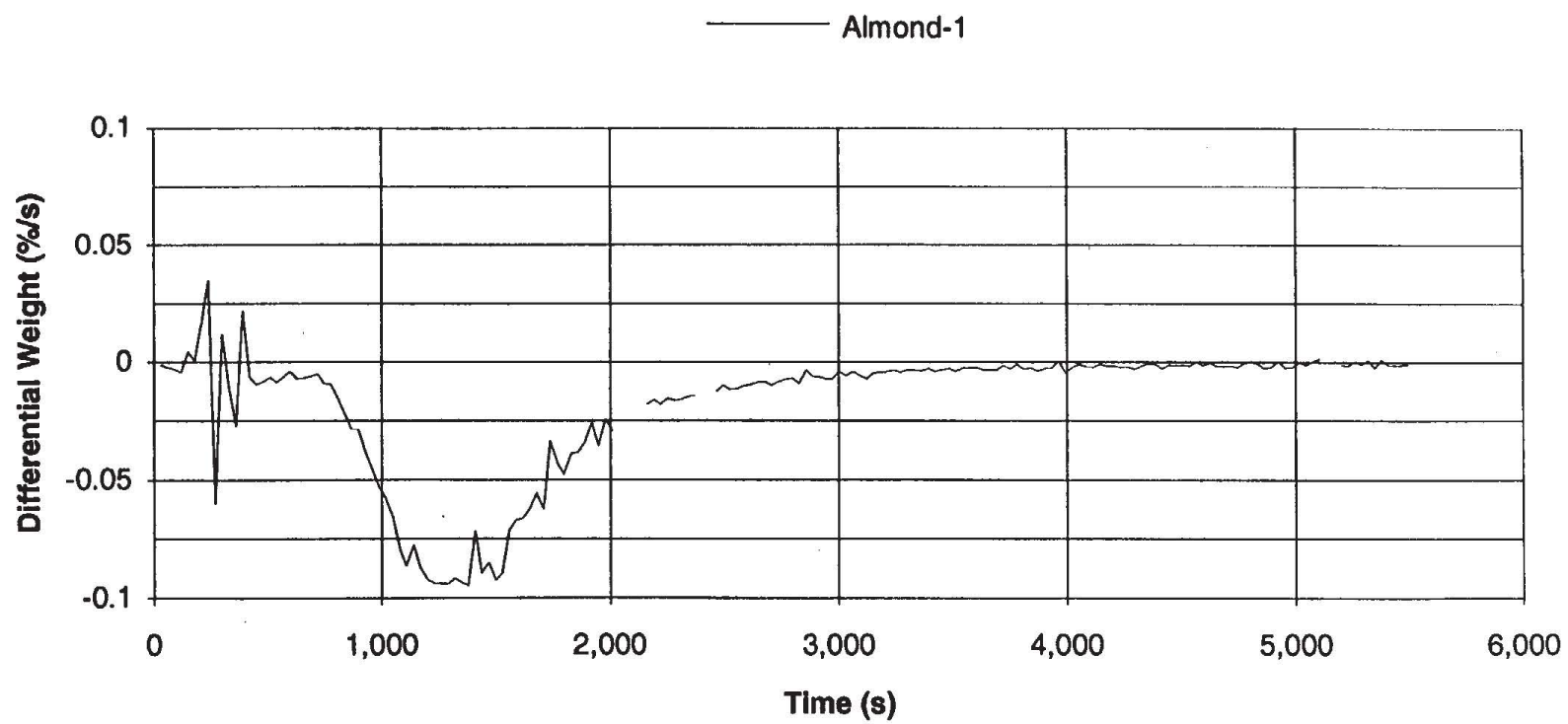


Figure 3.6.17. Rate of weight loss, second test, almond tree prunings.

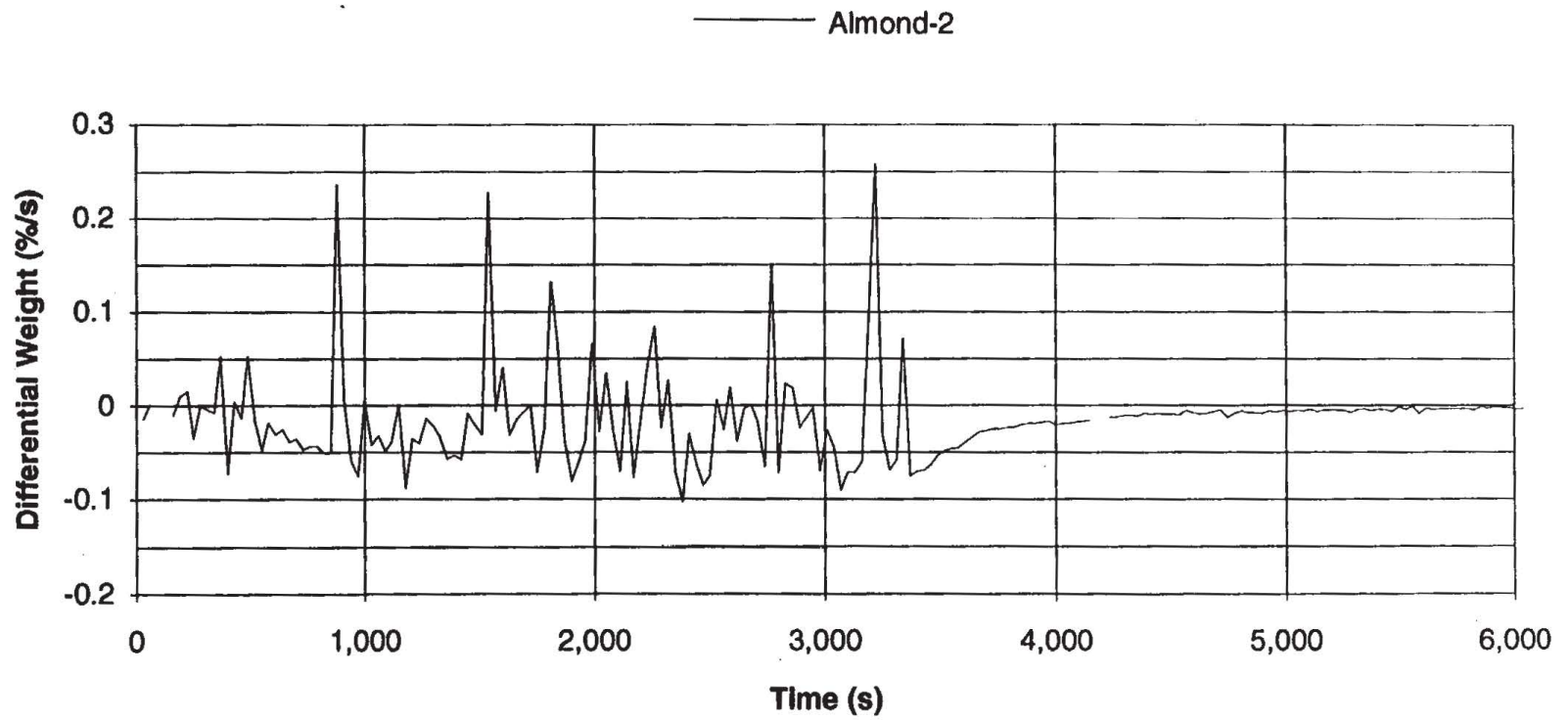


Figure 3.6.18. Nitrogen balance.

Date of Test:
Fuel

6-Apr-93
Almond
Test 1

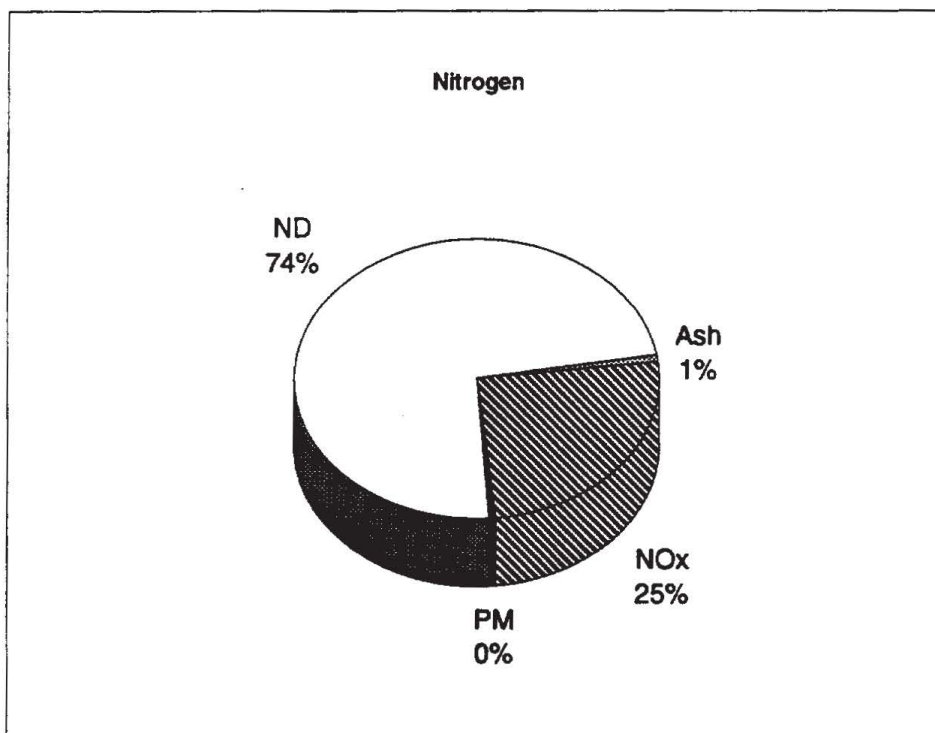


Figure 3.6.19. Sulfur balance.
Date of Test:
Fuel

6-Apr-93
Almond
Test 1

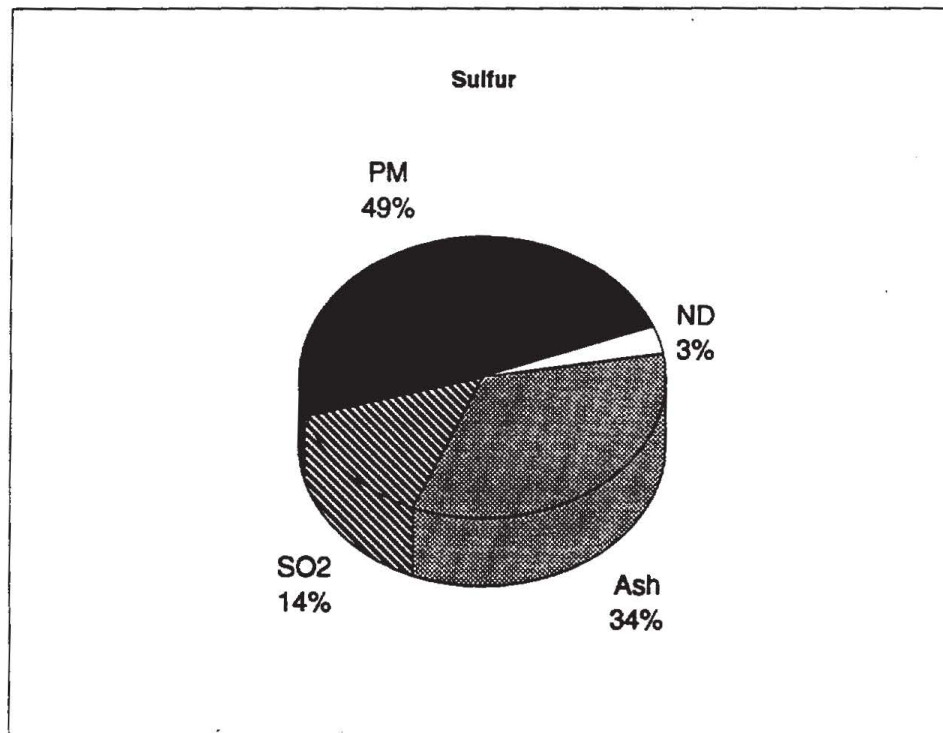
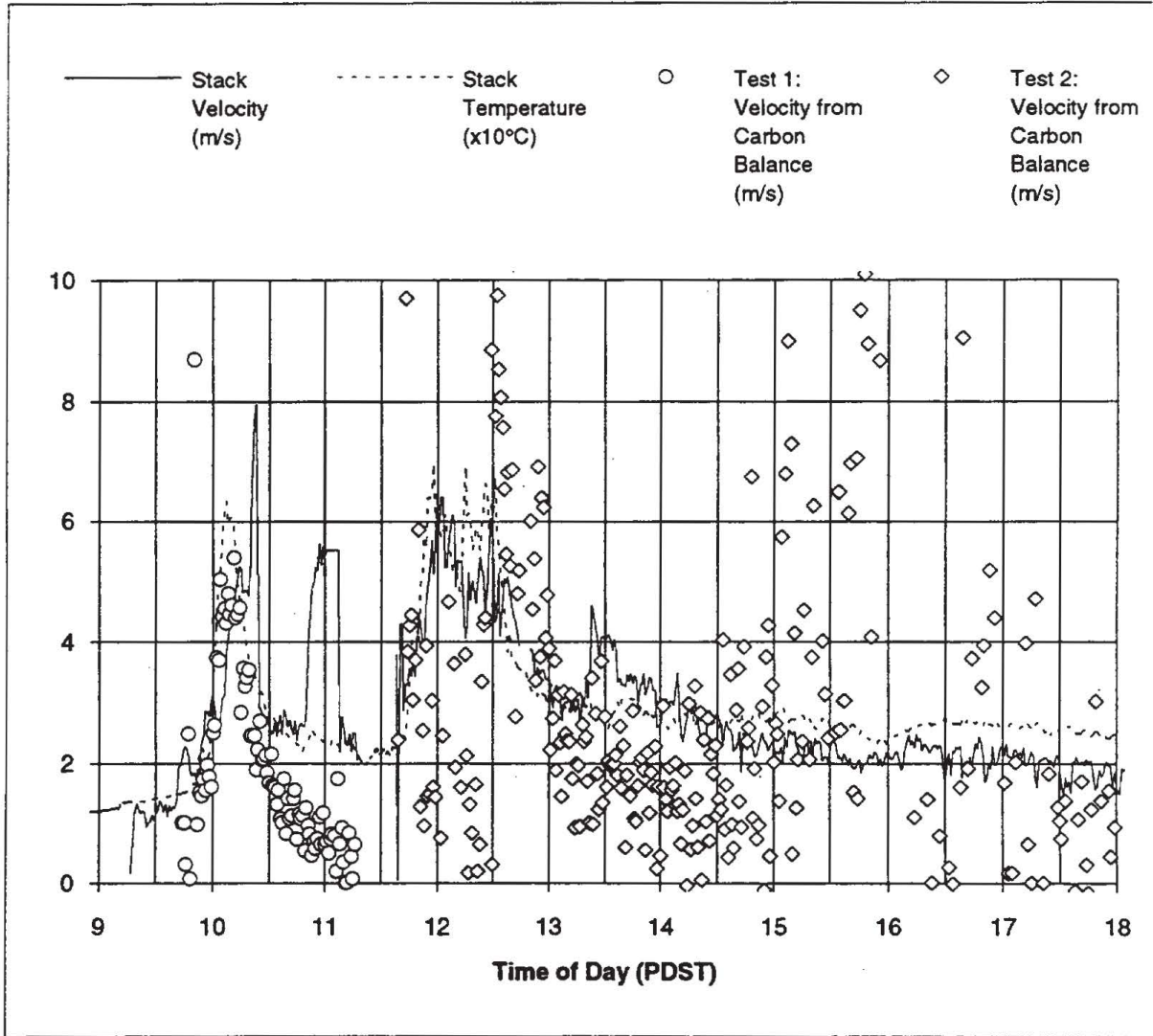


Figure 3.6.20. Comparison of estimated and measured stack gas velocity.

Fuel Type: Almond
Configuration: Pile

Test Date: 6-Apr



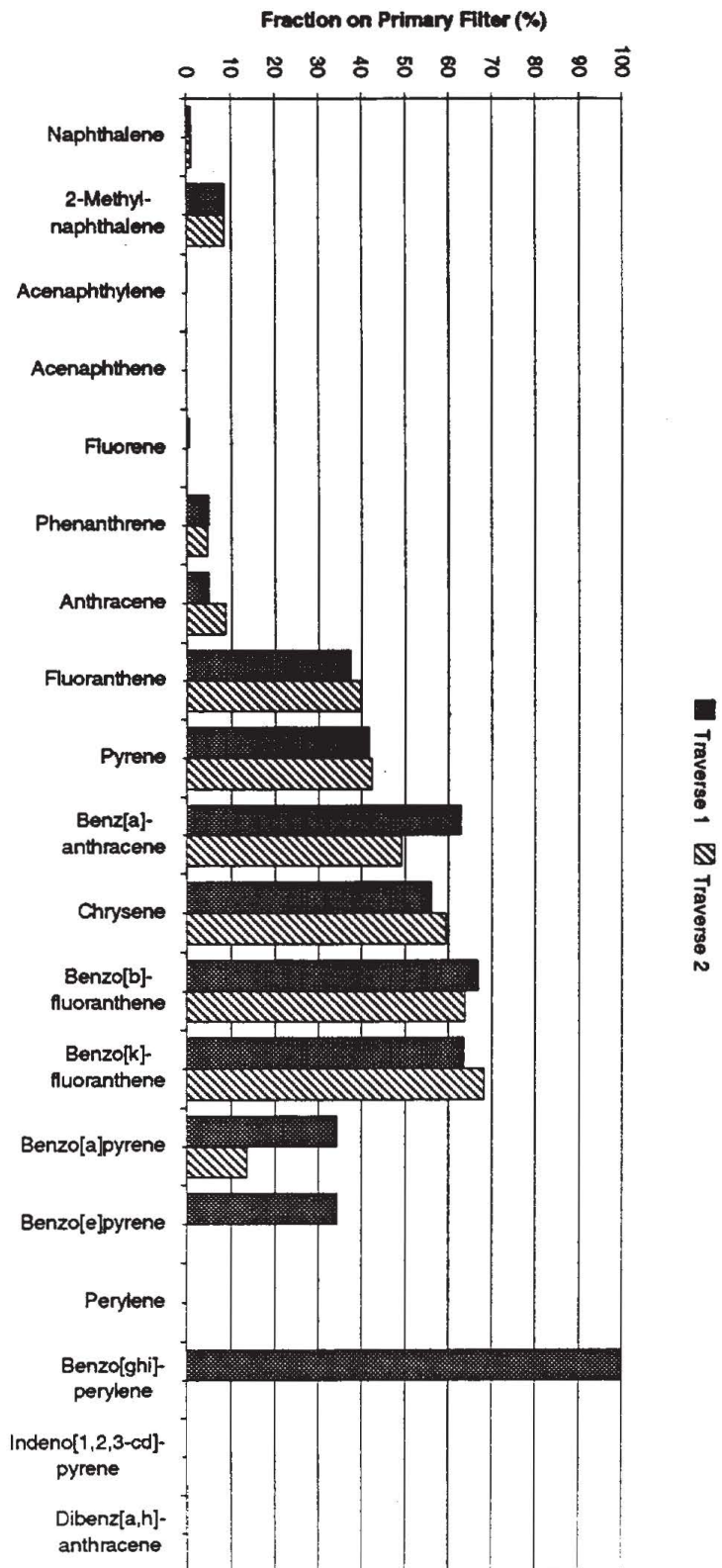


Figure 3.6.21. Mass fraction of PAH on primary filter samples, 6 April 1993, almond tree prunings (measured stack gas velocity).

Table 3.7.1

Fuel analysis

Run Date	29-Apr-93	29-Apr-93	29-Apr-93	29-Apr-93
Fuel Type	Ponderosa Pine	Ponderosa Pine	Ponderosa Pine	Ponderosa Pine
Sample Type	Fuel	Fuel	Fuel	Fuel
	Large Branch	Medium Branch	Small Branch	Needles
<u>Ultimate Analysis</u>				
(% dry weight)				
C	51.65	52.17	53.29	52.77
H	6.25	6.19	6.16	6.42
N			0.10	0.95
<u>Elemental Analysis</u>				
(% by weight dry basis)				
N	0.30	0.22	0.32	1.12
P	0.02	0.01	0.02	0.10
K	0.17	0.12	0.18	0.41
Ca	0.14	0.39	0.48	0.33
Mg	0.06	0.04	0.07	0.18
Na			0.0006	0.0031
Cl	0.01			
(mg/kg dry weight)				
S	177	141	241	779
B	5	2	4	13
Zn	13	11	16	26
Mn	52	50	63	411
Fe	120	160	229	260
Cu	3	2	3	5
Si	681	563	639	4,670
Total (% dry weight)	58.71	59.24	60.64	61.95
<u>Proximate Analysis</u>				
(% dry weight)				
Ash	0.24	1.22	1.37	8.12
Volatiles	82.93	82.93	79.09	76.46
Fixed Carbon	16.83	15.85	19.54	15.42
<u>Higher Heating Value</u>				
(MJ/kg dry weight)	20.2566	20.5804	21.0412	21.2838

Table 3.7.2

Fuel: Ponderosa Pine
Date of Test: 29-Apr-93

Fuel Properties

	Large Branch	Medium Branch	Small Branch	Needle	Total
Diameter (mm)	> 50	25-50	<25	-	
Mass Fraction (% wet weight)	32.5	35.1	29.6	2.8	100.0
Moisture (% wet weight)	39.8	17.0	17.4	15.3	24.5
Mass Fraction (% dry weight)	26	39	32	3	100
Carbon (% dry weight)	51.65	52.17	53.29	52.77	52.42
Nitrogen (% dry weight)	0.30	0.22	0.32	1.12	0.30
Sulfur (mg/kg dry weight)	177	141	241	779	203
Ash (% dry weight)	0.24	1.22	1.37	8.12	1.23
Heating Value (MJ/kg dry weight)	20.26	20.58	21.04	21.28	20.67

Table 3.7.3

Residue analysis

Run Date	29-Apr-93	29-Apr-93	29-Apr-93	29-Apr-93
Fuel Type	Ponderosa Pine	Ponderosa Pine	Ponderosa Pine	Ponderosa Pine
Sample Type	Residue	Residue	Ash	Ash
	Test #1	Test #2	Test #1	Test #2
<u>Ultimate Analysis</u>				
(% dry weight)				
C	30.97	37.34	15.47	17.11
H	3.13	3.37	1.02	0.96
N				
<u>Elemental Analysis</u>				
(% by weight dry basis)				
N	0.16	0.19	0.10	0.14
P	0.34	0.40	0.51	0.35
K	2.07	3.46	4.49	5.16
Ca	4.83	7.78	7.15	8.01
Mg	1.46	1.55	1.55	1.54
Na	0.05	0.08	0.09	0.11
Cl	0.05	0.02	0.10	0.09
(mg/kg dry weight)				
S	711	1,180	970	760
B	113	179	181	199
Zn	77	248	132	196
Mn	1,360	2,690	2,850	3,010
Fe	46,400	4,280	63,600	45,600
Cu	56	89	92	101
Si	12,700	12,300	18,000	18,300
Total (% dry weight)	49.20	56.28	39.06	40.29
<u>Proximate Analysis</u>				
(% dry weight)				
Ash	44.53	68.24	80.92	80.73
Volatiles	52.60	26.93	38.89	38.99
Fixed Carbon	2.88	4.83	-19.81	-19.72
<u>Higher Heating Value</u>				
(MJ/kg dry weight)	11.0993	8.8986	3.4926	3.6194

Table 3.7.4. Operating conditions, Ponderosa pine slash, 29 April 93.

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

	Test 1	Test 2
Total Fuel Consumption (kg w.b.)	46.4	45.1
Total Ash Recovered (kg w.b.)	1.4	2.6
Ash Fraction (w.b.)	0.03	0.06

	Traverse 1	Traverse 2	Test 1	Test 2
Mean Values				
Air Temperature (°C)	26	30	26	30
Air Relative Humidity (%)	37	23	36	22
Inlet Air Temperature (°C)	27.52	31.44	28.00	31.32
Stack Temperature (°C)	87.18	46.15	55.62	57.88
Impinger Outlet Temperature (°C)	29.24	24.84	30.73	28.14
Stack Gas Velocity (m/s)	2.29	1.67	1.94	1.84
Duration (minutes)	24	48	72	72

Table 3.7.5. Concentrations, Ponderosa pine slash, 29 April 93.

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

<u>Gas and PM Concentrations (less background)</u>	<u>Traverse 1</u>	<u>Traverse 2</u>	<u>Test 1</u>	<u>Test 2</u>
CO (ppmv)	177.66	99.60	115.57	112.63
NO (ppmv)	5.04	0.46	1.93	1.63
NOx (ppmv)	7.14	0.80	2.77	2.36
SO2 (ppmv)	0.14	0.003	0.05	0.05
THC (ppmv as CH4)	33.71	19.14	21.24	21.94
HC (ppmv as CH4 by GC)	11.83	9.90		
CH4 (ppmv by GC)	4.93	4.86		
NMHC (ppmv as CH4)	28.78	14.29		
NMHC (ppmv as CH4 by GC)	6.90	5.05		
CO2 (ppmv)	5,133	1,127	2,274	2,166
Total S (ppmv as SO2)	0.09	0.01	0.04	0.04
PM (mg/cu.m)	26.91	7.06		
PM10 (mg/cu.m)	25.30	6.88		
PM2.5 (mg/cu.m)	22.20	6.42		

Table 3.7.6. Mass balance, Ponderosa pine, 29 April 93.

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Test 1	Test 2
Fuel Moisture Content (% w.b.)	24.5	0.0	24.5	24.5
Fuel Consumption (g w.b.)	41,103	9,336	46,365	45,111
Fuel Consumption (g d.b.)	31,041	9,336	35,015	34,067
Ash (g)	382	2,731	1,381	2,647
Fuel Vaporized (g)	40,721	6,605	44,985	42,464
Average Burning Rate (g/s w.b.)	28.54	3.24	10.73	10.44
Average Burning Rate (g/s d.b.)	21.56	3.24	8.11	7.89
Fuel Vaporization Rate (g/s)	28.28	2.29	10.41	9.83
Stack Gas Density (kg/cu.m)	0.9808	1.1069	1.0750	1.0677
Stack Gas Flow Rate (cu.m/s)	3.40	2.48	2.89	2.74
Stack Gas Mass Flow Rate (kg/s)	3.34	2.74	3.11	2.93
Inlet Air Mass Flow Rate (kg/s)	3.31	2.74	3.10	2.92
Overall Air-Fuel Ratio (w.b.)	115.96	845.24	288.51	279.26
Overall Air-Fuel Ratio (d.b.)	153.55	845.24	382.04	369.79

Table 3.7.7. Emission factors, Ponderosa pine, 29 April 93 (integrated basis).

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Test 1	Test 2
CO	2.610	8.220	4.449	4.236
NO	0.067	0.047	0.068	0.062
NOx (as NO2)	0.141	0.122	0.146	0.141
SO2	0.003	0.001	0.003	0.003
THC (as CH4)	0.291	0.988	0.489	0.517
HC (as CH4 by GC)	0.101	0.462	0.185	0.185
CH4 (by GC)	0.042	0.227	0.085	0.085
NMHC (as CH4)	0.249	0.761	0.404	0.432
NMHC (as CH4 by GC)	0.059	0.235	0.100	0.100
CO2	116.210	210.403	152.105	154.569
Total S (as SO2)	0.002	0.001	0.002	0.002
SO2/Total S	1.44	0.88	1.20	1.35
PM	0.357	0.504	0.391	0.391
PM10	0.335	0.491	0.371	0.371
PM2.5	0.294	0.458	0.332	0.332
MMAD	0.206	0.267	0.220	0.220
σ	10.013	4.474		
<u>Mass Averaged</u>				

Table 3.7.8. Emission factors, Ponderosa pine, 29 April 93 (average basis).

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Test 1	Test 2
CO	2.656	8.135	4.277	4.035
NO	0.081	0.041	0.076	0.063
NOx (as NO2)	0.175	0.108	0.168	0.139
SO2	0.005	0.001	0.004	0.004
THC (as CH4)	0.288	0.893	0.449	0.449
HC (as CH4 by GC)	0.101	0.462	0.185	0.185
CH4 (by GC)	0.042	0.227	0.085	0.085
NMHC (as CH4)	0.246	0.667	0.343	0.343
NMHC (as CH4 by GC)	0.059	0.235	0.100	0.100
CO2	120.616	144.668	132.235	121.908
Total S (as SO2)	0.003	0.001	0.003	0.003
SO2/Total S	1.50	0.49	1.28	1.29
PM	0.357	0.504	0.391	0.391
PM10	0.335	0.491	0.371	0.371
PM2.5	0.294	0.458	0.332	0.332
MMAD	0.206	0.267	0.220	0.220
σ	10.013	4.474		

Mass Averaged

Table 3.7.9. Carbon balance.

Date of Test: Fuel:	29-Apr-93 Ponderosa Pine			
	Traverse 1	Traverse 2	Test 1	Test 2
<u>Carbon Balance</u>				
Dry Fuel Consumption Rate (g/s)	21.56	3.24	8.11	7.89
Ash Generation Rate (g/s)	0.27	0.95	0.32	0.61
Ash Fraction (% dry basis)	1.23	29.26	3.94	7.77
Fuel Carbon Concentration (%)	52.42	81.67	52.42	52.42
Residual Ash Carbon Concentration (%)	0.00	37.34	30.97	37.34
Carbon released to stack (g/s)	11.30	2.29	4.15	3.91
Maximum CO2 emission factor (%)	192.21	259.40	187.73	181.57
Stack Gas Density (kg/cubic meter)	0.98	1.11	1.08	1.07
Average CO2 concentration (ppmv)	5,133	1,127	2,274	2,166
Average CO concentration (ppmv)	177.66	99.60	115.57	112.63
Average THC concentration (ppmv as CH4)	33.71	19.14	21.24	21.94
PM Concentration (mg/cubic meter)	26.91	7.06	10.95	11.24
PM Carbon Concentration (%)	78.55	78.55	78.55	78.55
PM Carbon (mg/cubic meter)	21.14	5.55	8.60	8.83
Stack Gas Temperature (°C)	87.18	46.15	55.62	57.88
Impinger Temperature (°C)	29.24	24.84	30.73	28.14
PM molar concentration (ppm)	43.71	11.30	17.87	18.19
Estimated Average Stack Gas Velocity (m/s)	3.48	2.68	2.59	2.57
Emission Factors (% Average Basis):				
CO2	120.616	144.668	132.235	121.908
CO	2.656	8.135	4.277	4.035
THC (as CH4)	0.288	0.893	0.449	0.449
PM	0.357	0.504	0.391	0.391
Emission Factors (% Integrated Basis):				
CO2	116.210	210.403	152.105	154.569
CO	2.610	8.220	4.449	4.236
THC (as CH4)	0.291	0.988	0.489	0.517
PM	0.357	0.504	0.391	0.391
Closure (% Average Basis)	66	62	75	72
Closure (% Integrated Basis)	63	87	86	90

Table 3.7.10. Nitrogen balance

Date of Test: Fuel:	29-Apr-93 Ponderosa Pine			
	Traverse 1	Traverse 2	Test 1	Test 2
<u>Nitrogen Balance</u>				
Fuel Nitrogen Concentration (% dry weight)	0.30	0.30	0.30	0.30
Ash Nitrogen Concentration (% weight)	0.10	0.14	0.10	0.14
Emission Factors (% Average Basis):				
NOx (as NO2)	0.175	0.108	0.168	0.139
PM	0.357	0.504	0.391	0.391
Emission Factors (% Integrated Basis):				
NOx (as NO2)	0.141	0.122	0.146	0.141
NO3- Concentration of PM (% weight)	0.268	0.268	0.268	0.268
NH4+ Concentration of PM (% weight)	0.093	0.093	0.093	0.093
Nitrogen Concentration of PM (%)	0.133	0.133	0.133	0.133
Fuel Nitrogen (mg/s)	64.68	9.72	24.33	23.67
Ash Nitrogen (mg/s)	0.27	1.33	0.32	0.86
Nitrogen as NOx (mg/s Average Basis)	11.48	1.06	4.15	3.34
Nitrogen as NOx (mg/s Integrated Basis)	9.25	1.20	3.60	3.39
Nitrogen as PM (mg/s Average Basis)	0.10	0.02	0.04	0.04
Nitrogen as NOx+PM (mg/s Average Basis)	11.59	1.09	4.19	3.38
Nitrogen as NOx+PM (mg/s Integrated Basis)	9.35	1.22	3.65	3.43
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.179	0.112	0.172	0.143
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.145	0.126	0.150	0.145
Ash Nitrogen/Fuel Nitrogen	0.004	0.137	0.013	0.036
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.183	0.248	0.185	0.179
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.149	0.263	0.163	0.181

Table 3.7.11. Sulfur balance.

Date of Test:	29-Apr-93			
Fuel:	Ponderosa Pine			
	Traverse 1	Traverse 2	Test 1	Test 2
Sulfur Balance				
Fuel Sulfur Concentration (mg/kg dry weight)	203	203	203	203
Ash Sulfur Concentration (mg/kg weight)	970	760	970	760
Emission Factors (% Average Basis)				
SO ₂	0.005	0.001	0.004	0.004
PM	0.357	0.504	0.391	0.391
Emission Factors (% Integrated Basis)				
SO ₂	0.003	0.001	0.003	0.003
Sulfur Concentration of PM (% weight)				
Fuel Sulfur (mg/s)	4.38	0.66	1.65	1.60
Ash Sulfur (mg/s)	0.26	0.72	0.31	0.47
Sulfur as SO ₂ (mg/s Average Basis)	0.54	0.02	0.16	0.16
Sulfur as SO ₂ (mg/s Integrated Basis)	0.32	0.02	0.12	0.12
Sulfur as PM (mg/s Average Basis)	0.98	0.21	0.40	0.39
Sulfur as SO ₂ +PM (mg/s Average Basis)	1.52	0.22	0.56	0.55
Sulfur as SO ₂ +PM (mg/s Integrated Basis)	1.30	0.22	0.52	0.51
SO ₂ +PM Sulfur/Fuel Sulfur (Average Basis)	0.346	0.340	0.343	0.343
SO ₂ +PM Sulfur/Fuel Sulfur (Integrated Basis)	0.297	0.340	0.318	0.318
Ash Sulfur/Fuel Sulfur	0.059	1.095	0.188	0.291
Closure (% Average Basis)	41	144	53	63
Closure (% Integrated Basis)	36	144	51	61

Table 3.7.12. Water balance.

Estimated Stack Humidity			
Fuel	Ponderosa Pine		
Configuration	Pile		
Date of Test	29-Apr-93		
	Traverse 1	Traverse 2	
Ambient Air Temperature (°C)	26	30	
Ambient Air Relative Humidity (%)	37	23	
Air Temperature (K)	299	303	
Saturation Pressure (Pa)	3,363	4,246	
Vapor Pressure (Pa)	1,244	977	
Air Dew Point Temperature (°C)	10.2	6.7	
Ambient Volume Fraction Water Vapor	0.0123	0.0096	
Ambient Mass Fraction Water Vapor	0.0076	0.0060	
Fuel Burning Rate (g/s wet basis)	28.54	3.24	
Fuel Moisture Content (%)	24.5	0.0	
Ash Fraction (wet basis)	0.03	0.29	
Fuel Hydrogen Content* (%)	6.20	0.27	
Ash Hydrogen Content† (%)	0.00	0.96	
Moisture Evaporated (g/s)	6.99	0.00	
Water of Combustion (g/s)	12.02	0.00	
Total Fuel Water Added (g/s)	19.02	0.00	
Inlet Air Mass Flowrate (g/s)	3,310	2,740	
Inlet Air Water Vapor Flowrate (g/s)	25	16	
Total Stack Water Vapor Flowrate (g/s)	44	16	
Stack Gas Mass Flowrate (g/s)	3,338	2,742	
Mass Fraction Water Vapor in Stack	0.0133	0.0060	
Volume Fraction Water Vapor in Stack	0.0214	0.0096	
Stack Vapor Pressure (Pa)	2,164	976	
Stack Temperature (°C)	87	46	
Stack Temperature (K)	360	319	
Stack Saturation Pressure (Pa)	62,991	10,175	
Stack Relative Humidity (%)	3	10	
Stack Dew Point Temperature (°C)	18.8	6.6	
Impinger Outlet Temperature (°C)	29.2	24.8	
Volume Stack Gas Sampled for PM (L)	275	382	
Estimated Impinger/Desiccant Weight Gain (g)	4.3	2.7	
Totals:			
	Estimated	Measured	
Total Impinger/Desiccant Weight Gain (g)	7.0	8.5	
Estimated/Measured Weight Gain	0.82		

*assumes no hydrogen lost from fuel during traverse 2

†assumes complete fuel conversion during traverse 1

Table 3.7.13. Power balance.

Date of Test: Fuel:	29-Apr-93 Ponderosa Pine			
	Traverse 1	Traverse 2	Test 1	Test 2
<u>Power Balance</u>				
Fuel Heating Value* (MJ/kg dry weight)	20.67	26.79	20.67	20.67
Ash Heating Value (MJ/kg dry weight)	0	8.8986	11.0993	8.8986
Average Energy Release Rate (kW)	445.6	78.4	164.1	157.6
Products of Incomplete Combustion (kW)				
CO	5.8	2.7	3.5	3.2
THC (as CH4)	3.4	1.6	2.0	2.0
PM	2.0	0.4	0.8	0.8
Heat Release Rate (kW)	434.4	73.7	157.7	151.6
Stack Gas Flow (kg/s)	3.34	2.74	3.10	2.92
Stack Gas Temperature (°C)	87.18	46.15	55.62	57.88
Ambient Temperature (°C)	26	30	26	30
Sensible Power at Top of Stack (kW)	205.6	44.5	92.4	81.9
<u>Tunnel Dissipation (kW)</u>	<u>228.9</u>	<u>29.2</u>	<u>65.4</u>	<u>69.8</u>

*Estimated for Traverse 2.

Table 3.7.14. Operating conditions*, Ponderosa pine slash, 29 April 93.

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

	Test 1	Test 2		
Total Fuel Consumption (kg w.b.)	46.4	45.1		
Total Ash Recovered (kg w.b.)	1.4	2.6		
Ash Fraction (w.b.)	0.03	0.06		
	Test 1	Test 2	Test 1	Test 2
Mean Values				
Air Temperature (°C)	26	30	26	30
Air Relative Humidity (%)	37	23	36	22
Inlet Air Temperature (°C)	27.52	31.44	28.00	31.32
Stack Temperature (°C)	87.18	46.15	55.62	57.88
Impinger Outlet Temperature (°C)	29.24	24.84	30.73	28.14
Stack Gas Velocity* (m/s)	3.48	2.68	2.59	2.57
Duration (minutes)	24	48	72	72

*stack gas velocity from carbon balance.

Table 3.7.15. Mass balance*, Ponderosa pine, 29 April 93.

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Test 1	Test 2
Fuel Moisture Content (% w.b.)	24.5	0.0	24.5	24.5
Fuel Consumption (g w.b.)	41,103	9,336	46,365	45,111
Fuel Consumption (g d.b.)	31,041	9,336	35,015	34,067
Ash (g)	382	2,731	1,381	2,647
Fuel Vaporized (g)	40,721	6,605	44,985	42,464
Average Burning Rate (g/s w.b.)	28.54	3.24	10.73	10.44
Average Burning Rate (g/s d.b.)	21.56	3.24	8.11	7.89
Fuel Vaporization Rate (g/s)	28.28	2.29	10.41	9.83
Stack Gas Density (kg/cu.m)	0.9808	1.1069	1.0750	1.0677
Stack Gas Flow Rate (cu.m/s)	5.17	3.98	3.85	3.82
Stack Gas Mass Flow Rate (kg/s)	5.07	4.41	4.14	4.08
Inlet Air Mass Flow Rate (kg/s)	5.04	4.41	4.13	4.07
Overall Air-Fuel Ratio (w.b.)	176.74	1359.43	384.61	389.61
Overall Air-Fuel Ratio (d.b.)	234.04	1359.43	509.29	515.91

*stack gas velocity from carbon balance.

Table 3.7.16. Emission factors*, Ponderosa pine, 29 April 93 (integrated basis).

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Test 1	Test 2
CO	3.871	4.594	4.353	4.214
NO	0.154	0.030	0.141	0.120
NOx (as NO2)	0.341	0.076	0.312	0.254
SO2	0.010	0.001	0.009	0.009
THC (as CH4)	0.441	0.567	0.505	0.504
HC (as CH4 by GC)	0.154	0.743	0.290	0.290
CH4 (by GC)	0.064	0.364	0.133	0.133
NMHC (as CH4)	0.377	0.202	0.371	0.370
NMHC (as CH4 by GC)	0.090	0.379	0.156	0.156
CO2	214.764	123.948	218.670	208.573
Total S (as SO2)	0.007	0.001	0.008	0.009
SO2/Total S	1.29	1.02	1.17	1.11
PM	0.542	0.810	0.604	0.604
PM10	0.509	0.789	0.574	0.574
PM2.5	0.447	0.737	0.514	0.514
MMAD	0.206	0.267	0.220	0.220
σ	10.013	4.474		

Mass Averaged

*stack gas velocity from carbon balance.

Table 3.7.17. Emission factors*, Ponderosa pine, 29 April 93 (average basis).

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Test 1	Test 2
CO	4.037	13.080	5.697	5.624
NO	0.123	0.065	0.102	0.087
NOx (as NO2)	0.267	0.173	0.224	0.194
SO2	0.007	0.001	0.005	0.005
THC (as CH4)	0.438	1.436	0.598	0.626
HC (as CH4 by GC)	0.154	0.743	0.290	0.290
CH4 (by GC)	0.064	0.364	0.133	0.133
NMHC (as CH4)	0.374	1.072	0.535	0.535
NMHC (as CH4 by GC)	0.090	0.379	0.156	0.156
CO2	183.304	232.602	176.133	169.919
Total S (as SO2)	0.005	0.002	0.004	0.004
SO2/Total S	1.50	0.49	1.28	1.29
PM	0.542	0.810	0.604	0.604
PM10	0.509	0.789	0.574	0.574
PM2.5	0.447	0.737	0.514	0.514
MMAD	0.206	0.267	0.220	0.220
σ	10.013	4.474		

Mass Averaged

*stack gas velocity from carbon balance.

Table 3.7.18. Carbon balance, Ponderosa pine slash, closure forced.

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
 Configuration: Pile

Carbon Balance

	Traverse 1	Traverse 2	Test 1	Test 2
Dry Fuel Consumption Rate (g/s)	21.56	3.24	8.11	7.89
Ash Fraction (% dry basis)	1.23	29.26	3.94	7.77
Ash Generation Rate (g/s)	0.27	0.95	0.32	0.61
Fuel Carbon Concentration* (%)	52.42	81.67	52.42	52.42
Residual Ash Carbon Concentration (%)	0.00	37.34	30.97	37.34
Carbon Released to Stack (g/s)	11.30	2.29	4.15	3.90
Maximum CO2 emission factor (%)	192.19	259.40	187.72	181.56
Average CO2 concentration (ppmv)	5,133.37	1,127.13	2,273.68	2,165.52
Average CO concentration (ppmv)	177.66	99.60	115.57	112.63
Average THC concentration (ppmv)	33.71	19.14	21.24	21.94
PM concentration (mg/cubic meter)	26.91	7.06	12.71	12.47
PM Carbon concentration (%)	78.55	78.55	78.55	78.55
PM Carbon (mg/cubic meter)	21.14	5.55	9.99	9.79
PM Carbon molar concentration (ppm)	43.70	11.30	20.75	20.17
Estimated Average Stack Gas Velocity (m/s)	3.48	2.68	2.58	2.56
Closure* (% , Average Basis)	100	100	100	100
Closure (% , Integrated Basis)	116	52	122	120

*Computed for traverse 2.

*forced by stack gas velocity

Table 3.7.19. Mass concentrations (%) from DRI filter samples

Date	29-Apr-93		29-Apr-93		
Fuel	Ponderosa Pine Slash		Ponderosa Pine Slash		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT057		ABTT058		
Quartz Filter ID	ABTQ057		ABTQ058		
Teflon Field Sample Flag					
Quartz field sample field					
Teflon mass sample flag					
Quartz mass sample flag					
Anions sample flag					
Ammonium analysis flag					
Sodium ion analysis flag					
Magnesium ion analysis flag					
Potassium ion analysis flag					
Carbon analysis flag					
XRF analysis flag					
	\pm Uncertainty		\pm Uncertainty		
Teflon sample volume (m ³)	0.22	0.01	0.22	0.01	
Quartz sample volume (m ³)	0.22	0.01	0.22	0.01	
Teflon mass concentration ($\mu\text{g}/\text{m}^3$)	14,849	746	14,867	747	
	Concentration (%)	\pm Uncertainty	Concentration (%)	\pm Uncertainty	PM2.5/PM10
Cl-	0.5948	0.0522	0.5098	0.0455	1.17
NO3-	0.3012	0.0305	0.2675	0.0289	1.13
SO4=	2.7551	0.2036	2.4462	0.1809	1.13
NH4+	0.0928	0.0228	0.0934	0.0228	0.99
Na+	0.1516	0.0160	0.1549	0.0162	0.98
K+	4.8659	0.3663	4.3813	0.3299	1.11
C(org)	48.2254	4.6356	52.0690	5.0021	0.93
C(oh)	42.4954	6.4359	41.2519	6.2495	1.03
C(e)	28.2793	2.6743	26.4764	2.5036	1.07
C(eht)	0.4016	0.2488	1.9099	1.1656	0.21
C	76.5047		78.5454		0.97
Al	0.0234	0.0254	0.0429	0.0095	0.55
Si	0.0954	0.0206	0.1150	0.0205	0.83
P	0.0102	0.0386	0.0211	0.0344	0.48
S	1.4378	0.1022	1.2695	0.0902	1.13
Cl	0.6376	0.0495	0.5856	0.0454	1.09
K	5.7326	0.4066	5.1123	0.3626	1.12
Ca	0.0328	0.0825	0.2315	0.0298	0.14
Ti	0.0000	0.0207	0.0000	0.0216	
V	0.0000	0.0090	0.0000	0.0127	
Cr	0.0000	0.0020	0.0000	0.0036	
Mn	0.0026	0.0010	0.0061	0.0011	0.43
Fe	0.0033	0.0036	0.0336	0.0044	0.10
Co	0.0000	0.0009	0.0000	0.0011	
Ni	0.0000	0.0010	0.0000	0.0010	
Cu	0.0047	0.0008	0.0038	0.0007	1.24
Zn	0.3117	0.0221	0.2842	0.0202	1.10
Ga	0.0000	0.0019	0.0000	0.0018	
As	0.0000	0.0023	0.0000	0.0024	
Se	0.0000	0.0011	0.0000	0.0011	
Br	0.0035	0.0007	0.0033	0.0007	1.06
Rb	0.0233	0.0018	0.0198	0.0016	1.18
Sr	0.0002	0.0010	0.0011	0.0007	0.18
Y	0.0000	0.0017	0.0002	0.0015	0.00
Zr	0.0000	0.0015	0.0000	0.0014	
Mo	0.0000	0.0026	0.0000	0.0025	
Pd	0.0000	0.0088	0.0000	0.0089	
Ag	0.0001	0.0102	0.0000	0.0101	
Cd	0.0000	0.0110	0.0000	0.0108	
In	0.0020	0.0123	0.0012	0.0122	1.67
Sn	0.0057	0.0155	0.0023	0.0152	2.48
Sb	0.0026	0.0178	0.0000	0.0174	
Ba	0.0000	0.0623	0.0000	0.0612	
La	0.0008	0.0837	0.0361	0.0821	0.02
Au	0.0000	0.0113	0.0000	0.0100	
Hg	0.0000	0.0024	0.0000	0.0022	
Tl	0.0001	0.0023	0.0004	0.0022	0.25
Pb	0.0046	0.0020	0.0068	0.0021	0.68
U	0.0000	0.0037	0.0000	0.0033	
Sum of measured species	85.3852	5.3706	86.8378	5.6078	0.98

Table 3.7.20. Element ratios from DRI filter samples.

Date Fuel Configuration	29-Apr-93 Ponderosa Pine Slash Pile		29-Apr-93 Ponderosa Pine Slash Pile	
	PM2.5	PM10	PM2.5/PM10	
Size Fraction				
Teflon Filter ID	ABTT057	ABTT058		
Quartz Filter ID	ABTQ057	ABTQ058		
Cl-/Cl	0.93	0.87		1.07
K+/K	0.85	0.86		0.99
Sulfate S/Total S	0.64	0.64		0.99
C(org)/C	0.63	0.66		0.95
Cl/K	0.11	0.11		0.97
Cl-/K+	0.12	0.12		1.05
Cl-/Na+	3.92	3.29		1.19
S/K	0.25	0.25		1.01
S/Na+	9.48	8.20		1.16
Al/Si	0.25	0.37		0.66

Table 3.7.21. Emission factors (mg/kg) from DRI filter samples.

Date	29-Apr-93		29-Apr-93		
Fuel	Ponderosa Pine Slash		Ponderosa Pine Slash		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT057		ABTT058		
Quartz Filter ID	ABTQ057		ABTQ058		
Start Time	10:36				
Stop Time	10:58				
Start Time					
End Time					
Elapsed Time (minutes)	22				Traverse 1
PM (mg/m ³ by total filter)					26.910
PM10 (by total filter/impactor)					25.300
PM2.5 (by total filter/impactor)					22.200
PM emission factor (%)					0.542
PM10 emission factor (%)					0.509
PM2.5 emission factor (%)					0.447
	<u>±Uncertainty</u>		<u>±Uncertainty</u>		
Teflon sample volume (m ³)	0.22	0.01	0.22	0.01	
Quartz sample volume (m ³)	0.22	0.01	0.22	0.01	
Teflon mass concentration (mg/m ³)	14.849	0.746	14.867	0.747	
Teflon mass/Total mass	0.669		0.588		
	<u>Emission (mg/kg)</u>	<u>±Uncertainty</u>	<u>Emission (mg/kg)</u>	<u>±Uncertainty</u>	<u>PM2.5/PM10</u>
Cl-	31.1384	2.3333	29.8819	2.3160	1.04
NO3-	15.7681	1.3634	15.6795	1.4710	1.01
SO4=	144.2322	9.1009	143.3841	9.2078	1.01
NH4+	4.8582	1.0192	5.4746	1.1605	0.89
Na+	7.9364	0.7152	9.0795	0.8246	0.87
K+	254.7347	16.3736	256.8100	16.7919	0.99
C(org)	2524.6476	207.2113	3052.0258	254.6069	0.83
C(ohf)	2224.6764	287.6847	2417.9812	318.0996	0.92
C(e)	1480.4494	119.5412	1551.9149	127.4332	0.95
C(eht)	21.0242	11.1214	111.9488	59.3290	0.19
C	4005.0970	0.0000	4603.9407	0.0000	0.87
Al	1.2250	1.1354	2.5146	0.4836	0.49
Si	4.9943	0.9208	6.7407	1.0435	0.74
P	0.5340	1.7254	1.2368	1.7510	0.43
S	75.2703	4.5683	74.4118	4.5912	1.01
Cl	33.3790	2.2127	34.3250	2.3109	0.97
K	300.1073	18.1750	299.6576	18.4563	1.00
Ca	1.7171	3.6878	13.5694	1.5168	0.13
Ti	0.0000	0.9253	0.0000	1.0994	
V	0.0000	0.4023	0.0000	0.6464	
Cr	0.0000	0.0894	0.0000	0.1832	
Mn	0.1361	0.0447	0.3576	0.0560	0.38
Fe	0.1728	0.1609	1.9695	0.2240	0.09
Co	0.0000	0.0402	0.0000	0.0560	
Ni	0.0000	0.0447	0.0000	0.0509	
Cu	0.2460	0.0358	0.2227	0.0356	1.10
Zn	16.3178	0.9879	16.6584	1.0282	0.98
Ga	0.0000	0.0849	0.0000	0.0916	
As	0.0000	0.1028	0.0000	0.1222	
Se	0.0000	0.0492	0.0000	0.0560	
Br	0.1832	0.0313	0.1934	0.0356	0.95
Rb	1.2198	0.0805	1.1606	0.0814	1.05
Sr	0.0105	0.0447	0.0645	0.0356	0.16
Y	0.0000	0.0760	0.0117	0.0764	0.00
Zr	0.0000	0.0671	0.0000	0.0713	
Mo	0.0000	0.1162	0.0000	0.1273	
Pd	0.0000	0.3934	0.0000	0.4530	
Ag	0.0052	0.4559	0.0000	0.5141	
Cd	0.0000	0.4917	0.0000	0.5497	
In	0.1047	0.5498	0.0703	0.6210	1.49
Sn	0.2984	0.6929	0.1348	0.7737	2.21
Sb	0.1361	0.7957	0.0000	0.8857	
Ba	0.0000	2.7848	0.0000	3.1151	
La	0.0419	3.7414	2.1160	4.1789	0.02
Au	0.0000	0.5051	0.0000	0.5090	
Hg	0.0000	0.1073	0.0000	0.1120	
Tl	0.0052	0.1028	0.0234	0.1120	0.22
Pb	0.2408	0.0894	0.3986	0.1069	0.60
U	0.0000	0.1654	0.0000	0.1680	
Sum of measured species	4.470	240	5.090	251	0.88

Table 3.7.22. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Ponderosa Pine
 Date: 29-Apr-92
 Time: 10:36
 Filter ID: BJ-01

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	1,475,015	84,866	5,002
Na	123,670	15,745	15,441
Mg	46,066	6,506	6,119
Al	54,162	5,749	4,643
Si	34,433	3,794	3,927
P			4,072
S	218,130	12,218	4,407
Cl	259,567	14,552	4,681
K	1,371,387	69,574	2,946
Ca	223,883	20,091	2,126
Ti	1,363	656	1,805
V			1,569
Cr			1,289
Mn	6,106	884	1,189
Fe	24,608	1,809	1,048
Ni			755
Cu			768
Zn	82,246	4,318	699
As			669
Pb			1,817
Se			726
Br	1,808	419	775
Rb	4,887	958	1,208
Sr			1,269
Zr			2,047

Table 3.7.23. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Ponderosa Pine
 Date: 29-Apr-92
 Time: 10:36
 Filter ID: BJ-01

Fuel rate (g/s) 21.56
 Stack gas flow rate (m³/s) 5.17
 Stack Temperature (°C) 87.18
 Ambient Temperature (°C) 26.00

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	293.6	16.9
Na	24.6	3.1
Mg	9.2	1.3
Al	10.8	1.1
Si	6.9	0.8
P		
S	43.4	2.4
Cl	51.7	2.9
K	273.0	13.9
Ca	44.6	4.0
Ti	0.3	0.1
V		
Cr		
Mn	1.2	0.2
Fe	4.9	0.4
Ni		
Cu		
Zn	16.4	0.9
As		
Pb		
Se		
Br	0.4	0.1
Rb	1.0	0.2
Sr		
Zr		

Table 3.7.24. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Ponderosa Pine
 Date: 29-Apr-92
 Time: 11:06
 Filter ID: BJ-02

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H			
Na			13,772
Mg			5,300
Al	29,571	5,373	3,942
Si	20,918	2,827	3,223
P			3,213
S	28,956	2,879	3,352
Cl	77,908	5,358	3,423
K	263,582	14,083	2,132
Ca	51,229	5,291	1,570
Ti	1,788	598	1,452
V			1,265
Cr	2,063	641	1,039
Mn	1,674	598	959
Fe			
Ni			
Cu			
Zn			
As			
Pb			
Se			
Br			
Rb			
Sr			
Zr			

Table 3.7.25. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Ponderosa Pine
 Date: 29-Apr-92
 Time: 11:06
 Filter ID: BJ-02

Fuel rate (g/s) 3.24
 Stack gas flow rate (m³/s) 3.98
 Stack Temperature (°C) 46.15
 Ambient Temperature (°C) 30.00

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H		
Na		
Mg		
Al	34.5	6.3
Si	24.4	3.3
P		
S	33.8	3.4
Cl	90.9	6.2
K	307.4	16.4
Ca	59.7	6.2
Ti	2.1	0.7
V		
Cr	2.4	0.7
Mn	2.0	0.7
Fe		
Ni		
Cu		
Zn		
As		
Pb		
Se		
Br		
Rb		
Sr		
Zr		

Table 3.7.26.
VOC concentrations (ppbv)

Date	29-Apr-93	29-Apr-93
Fuel	Ponderosa Pine	Ponderosa Pine
Traverse	Traverse 1	Traverse 2
Acetic acid	303.7	319
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)	270.3	166.1
Benzene	430.4	277.3
Dimethylbutane		
Hexane	2263	221
Phenol	170.6	148.8
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	242.3	212.3
Benzonitrile		
Benzaldehyde		
Methylphenol (hydroxy toluene)		172.9
Styrene	204.9	122.4
Xylene	39.3	26.1
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		270
Naphthalene	81.5	
C10H12		
Alpha-pinene		
Camphene		
Δ^3 -Carene	263.6	
Limonene	234.9	117.2
No match r.t. (6.7)		
No match r.t. (8.51)		
No match r.t. (8.71)		
No match r.t. (8.73)		
No match r.t.(6.4)		
No match r.t.(8.5)		

Table 3.7.27.

VOC emission factors (mg/kg)

Date	29-Apr-93	29-Apr-93
Fuel	Ponderosa Pine	Ponderosa Pine
Traverse	Traverse 1	Traverse 2
Fuel Consumption Rate (g/s d.b)	21.56	3.24
Stack Gas Mass Flow Rate* (kg/s)	5.07	4.41
Acetic acid	148	899
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)	211	749
Benzene	273	1,017
Dimethylbutane		
Hexane	1,581	894
Phenol	130	657
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	181	918
Benzonitrile		
Benzaldehyde		
Methylphenol (hydroxy toluene)		878
Styrene	173	598
Xylene	34	130
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		1,751
Naphthalene	85	
Unknown		
Alpha-pinene		
Camphene		
Δ 3-Carene	291	
Limonene	260	749

*uses stack gas flow rate from carbon balance

Table 3.7.28. PAH emission factors, Ponderosa pine slash, 29 April 1993, measured stack gas velocity (zero indicates not detected).

	Traverse 1 Filter	Traverse 2 Filter	Trap	Traverse 1 Sorbent	Traverse 2 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 2	Total Mass Average
µg/kg dry fuel									
Naphthalene	46	14	1	5,799	27,162	26	5,872	27,203	10,804
2-Methyl-naphthalene	10	4	0	847	3,364	8	865	3,376	1,446
Acenaphthylene	3	1	0	506	2,192	0	510	2,194	899
Acenaphthene	0	0	0	805	2,497	0	805	2,497	1,196
Fluorene	2	1	0	280	947	0	281	948	435
Phenanthrene	59	75	0	1,202	2,899	10	1,272	2,984	1,668
Anthracene	11	20	0	201	459	2	214	481	276
Fluoranthene	247	188	2	306	1,706	0	555	1,894	864
Pyrene	187	150	0	217	1,454	0	403	1,604	681
Benz[a]-anthracene	43	38	1	18	78	0	61	114	74
Chrysene	34	54	0	18	50	0	53	105	65
Benzo[b]-fluoranthene	25	0	0	6	0	0	31	0	24
Benzo[k]-fluoranthene	15	0	0	19	0	0	33	0	25
Benzo[a]pyrene	10	0	0	6	0	0	16	0	12
Benzo[e]pyrene	6	0	0	12	8	0	17	8	15
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	0	0	0	0	0	0	0	0	0
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	698	541	4	10,242	42,818	46	10,988	43,409	18,485

Table 3.7.29. PAH emission factors, Ponderosa pine slash, 29 April 1993, stack gas velocity from carbon balance.

	Traverse 1 Filter	Traverse 2 Filter	Trap	Traverse 1 Sorbent	Traverse 2 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 2	Total Mass Average
	µg/kg dry fuel								
Naphthalene	70	22	1	8,818	43,591	42	8,931	43,656	16,960
2-Methyl-naphthalene	16	6	0	1,288	5,399	12	1,316	5,418	2,265
Acenaphthylene	4	2	0	770	3,519	1	775	3,521	1,410
Acenaphthene	0	0	0	1,224	4,007	0	1,224	4,007	1,868
Fluorene	2	1	0	425	1,520	0	428	1,521	680
Phenanthrene	90	120	0	1,828	4,653	16	1,934	4,789	2,594
Anthracene	16	32	0	306	737	3	325	772	429
Fluoranthene	375	299	3	465	2,737	0	843	3,039	1,351
Pyrene	284	240	0	329	2,334	0	613	2,574	1,066
Benz[a]-anthracene	65	57	1	27	126	0	93	184	114
Chrysene	52	87	1	28	80	0	80	168	100
Benzo[b]-fluoranthene	38	0	0	9	0	0	48	0	37
Benzo[k]-fluoranthene	22	0	0	28	0	0	50	0	39
Benzo[a]pyrene	15	0	0	9	0	0	24	0	19
Benzo[e]pyrene	9	0	0	18	13	0	27	13	24
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	0	0	0	0	0	0	0	0	0
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	1,058	868	6	15,574	68,716	73	16,711	69,663	28,955

Figure 3.7.1. Air temperature and relative humidity from CIMIS station.

Fuel: Ponderosa Pine

Date of Test: 29-Apr-93

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

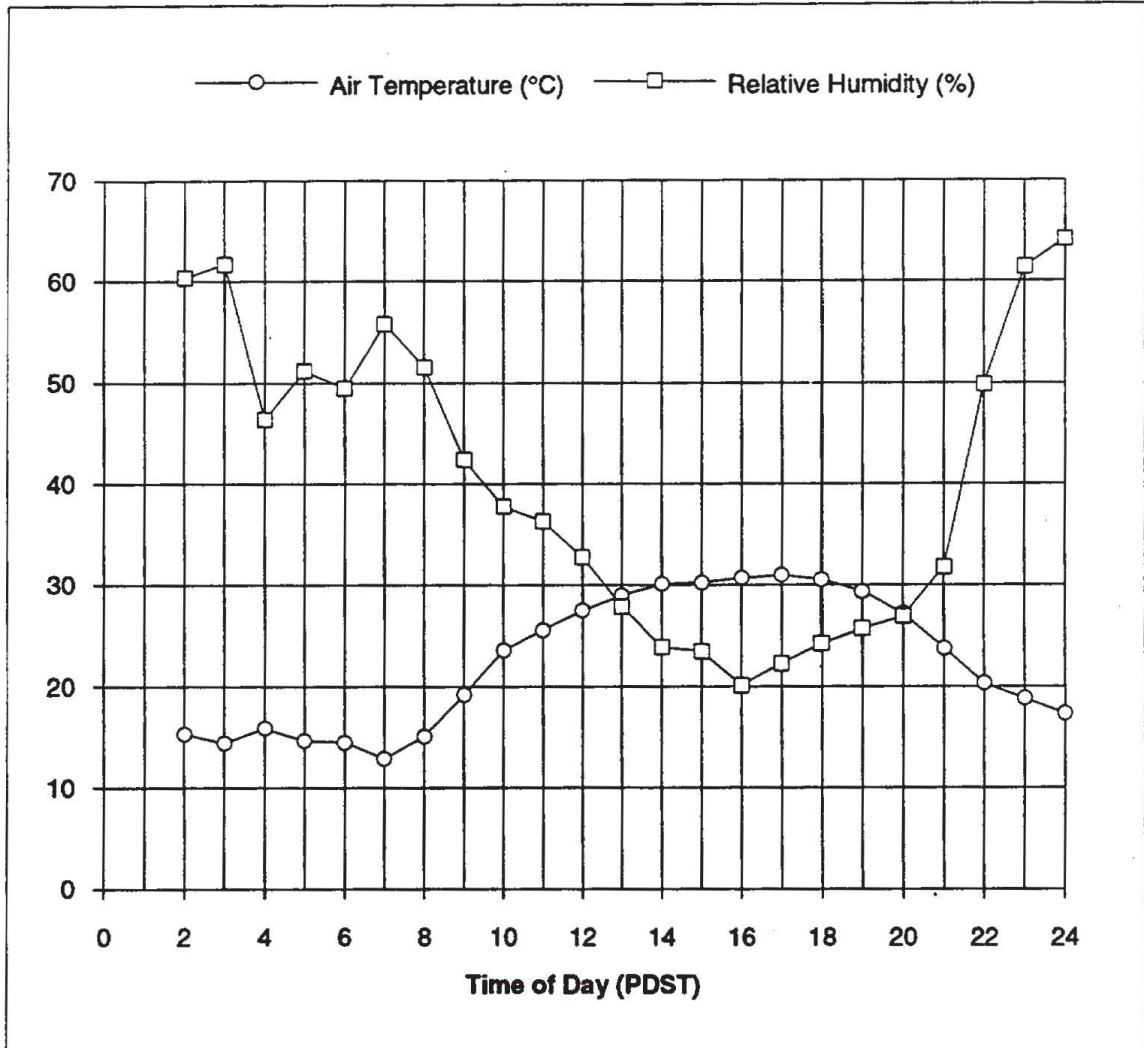


Figure 3.7.3. Wind direction and solar radiation from CIMIS station.

Fuel: Ponderosa Pine

Date of Test: 29-Apr-93

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

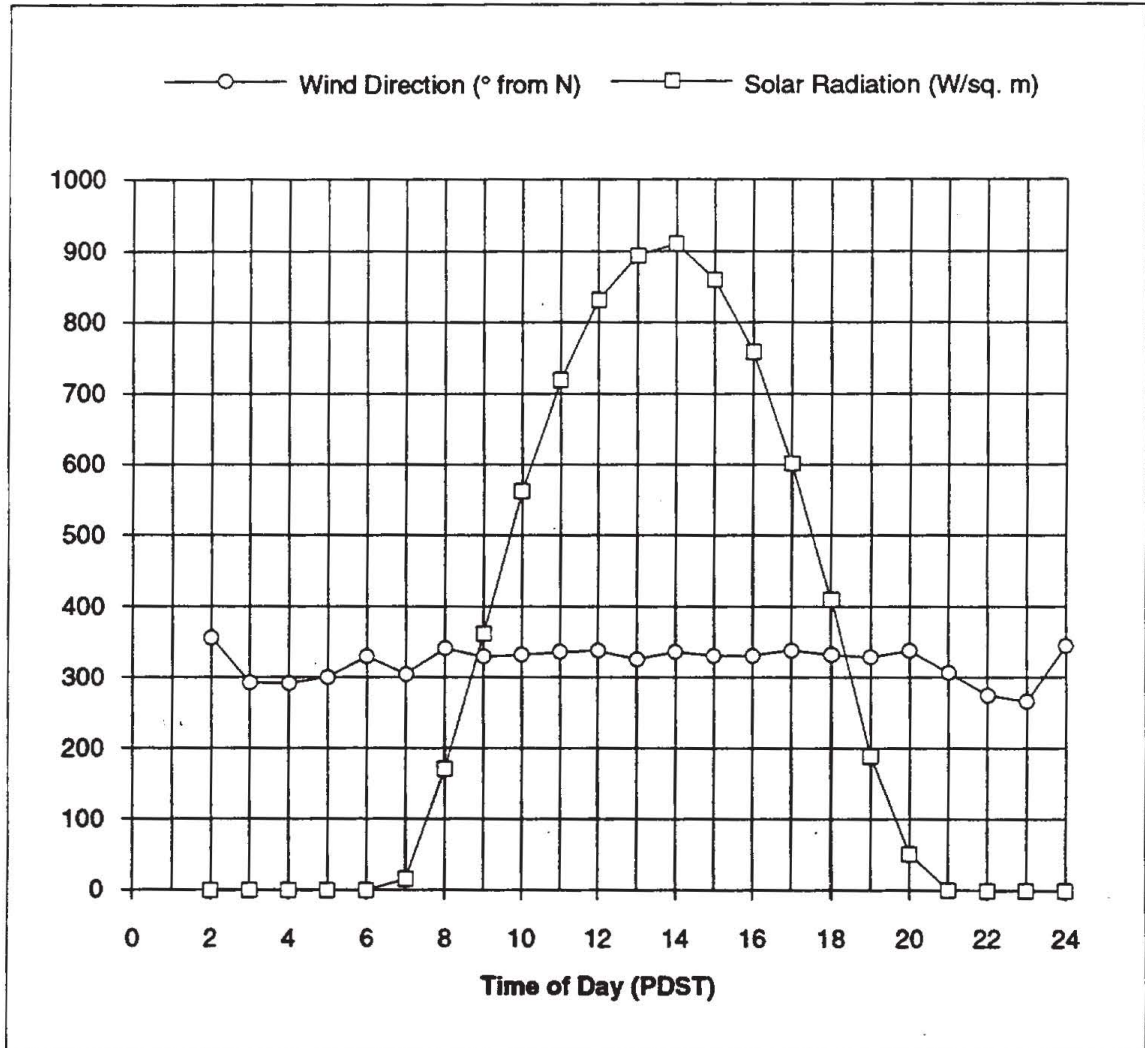


Figure 3.7.4. Inlet air, stack gas, and impinger temperatures, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date

29-Apr-93

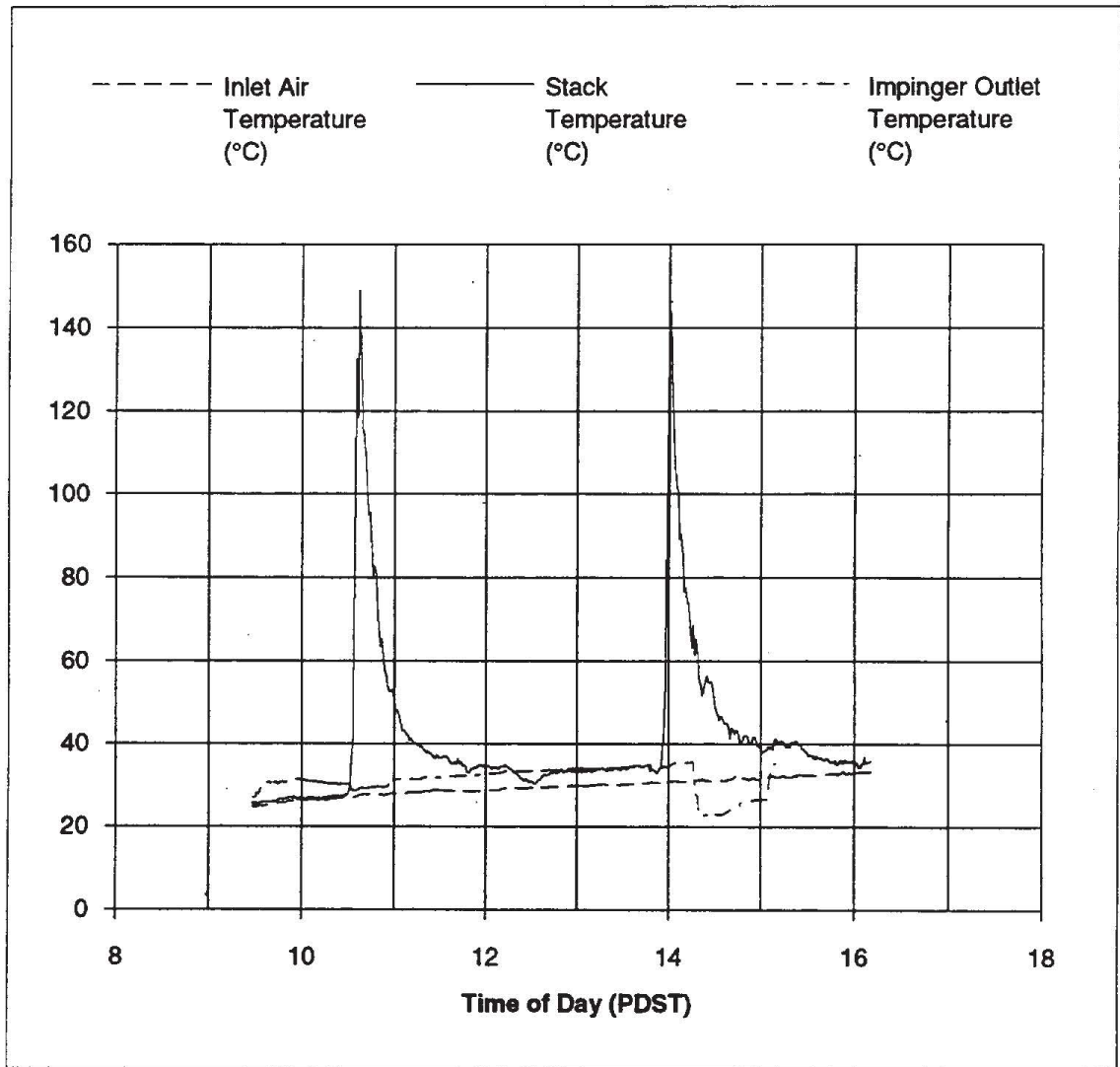


Figure 3.7.5. Stack gas velocity, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr-93

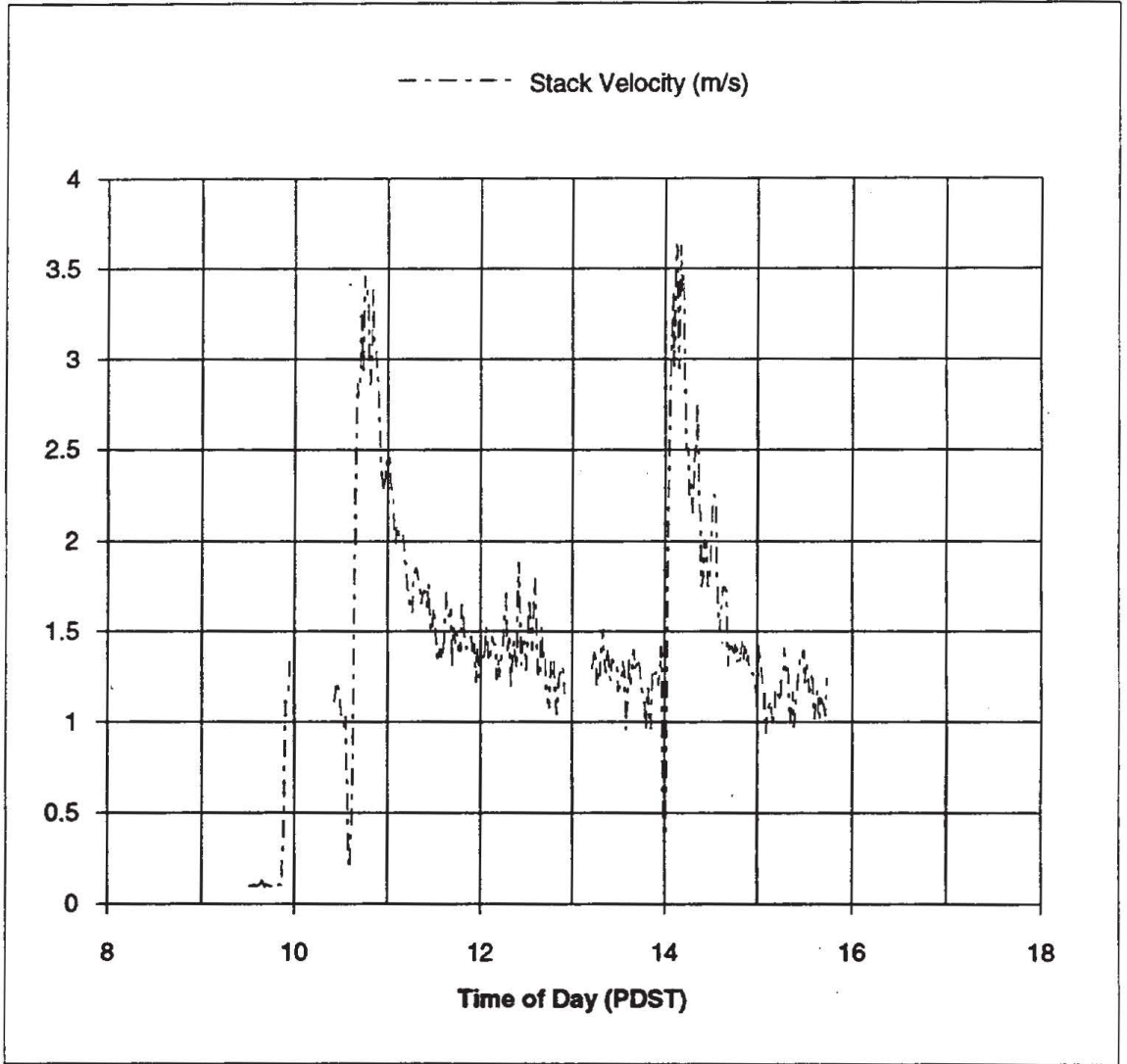


Figure 3.7.6. CO concentration in stack gas, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr-93

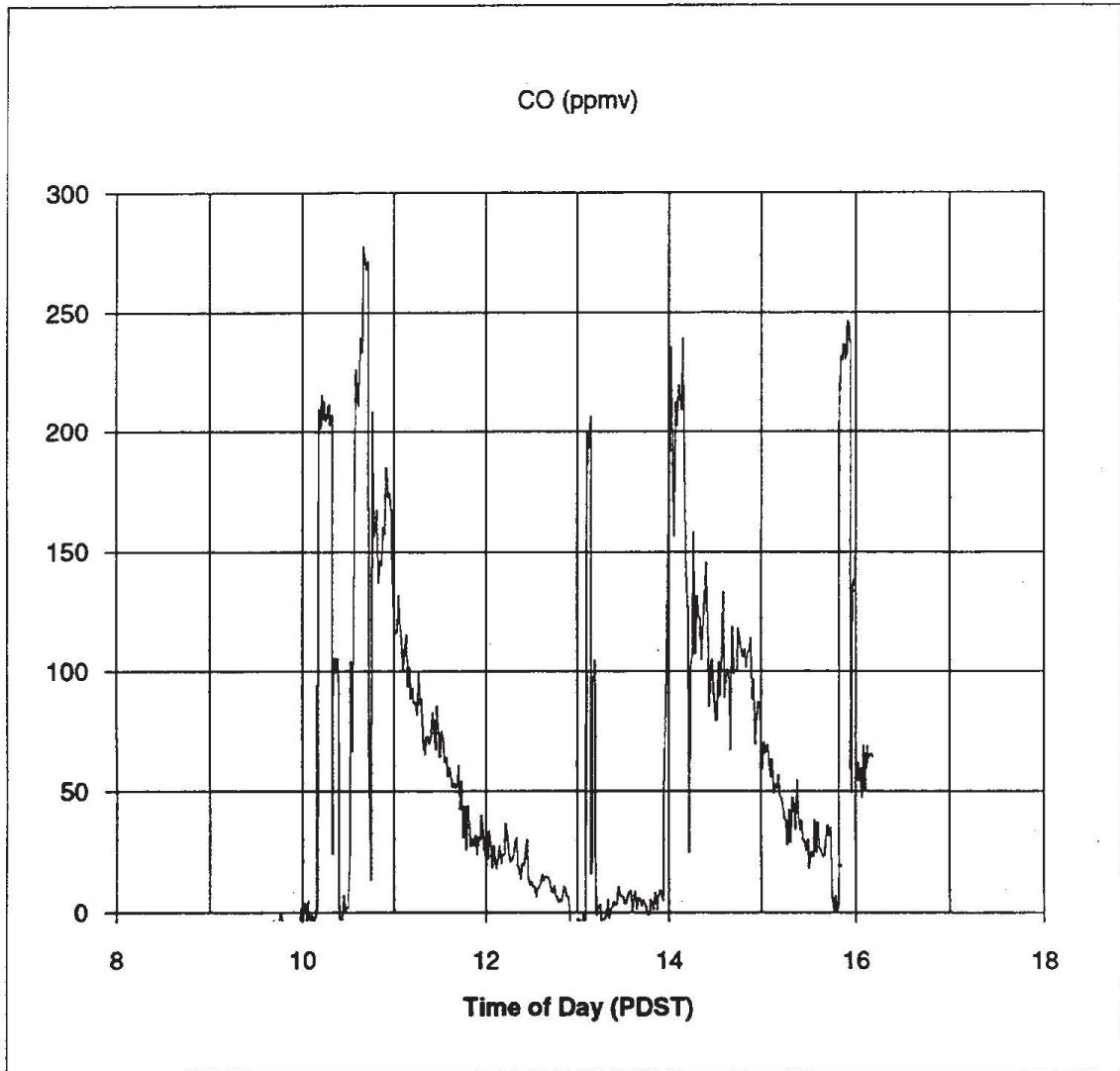


Figure 3.7.7. NO and NOx concentrations in stack gas, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr-93

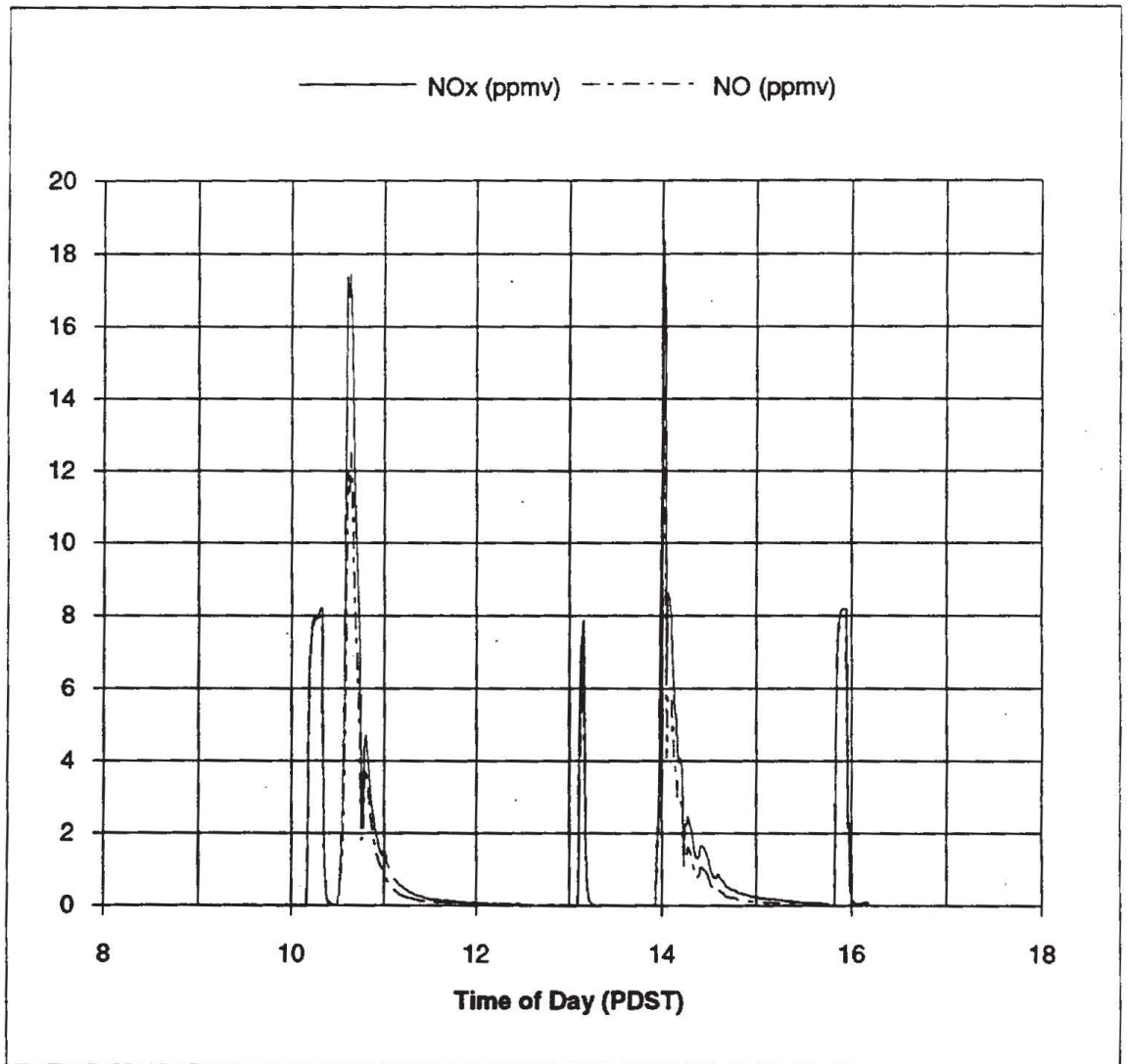


Figure 3.7.8. SO2 concentration in stack gas, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr-93

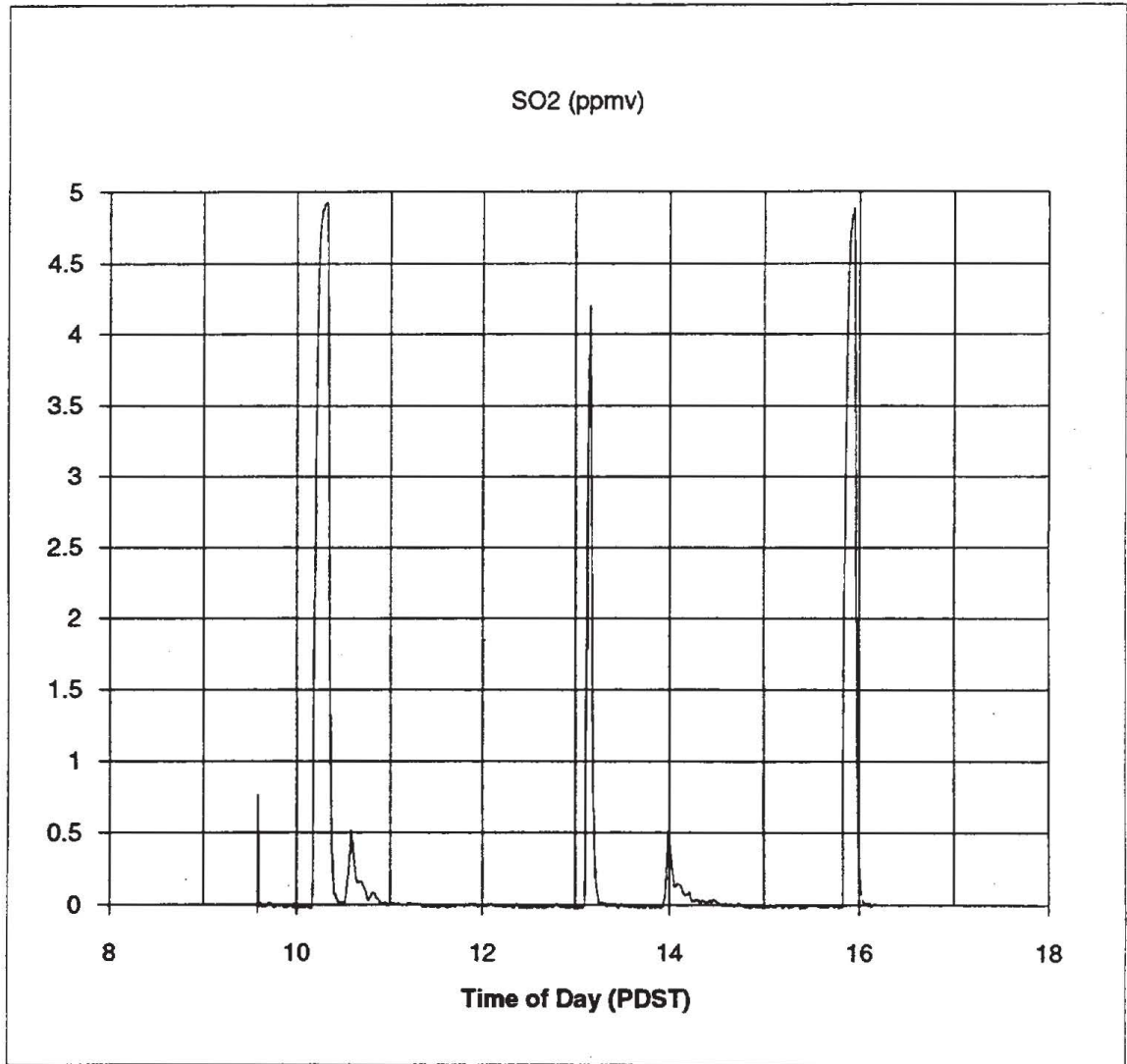


Figure 3.7.9. Total sulfur concentration in stack gas, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr-93

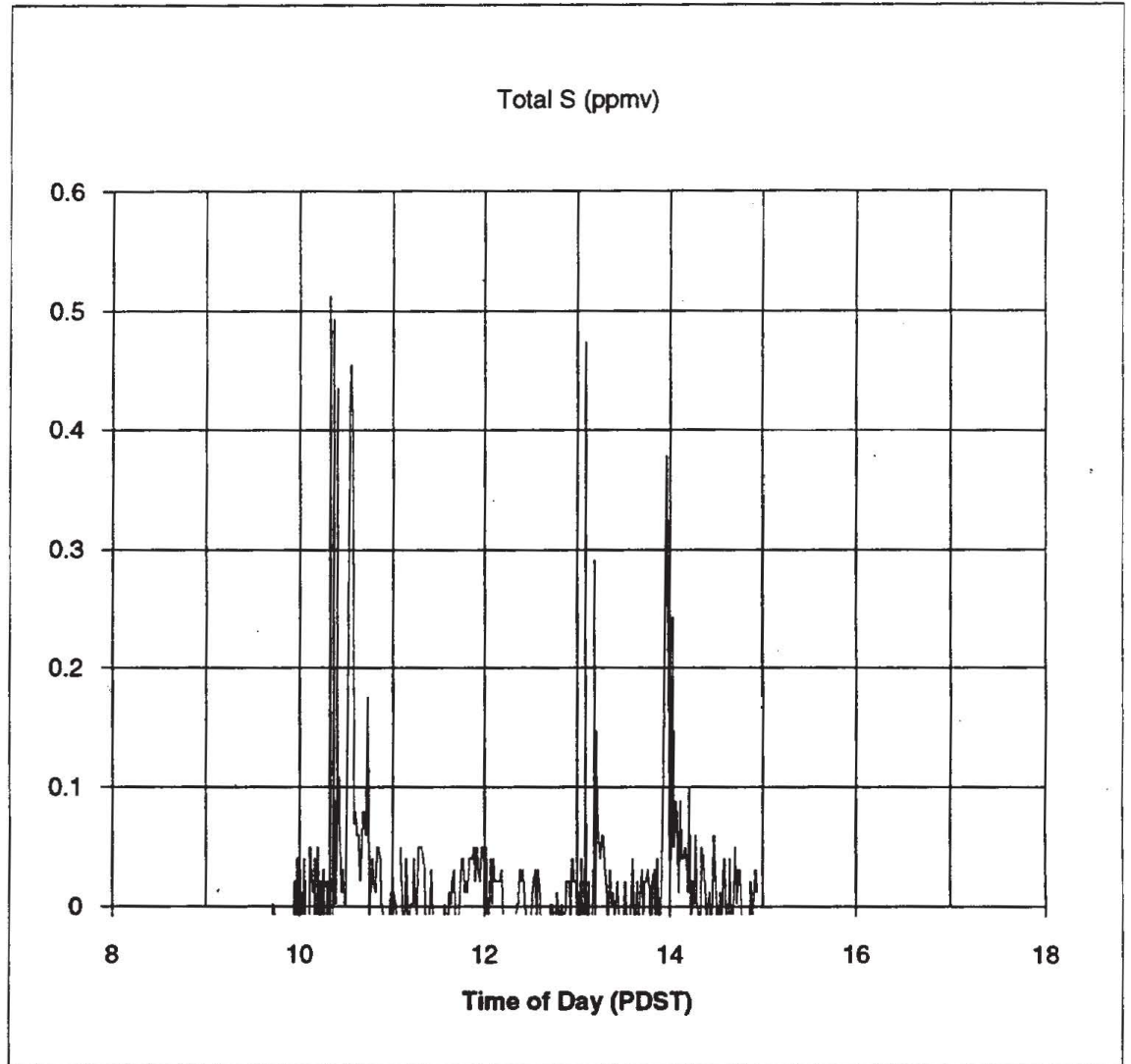


Figure 3.7.10. THC concentration in stack gas, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr-93

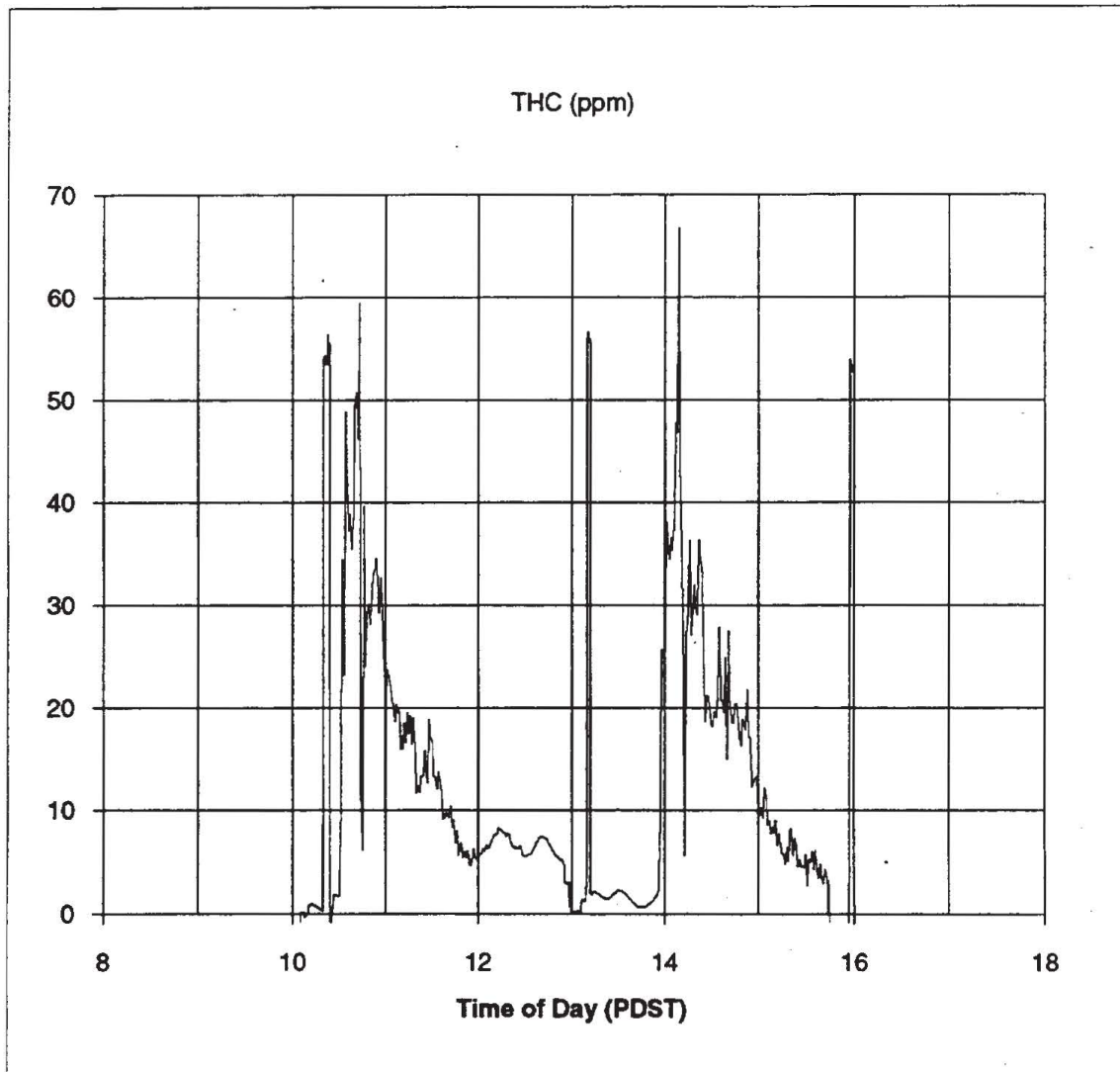


Figure 3.7.11. CO2 concentration in stack gas, 29 April 93.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr-93

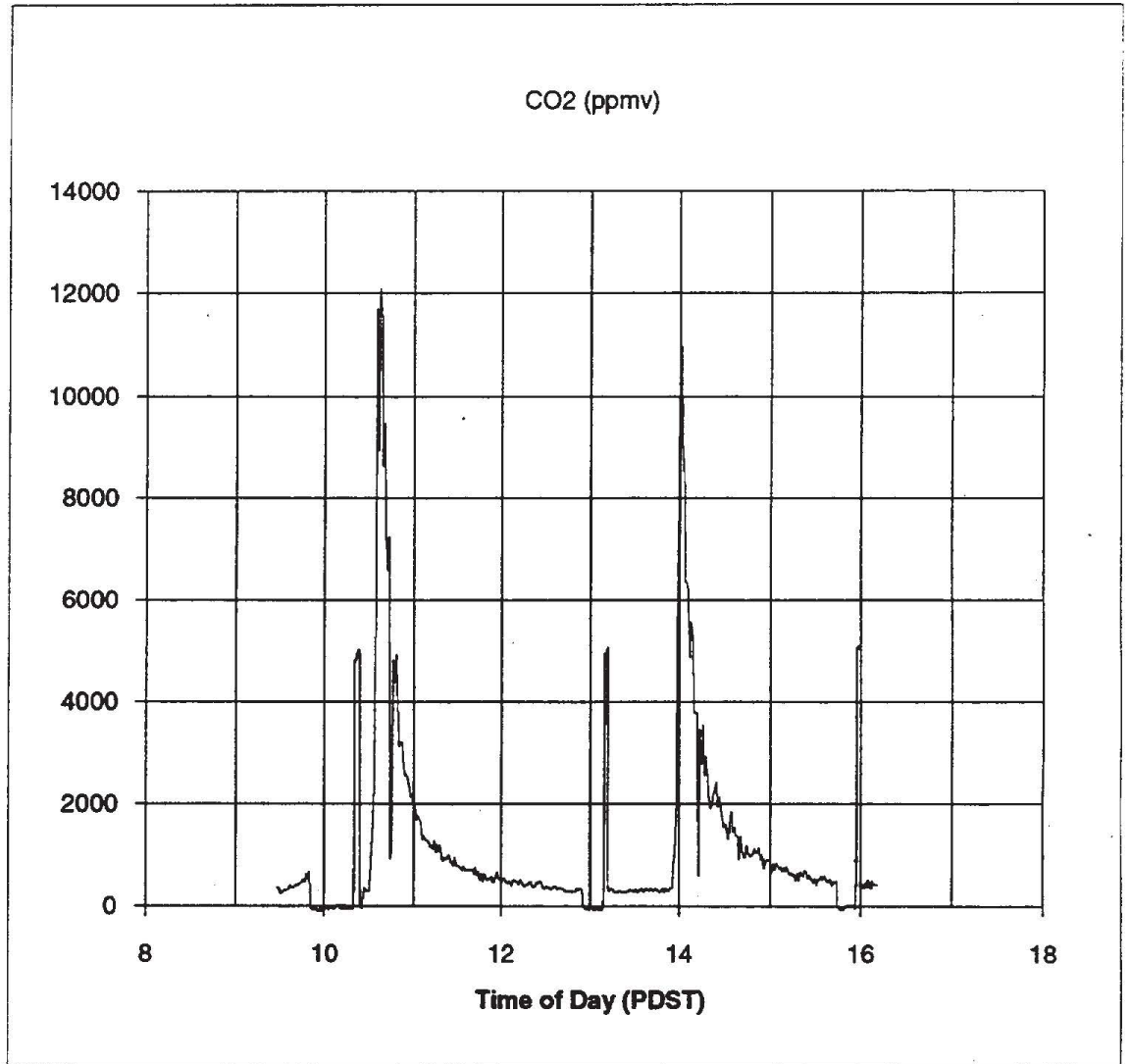


Figure 3.7.12. Particle size distribution, traverse 1, 29 April 93.

Fuel: Ponderosa Pine

Date of Test: 29-Apr-93

Configuration: Pile

Particle Size Distribution

Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.99	0.97	10.76	1.000
2	7.84	0.49	9.79	0.910
3	4.18	0.43	9.3	0.864
4	2.21	0.44	8.87	0.824
5	1.27	0.49	8.43	0.783
6	0.75	0.96	7.94	0.738
7	0.39	1.32	6.98	0.649
filter	0.00	5.66	5.66	0.526

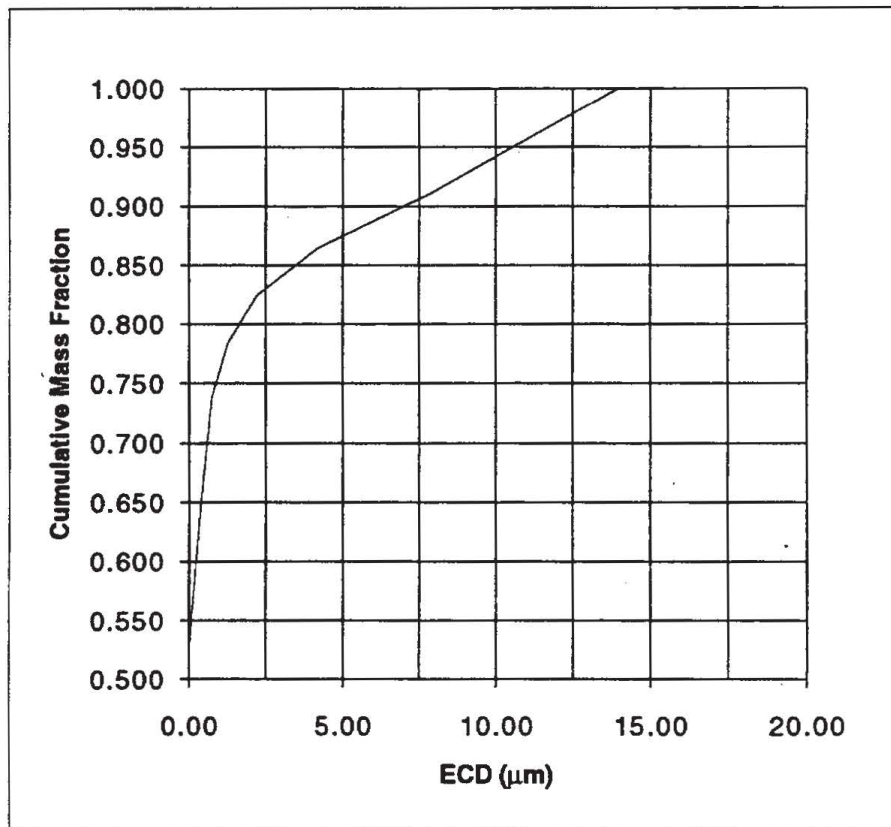


Figure 3.7.13. Particle size distribution, traverse 2, 29 April 93.

Fuel: Ponderosa Pine Date of Test: 29-Apr-93
Configuration: Pile

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	14.14	0.12	2.984	1.000
2	7.92	0.14	2.864	0.960
3	4.22	0.02	2.724	0.913
4	2.23	0.20	2.704	0.906
5	1.29	0.23	2.5	0.838
6	0.76	0.37	2.27	0.761
7	0.39	0.36	1.90	0.637
filter	0.00	1.54	1.54	0.516

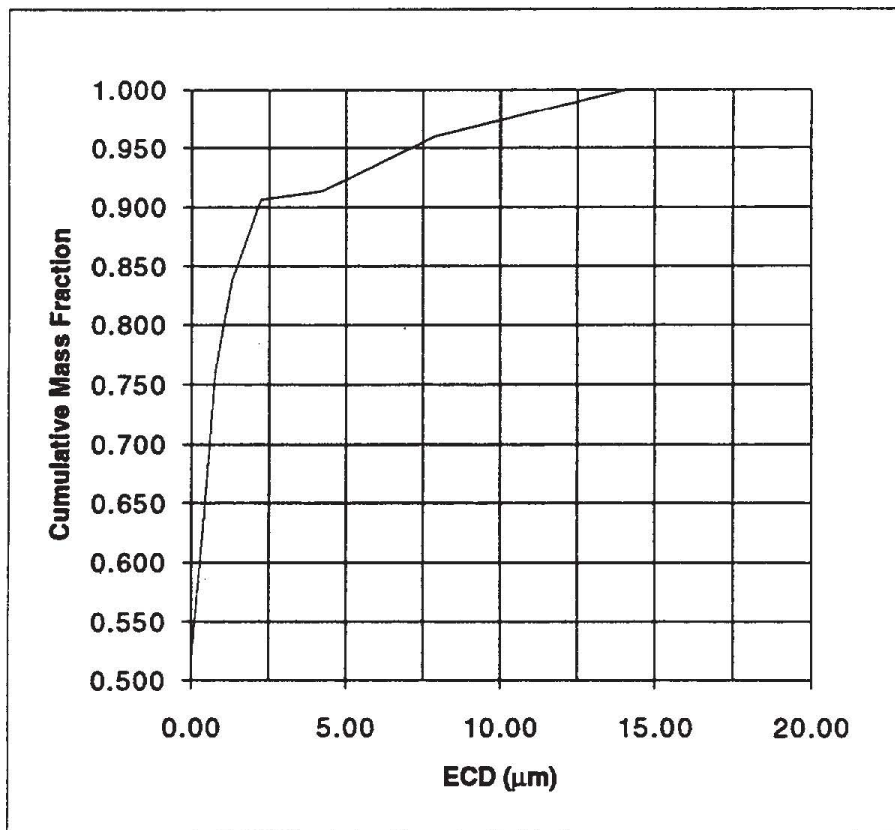


Figure 3.7.14. Weight on burning platform, Ponderosa pine slash burns.

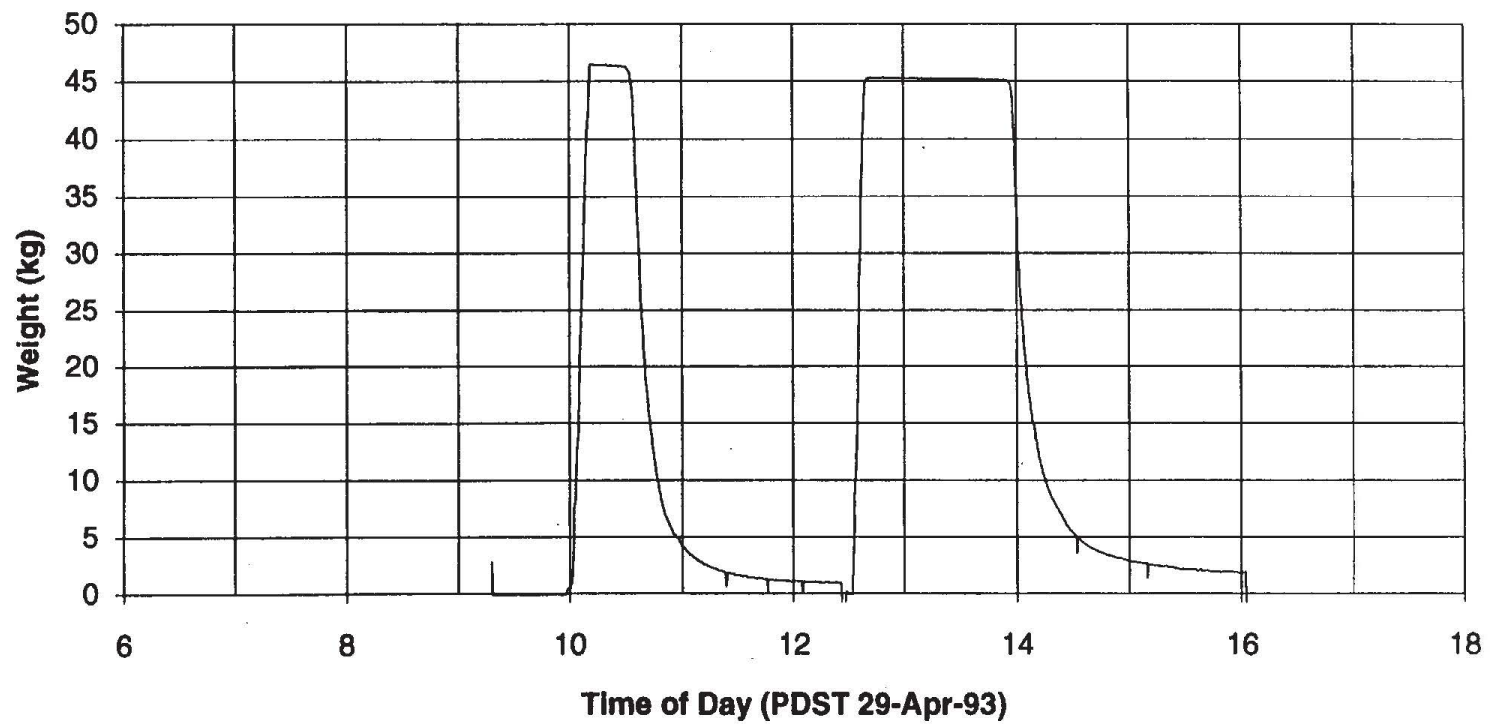


Figure 3.7.15. Residual weight profiles for Ponderosa pine slash burns.

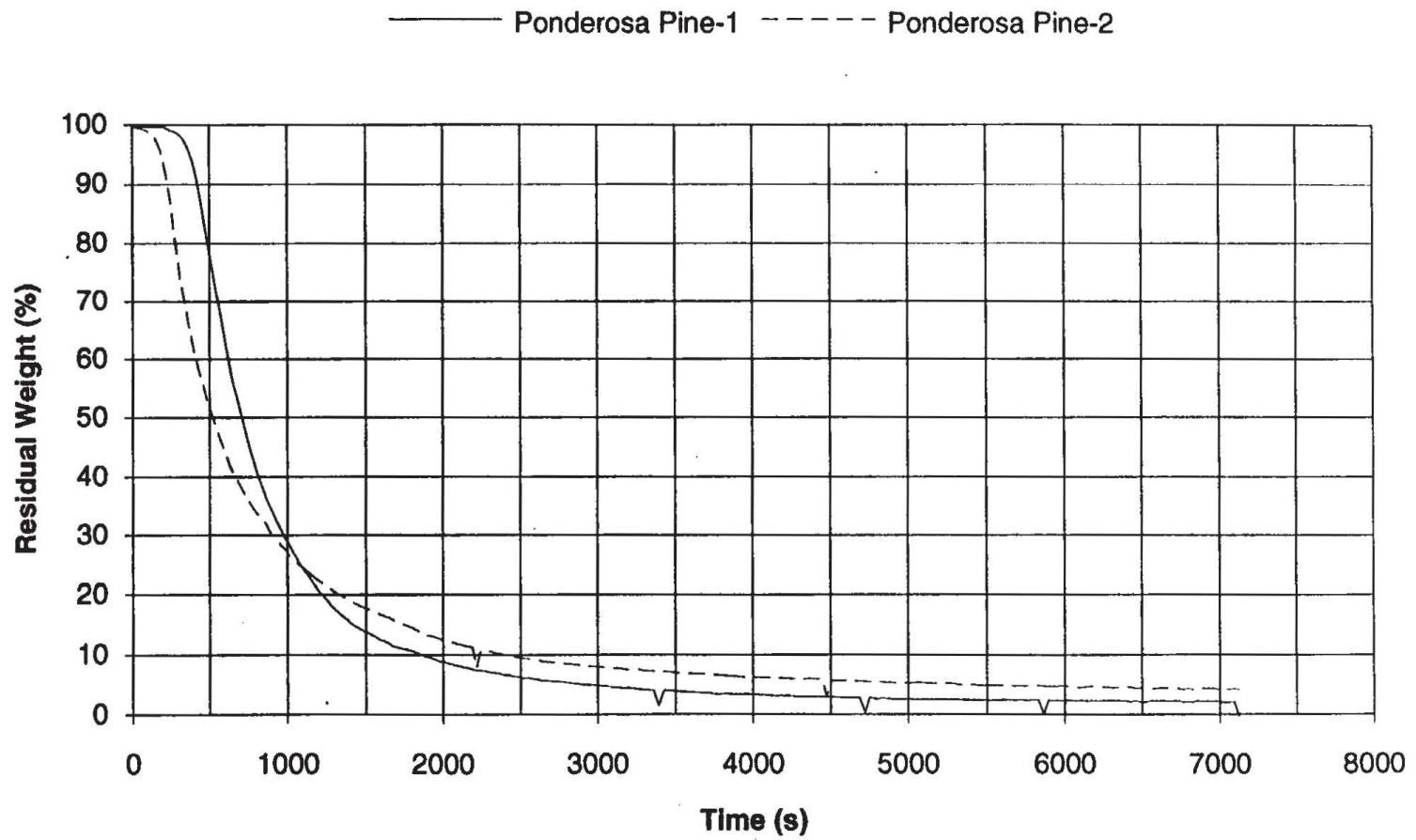


Figure 3.7.16. Rates of weight loss for Ponderosa pine slash.

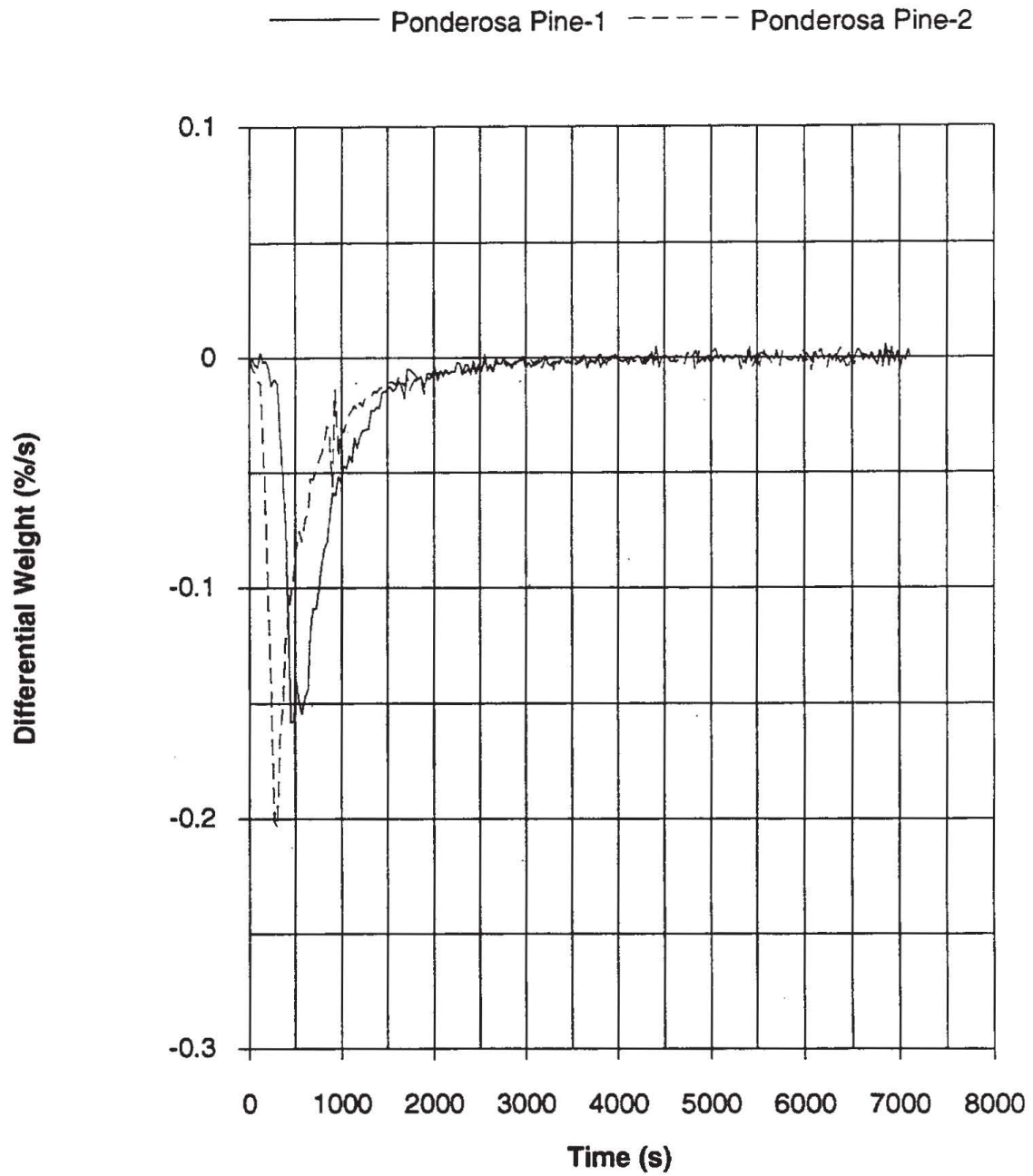


Figure 3.7.17. Nitrogen balance.

Date of Test:

Fuel

29-Apr-93

Ponderosa Pine

Average Tests 1, 2

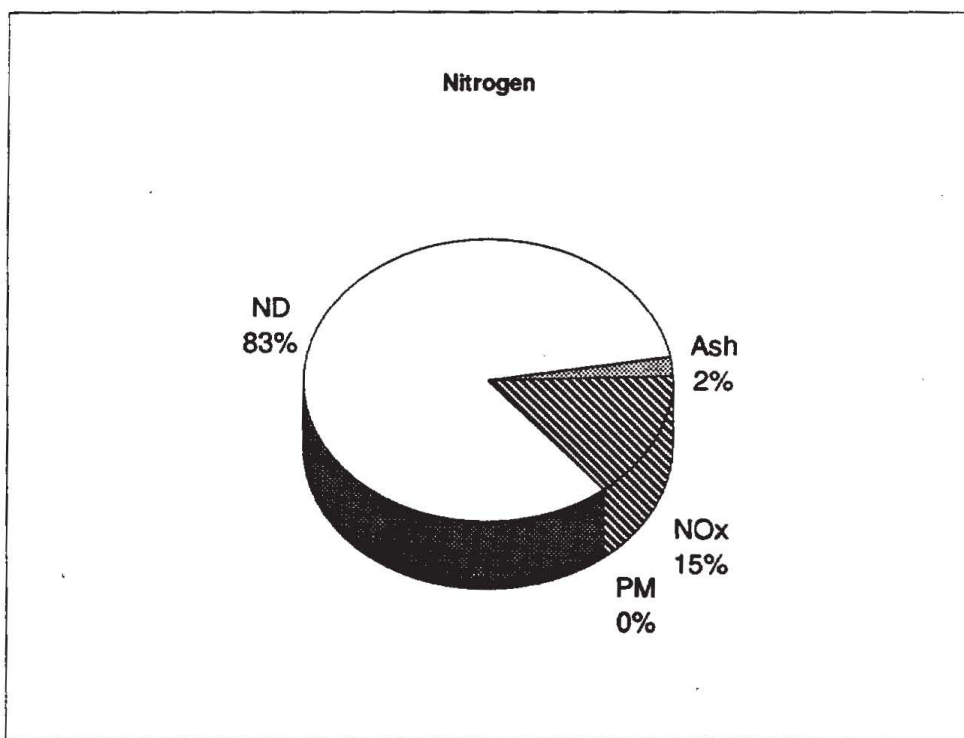


Figure 3.7.18. Sulfur balance.
Date of Test:
Fuel

29-Apr-93
Ponderosa Pine
Average Tests 1, 2

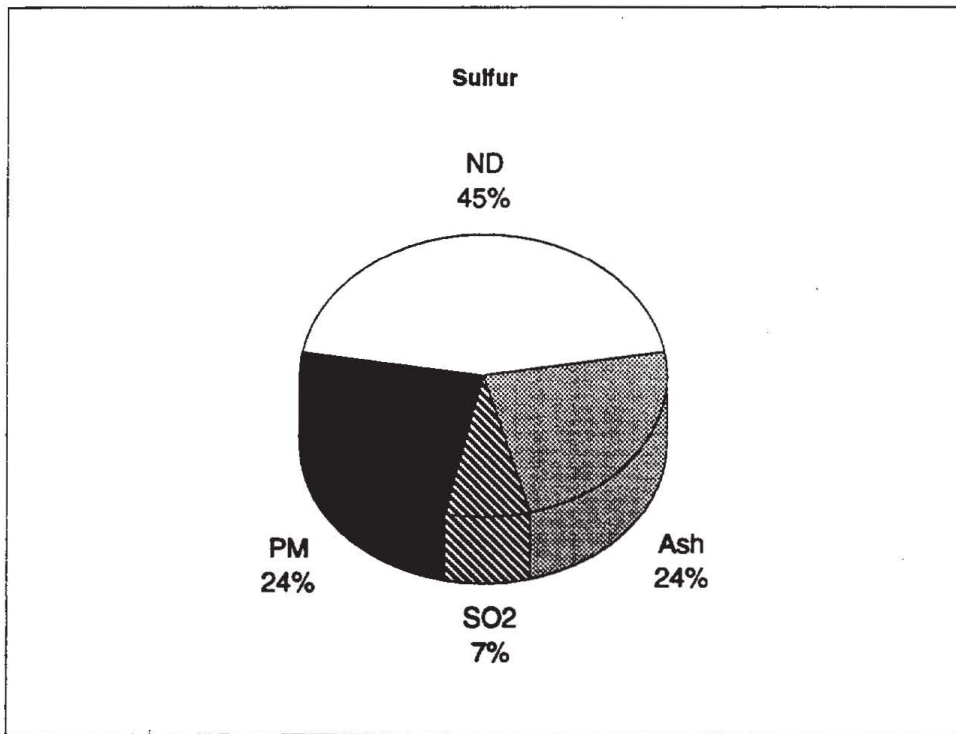
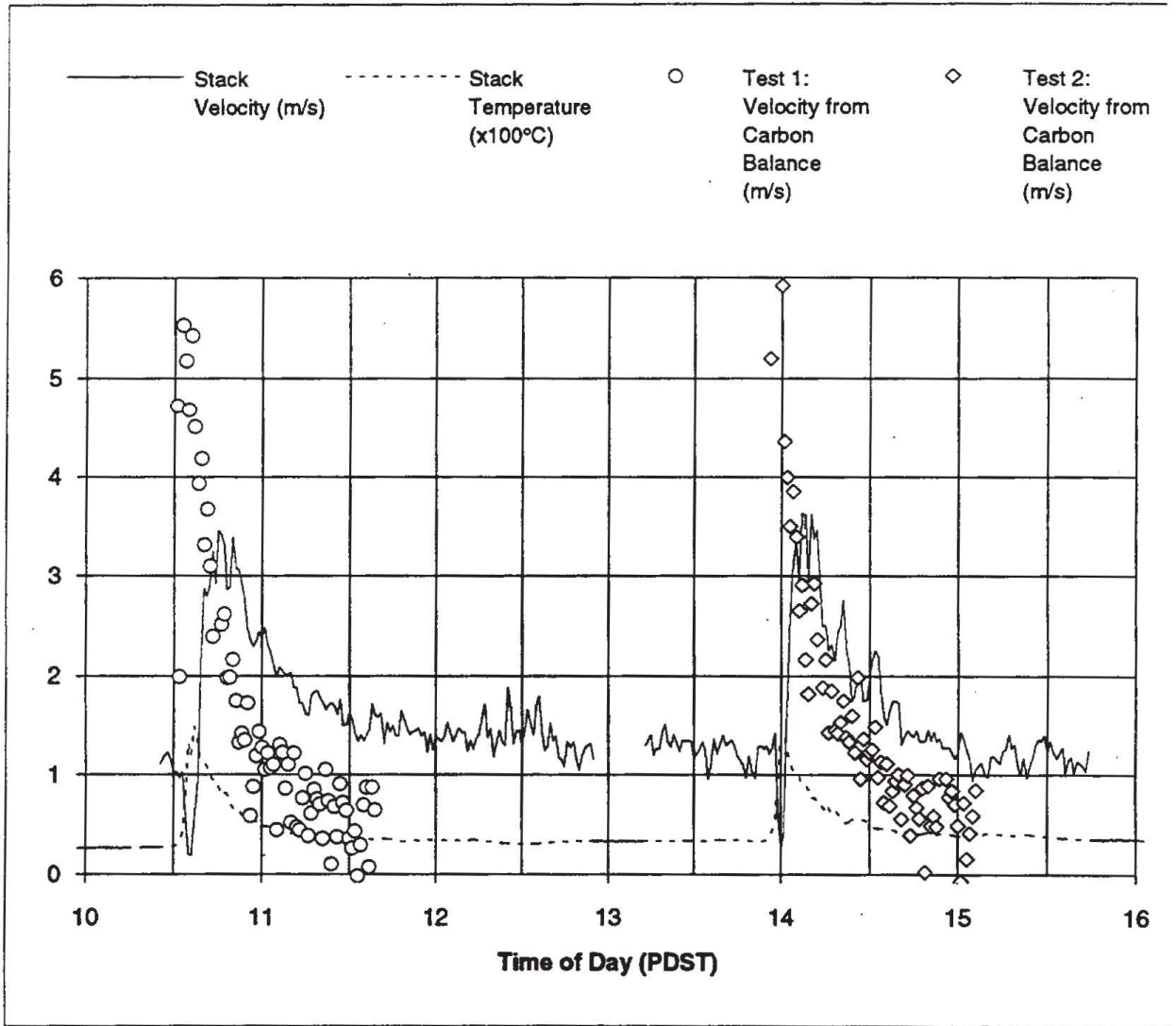


Figure 3.7.19. Comparison of estimated and measured stack gas velocity.

Fuel Type: Ponderosa Pine
Configuration: Pile

Test Date 29-Apr



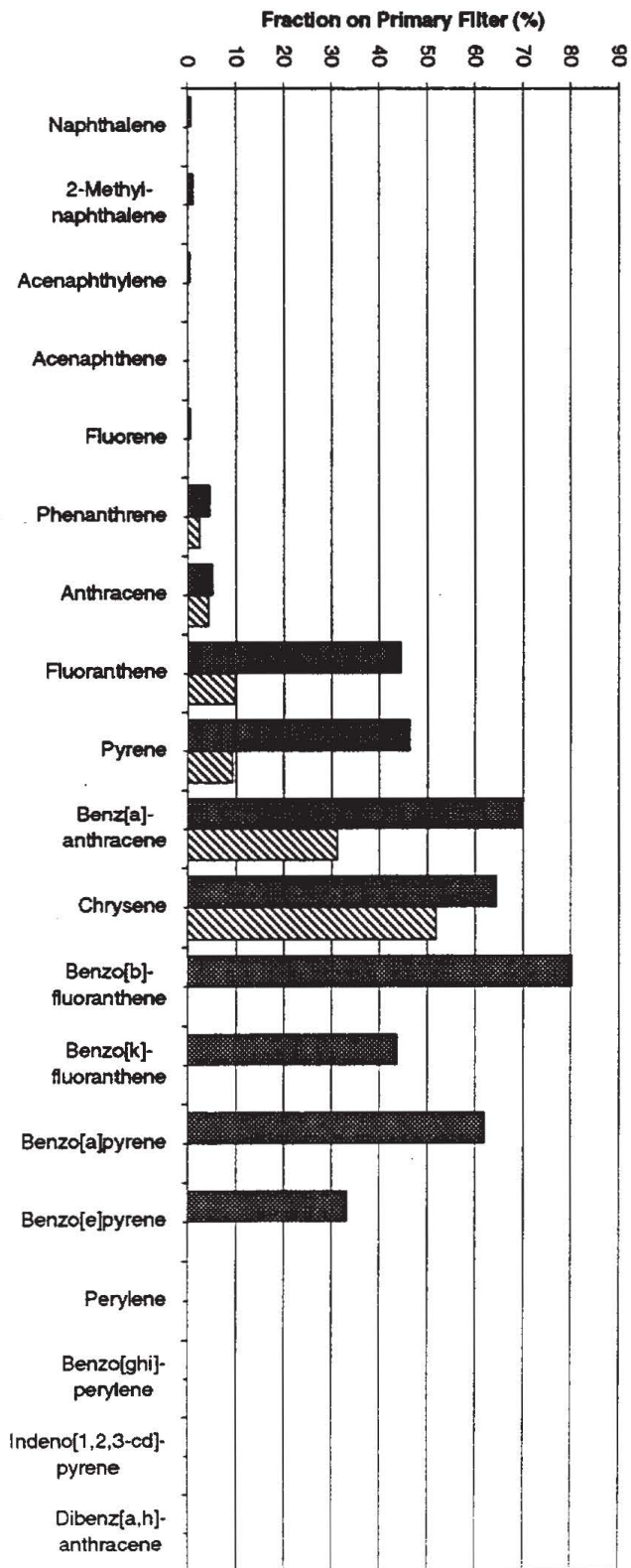


Figure 3.7.20. Mass fraction of PAH on primary filter samples, 29 April 1993, Ponderosa pine slash (measured stack gas velocity).

Table 3.8.1.

Fuel and Ash Analyses

Run Date	30-Apr-93	30-Apr-93	30-Apr-93	30-Apr-93
Fuel Type	Douglas Fir	Douglas Fir	Douglas Fir	Douglas Fir
Sample Type	Fuel	Fuel	Residue	Residue
	Large Branch	Small Branch	Test #1	Test #2
<u>Ultimate Analysis</u>				
(% dry weight)				
C	51.42	51.90	25.10	30.95
H	6.23	6.26	0.61	0.62
N				
<u>Elemental Analysis</u>				
(% by weight dry basis)				
N	0.23	0.31	0.14	0.19
P	0.02	0.03	0.95	0.23
K	0.15	0.20	3.49	4.10
Ca	0.24	0.48	12.61	9.62
Mg	0.03	0.04	1.55	1.52
Na		0.0002	0.11	0.08
Cl	0.01	0.01	0.01	0.05
(mg/kg dry weight)				
S	119	219	501	691
B	4	6	270	179
Zn	13	26	340	220
Mn	83	157	8,190	6,000
Fe	64	450	1,550	3,520
Cu	2	2	97	77
Si	339	471	21,100	15,400
Total (% dry weight)	58.39	59.37	47.78	49.96
<u>Proximate Analysis</u>				
(% dry weight)				
Ash	0.67	0.41	74.28	36.61
Volatiles	83.51	82.31	26.41	51.47
Fixed Carbon	15.82	17.27	-0.69	11.92
<u>Higher Heating Value</u>				
(MJ/kg dry weight)	20.3071	20.4916	6.9613	13.3197

Table 3.8.2

Fuel: Douglas Fir
Date of Test: 30-Apr-93

Fuel Properties

	Large Branch	Small Branch	Total
Diameter (mm)	> 50	< 50	
Mass Fraction (% wet weight)	57.0	43.0	100.0
Moisture (% wet weight)	34.70	23.80	30.01
Mass Fraction (% dry weight)	53	47	100
Carbon (% dry weight)	51.42	51.90	51.64
Nitrogen (% dry weight)	0.23	0.31	0.27
Sulfur (mg/kg dry weight)	119	219	166
Ash (% dry weight)	0.67	0.41	0.55
Heating Value (MJ/kg dry weight)	20.31	20.49	20.39

Table 3.8.3. Operating conditions, Douglas fir slash

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

	Test 1	Test 2			
Total Fuel Consumption (kg w.b.)	46.0	45.3			
Total Ash (kg w.b.)	0.4	0.4			
Ash Fraction (w.b.)	0.01	0.01			
	Test 1	Test 2	Test 1	Test 2	Test 2
	Test 1	Test 2	Test 1	Test 2	Test 2
<u>Mean Values</u>	Test 1	Test 2	Test 1	Test 2	Test 2
Air Temperature (°C)	24	27	29	26	28
Air Relative Humidity (%)	25	16	14	20	15
Inlet Air Temperature (°C)	25.53	27.52	29.71	26.75	30.20
Stack Temperature (°C)	38.46	33.92	73.13	44.27	51.93
Impinger Outlet Temperature (°C)	18.43	20.48	21.17	26.35	29.44
Stack Gas Velocity (m/s)	1.36	1.56	2.15	1.69	1.88
Total Duration (minutes)	24	24	24	132	100
Duration Flaming Stage (minutes)				57	33
Weight Loss, Flaming Stage (g w.b.)				31,925	32,492

Table 3.8.4. Average gas and particulate matter concentrations, Douglas fir slash

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

Gas and PM Concentrations (less background)	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
CO (ppmv)	78.65	63.87	124.32	82.49	103.06
NO (ppmv)	0.86	0.13	1.79	0.71	0.68
NOx (ppmv)	1.84	0.23	3.99	1.38	1.58
SO2 (ppmv)	0.08	0.00	0.13	0.04	0.04
THC (ppmv as CH4)	27.53	6.33	33.70	19.76	21.54
HC (ppmv as CH4 by GC)	9.39	2.21	9.31		
CH4 (ppmv by GC)	5.23	1.77	3.93		
NMHC (ppmv as CH4)	22.30	4.56	29.77		
NMHC (ppmv as CH4 by GC)	4.16	0.44	5.38		
CO2 (ppmv)	1,257	500	3,843	1,500	1,808
Total S (ppmv as SO2)	0.10	0.01	0.09	0.04	0.04
PM (mg/cu.m)	17.67	1.09	22.57		
PM10 (mg/cu.m)	17.49	1.04	21.44		
PM2.5 (mg/cu.m)	16.70	0.85	18.06		

Table 3.8.5. Mass balance, Douglas fir slash

Fuel: Douglas Fir

Date of Test: 30-Apr-93

Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
Fuel Moisture Content (% w.b.)	30.0	0.0	30.0	30.0	30.0
Fuel Consumption (g w.b.)	9,137	1,371	28,969	45,991	45,321
Fuel Consumption (g d.b.)	6,395	1,371	20,274	32,188	31,718
Ash (g)	35	520	111	356	379
Fuel Vaporized (g)	9,102	850	28,858	45,635	44,941
Average Burning Rate (g/s w.b.)	6.35	0.95	20.12	5.81	7.55
Average Burning Rate (g/s d.b.)	4.44	0.95	14.08	4.06	5.29
Fuel Vaporization Rate (g/s)	6.32	0.59	20.04	5.76	7.49
Stack Gas Density (kg/cu.m)	1.1342	1.1510	1.0206	1.1135	1.0872
Stack Gas Flow Rate (cu.m/s)	2.02	2.31	3.19	2.51	2.80
Stack Gas Mass Flow Rate (kg/s)	2.29	2.66	3.25	2.79	3.05
Inlet Air Mass Flow Rate (kg/s)	2.29	2.66	3.23	2.78	3.04
Overall Air-Fuel Ratio (w.b.)	360	2,797	161	479	402
Overall Air-Fuel Ratio (d.b.)	515	2,797	230	685	575

Table 3.8.6. Emission factors, Douglas fir slash, 30 April 93 (integrated basis).

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
CO	3.883	16.824	2.805	5.512	5.730
NO	0.046	0.036	0.041	0.051	0.041
NOx (as NO2)	0.149	0.099	0.133	0.151	0.139
SO2	0.009	0.000	0.006	0.006	0.005
THC (as CH4)	0.815	1.156	0.439	0.795	0.707
HC (as CH4 by GC)	0.267	0.341	0.119	0.290	0.182
CH4 (by GC)	0.149	0.273	0.050	0.187	0.113
NMHC (as CH4)	0.666	0.883	0.389	0.608	0.593
NMHC (as CH4 by GC)	0.118	0.068	0.069	0.103	0.068
CO2	132.166	362.867	149.691	209.018	198.087
Total S (as SO2)	0.011	0.004	0.004	0.006	0.004
SO2/Total S	0.85	0.00	1.58	0.89	1.10
Mass fraction converted during observed flaming stage (wet basis)*				0.69	0.72
PM	0.752	0.253	0.434	0.600	0.383
PM10	0.745	0.241	0.413	0.591	0.364
PM2.5	0.711	0.198	0.348	0.554	0.305
MMAD	0.152	0.247	0.165	0.181	0.188
σ	4.707	13.521	9.475		

Mass Averaged

*Best fit for mass fraction on CO2 from traverses: Test 1 = 0.83, Test 2 = 0.88.

Table 3.8.7. Emission factors, Douglas fir slash, 30 April 93 (average basis).

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
CO	3.919	17.254	2.774	5.468	5.733
NO	0.046	0.037	0.043	0.051	0.040
NOx (as NO2)	0.151	0.102	0.146	0.150	0.144
SO2	0.010	0.000	0.007	0.006	0.005
THC (as CH4)	0.784	0.978	0.430	0.749	0.685
HC (as CH4 by GC)	0.267	0.341	0.119	0.290	0.182
CH4 (by GC)	0.149	0.273	0.050	0.187	0.113
NMHC (as CH4)	0.635	0.705	0.380	0.562	0.571
NMHC (as CH4 by GC)	0.118	0.068	0.069	0.103	0.068
CO2	98.388	212.454	134.756	156.202	158.011
Total S (as SO2)	0.011	0.004	0.004	0.007	0.005
SO2/Total S	0.83	0.00	1.52	0.86	0.98
Mass fraction converted during observed flaming stage (wet basis)*				0.69	0.72
PM	0.752	0.253	0.434	0.600	0.383
PM10	0.745	0.241	0.413	0.591	0.364
PM2.5	0.711	0.198	0.348	0.554	0.305
MMAD	0.152	0.247	0.165	0.181	0.188
σ	4.707	13.521	9.475		

Mass Averaged

*Best fit for mass fraction on CO2 from traverses: Test 1 = 0.76, Test 2 = 0.88.

Table 3.8.8. Carbon balance.

Date of Test:	30-Apr-93				
	Douglas Fir				
Fuel:	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
Carbon Balance					
Dry Fuel Consumption Rate (g/s)	4.44	0.95	14.08	4.06	5.0
Ash Generation Rate (g/s)	0.02	0.36	0.08	0.05	0.0
Ash Fraction (% dry basis)	0.55	37.96	0.55	1.11	1.0
Fuel Carbon Concentration* (%)	51.64	79.29	51.64	51.64	51.0
Residual Ash Carbon Concentration* (%)	0.00	45.40	0.00	25.10	30.0
Carbon released to stack (g/s)	2.29	0.59	7.27	2.09	2.0
Maximum CO2 emission factor (%)	189.35	227.54	189.35	188.33	187.0
Stack Gas Density (kg/cubic meter)	1.13	1.15	1.02	1.11	1.0
Average CO2 concentration (ppmv)	1,257	500	3,843	1,500	1,800
Average CO concentration (ppmv)	78.65	63.87	124.32	82.49	103.0
Average THC concentration (ppmv as CH4)	27.53	6.33	33.70	19.76	21.0
PM Concentration (mg/cubic meter)	17.67	1.09	22.57	9.73	7.0
PM Carbon Concentration (%)	73.75	73.75	73.75	73.75	73.0
PM Carbon (mg/cubic meter)	13.03	0.80	16.65	7.18	5.0
Stack Gas Temperature (°C)	38.46	33.92	73.13	44.27	51.0
Impinger Temperature (°C)	18.43	20.48	21.17	26.35	29.0
PM molar concentration (ppm)	25.98	1.61	33.50	14.70	11.0
Estimated Average Stack Gas Velocity (m/s)	2.37	1.46	2.87	1.88	2.0
Emission Factors (% Average Basis):					
CO2	98.388	212.454	134.756	156.202	158.0
CO	3.919	17.254	2.774	5.468	5.70
THC (as CH4)	0.784	0.978	0.430	0.749	0.60
PM	0.752	0.253	0.434	0.600	0.30
Emission Factors (% Integrated Basis):					
CO2	132.166	362.867	149.691	209.018	198.0
CO	3.883	16.824	2.805	5.512	5.70
THC (as CH4)	0.815	1.156	0.439	0.795	0.70
PM	0.752	0.253	0.434	0.600	0.30
Closure (% Average Basis)	57	107	75	89	90
Closure (% Integrated Basis)	74	172	82	117	110

*computed for traverse 2.

Table 3.8.9. Nitrogen balance

Date of Test:

30-Apr-93

Fuel:

Douglas Fir

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
Nitrogen Balance					
Fuel Nitrogen Concentration (% dry weight)	0.27	0.27	0.27	0.27	0.27
Ash Nitrogen Concentration (% weight)	0.14	0.10	0.19	0.14	0.14
Emission Factors (% Average Basis):					
NOx (as NO2)	0.151	0.102	0.146	0.150	0.150
PM	0.752	0.253	0.434	0.600	0.600
Emission Factors (% Integrated Basis):					
NOx (as NO2)	0.149	0.099	0.133	0.151	0.151
NO3- Concentration of PM (% weight)	0.188	0.188	0.188	0.188	0.188
NH4+ Concentration of PM (% weight)	0.140	0.140	0.140	0.140	0.140
Nitrogen Concentration of PM (%)	0.152	0.152	0.152	0.152	0.152
Fuel Nitrogen (mg/s)	11.99	2.57	38.02	10.96	14.00
Ash Nitrogen (mg/s)	0.03	0.37	0.15	0.06	0.06
Nitrogen as NOx (mg/s Average Basis)	2.04	0.29	6.26	1.85	2.00
Nitrogen as NOx (mg/s Integrated Basis)	2.01	0.29	5.70	1.87	2.00
Nitrogen as PM (mg/s Average Basis)	0.05	0.00	0.09	0.04	0.00
Nitrogen as NOx+PM (mg/s Average Basis)	2.09	0.30	6.35	1.89	2.00
Nitrogen as NOx+PM (mg/s Integrated Basis)	2.06	0.29	5.79	1.90	2.00
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.174	0.116	0.167	0.172	0.150
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.172	0.113	0.152	0.174	0.150
Ash Nitrogen/Fuel Nitrogen	0.003	0.143	0.004	0.006	0.004
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.177	0.260	0.171	0.178	0.154
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.175	0.256	0.156	0.179	0.154

*computed for traverse 2

Table 3.8.10. Sulfur balance, Douglas fir slash

Date of Test: Fuel	30-Apr-93 Douglas Fir Traverse 1	30-Apr-93 Douglas Fir Traverse 2	30-Apr-93 Douglas Fir Traverse 3	30-Apr-93 Douglas Fir Test 1	30-Apr-93 Douglas Fir Test 2
Sulfur Balance					
Fuel Sulfur Concentration* (mg/kg dry weight)	166	101	166	166	
Ash Sulfur Concentration* (mg/kg weight)	501	365	691	501	
Emission Factors (% Average Basis)					
SO ₂	0.010	0.000	0.007	0.006	0
PM	0.752	0.253	0.434	0.600	0
Emission Factors (% Integrated Basis)					
SO ₂	0.009	0.000	0.006	0.006	0
Sulfur Concentration of PM (% weight)					
Fuel Sulfur (mg/s)	0.74	0.10	2.34	0.67	
Ash Sulfur (mg/s)	0.01	0.13	0.05	0.02	
Sulfur as SO ₂ (mg/s Average Basis)	0.22	0.00	0.49	0.12	
Sulfur as SO ₂ (mg/s Integrated Basis)	0.20	0.00	0.42	0.12	
Sulfur as PM (mg/s Average Basis)	0.09	0.01	0.17	0.07	
Sulfur as SO ₂ +PM (mg/s Average Basis)	0.31	0.01	0.66	0.19	
Sulfur as SO ₂ +PM (mg/s Integrated Basis)	0.29	0.01	0.59	0.19	
SO ₂ +PM Sulfur/Fuel Sulfur (Average Basis)	0.426	0.069	0.283	0.280	0
SO ₂ +PM Sulfur/Fuel Sulfur (Integrated Basis)	0.396	0.069	0.253	0.280	0
Ash Sulfur/Fuel Sulfur	0.017	1.373	0.023	0.034	0
Closure (% Average Basis)	44	144	31	31	
Closure (% Integrated Basis)	41	144	28	31	

*computed for traverse 2

Table 3.8.11. Water balance.

Estimated Stack Humidity			
Fuel	Douglas Fir		
Configuration	Pile		
Date of Test	30-Apr-93		
	Traverse 1	Traverse 2	Traverse 3
Ambient Air Temperature (°C)	24	27	29
Ambient Air Relative Humidity (%)	25	16	14
Air Temperature (K)	297	300	302
Saturation Pressure (Pa)	2,985	3,567	4,008
Vapor Pressure (Pa)	746	571	561
Air Dew Point Temperature (°C)	2.8	-1.0	-1.2
Ambient Volume Fraction Water Vapor	0.0074	0.0056	0.0055
Ambient Mass Fraction Water Vapor	0.0046	0.0035	0.0034
Fuel Burning Rate (g/s wet basis)	6.35	0.95	20.12
Fuel Moisture Content (%)	30.0	0.0	30.0
Ash Fraction (wet basis)	0.01	0.38	0.01
Fuel Hydrogen Content (%)	6.24	0.17	6.24
Ash Hydrogen Content* (%)	0.00	0.45	0.00
Moisture Evaporated (g/s)	1.91	0	6.04
Water of Combustion† (g/s)	2.50	0	7.91
Total Fuel Water Added (g/s)	4.40	0	13.95
Inlet Air Mass Flowrate (g/s)	2,290	2,660	3,230
Inlet Air Water Vapor Flowrate (g/s)	10	9	11
Total Stack Water Vapor Flowrate (g/s)	15	9	25
Stack Gas Mass Flowrate (g/s)	2,296	2,661	3,250
Mass Fraction Water Vapor in Stack	0.0065	0.0035	0.0077
Volume Fraction Water Vapor in Stack	0.0104	0.0056	0.0124
Stack Vapor Pressure (Pa)	1,057	571	1,258
Stack Temperature (°C)	38	34	73
Stack Temperature (K)	312	307	346
Stack Saturation Pressure (Pa)	6,798	5,300	35,671
Stack Relative Humidity (%)	16	11	4
Stack Dew Point Temperature (°C)	7.8	-1.0	10.4
Impinger Outlet Temperature (°C)	18.4	20.5	21.2
Volume Stack Gas Sampled for PM (L)	175	275	253
Estimated Impinger/Desiccant Weight Gain (g)	1.4	1.2	2.3
Totals:			
	Estimated	Measured	
Total Impinger/Desiccant Weight Gain (g)	4.9	6.7	
Estimated/Measured Weight Gain	0.73		

*assumes complete fuel conversion during traverses 1 and 3

†assumes no hydrogen lost from fuel during traverse 2

Table 3.8.12. Power balance.

Date of Test:	30-Apr-93			Test 1	Te
	Douglas Fir				
Fuel:	Traverse 1	Traverse 2	Traverse 3		
Power Balance					
Fuel Heating Value* (MJ/kg dry weight)	20.39	23.47	20.39	20.39	20
Ash Heating Value* (MJ/kg dry weight)	0	13.7506	0	6.9613	13.3
Average Energy Release Rate (kW)	90.5	17.3	287.1	82.5	10
Products of Incomplete Combustion (kW)					
CO	1.8	1.7	3.9	2.2	
THC (as CH4)	1.9	0.5	3.4	1.7	
PM	0.8	0.1	1.5	0.6	
Heat Release Rate (kW)	86.0	15.1	278.3	77.9	10
Stack Gas Flow (kg/s)	2.29	2.66	3.25	2.79	3
Stack Gas Temperature (°C)	38.46	33.92	73.13	44.27	5
Ambient Temperature (°C)	24	27	29	26	
Sensible Power at Top of Stack (kW)	33.3	18.5	144.3	51.3	7
Tunnel Dissipation (kW)	52.7	-3.4	134.0	26.7	2

*computed for traverse 2.

Table 3.8.13. Operating conditions, Douglas fir slash*.

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

	Test 1	Test 2
Total Fuel Consumption (kg w.b.)	46.0	45.3
Total Ash (kg w.b.)	0.4	0.4
Ash Fraction (w.b.)	0.01	0.01

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
Mean Values					
Air Temperature (°C)	24	27	29	26	28
Air Relative Humidity (%)	25	16	14	20	15
Inlet Air Temperature (°C)	25.53	27.52	29.71	26.75	30.20
Stack Temperature (°C)	38.46	33.92	73.13	44.27	51.93
Impinger Outlet Temperature (°C)	18.43	20.48	21.17	26.35	29.44
Stack Gas Velocity (m/s)	2.37	1.46	2.87	1.88	2.09
Total Duration (minutes)	24	24	24	132	100
Duration Flaming Stage (minutes)				57	33
<u>Weight Loss, Flaming Stage (g w.b.)</u>				31,925	32,492

*stack gas velocity from carbon balance

Table 3.8.14. Mass balance, Douglas fir slash*.

Fuel: Douglas Fir

Date of Test: 30-Apr-93

Configuration: Pile

Mass Balance

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
Fuel Moisture Content (% w.b.)	30.0	0.0	30.0	30.0	30.0
Fuel Consumption (g w.b.)	9,137	1,371	28,969	45,991	45,321
Fuel Consumption (g d.b.)	6,395	1,371	20,274	32,188	31,718
Ash (g)	35	520	111	356	379
Fuel Vaporized (g)	9,102	850	28,858	45,635	44,941
Average Burning Rate (g/s w.b.)	6.35	0.95	20.12	5.81	7.55
Average Burning Rate (g/s d.b.)	4.44	0.95	14.08	4.06	5.29
Fuel Vaporization Rate (g/s)	6.32	0.59	20.04	5.76	7.49
Stack Gas Density (kg/cu.m)	1.1342	1.1510	1.0206	1.1135	1.0872
Stack Gas Flow Rate (cu.m/s)	3.52	2.17	4.27	2.79	3.11
Stack Gas Mass Flow Rate (kg/s)	4.00	2.50	4.35	3.11	3.38
Inlet Air Mass Flow Rate (kg/s)	3.99	2.50	4.33	3.11	3.37
Overall Air-Fuel Ratio (w.b.)	629	2,624	215	535	446
Overall Air-Fuel Ratio (d.b.)	898	2,624	308	764	637

*stack gas velocity from carbon balance

Table 3.8.15. Emission factors, Douglas fir slash (Integrated basis)*.

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
CO	6.660	5.785	3.443	5.694	5.386
NO	0.070	0.013	0.070	0.061	0.057
NOx (as NO2)	0.225	0.035	0.238	0.184	0.205
SO2	0.013	0.000	0.012	0.008	0.010
THC (as CH4)	1.447	0.400	0.579	0.942	0.830
HC (as CH4 by GC)	0.466	0.320	0.159	0.421	0.204
CH4 (by GC)	0.260	0.256	0.067	0.259	0.121
NMHC (as CH4)	1.188	0.144	0.512	0.683	0.710
NMHC (as CH4 by GC)	0.206	0.063	0.092	0.163	0.084
CO2	237.638	122.810	216.721	227.962	219.522
Total S (as SO2)	0.021	0.002	0.007	0.009	0.008
SO2/Total S	0.61	0.00	1.68	0.86	1.30
PM	1.312	0.238	0.581	0.983	0.484
PM10	1.298	0.226	0.552	0.970	0.460
PM2.5	1.239	0.185	0.465	0.917	0.386
MMAD	0.152	0.247	0.165	0.181	0.188
σ	4.707	13.521	9.475		

Mass Averaged

*stack gas velocity from carbon balance

Table 3.8.16. Emission factors, Douglas fir slash (average basis)*.

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
CO	6.832	16.182	3.712	6.097	6.357
NO	0.080	0.035	0.057	0.056	0.045
NOx (as NO2)	0.263	0.096	0.196	0.167	0.160
SO2	0.017	0.000	0.009	0.006	0.006
THC (as CH4)	1.366	0.917	0.575	0.835	0.759
HC (as CH4 by GC)	0.466	0.320	0.159	0.421	0.204
CH4 (by GC)	0.260	0.256	0.067	0.259	0.121
NMHC (as CH4)	1.107	0.661	0.508	0.576	0.638
NMHC (as CH4 by GC)	0.206	0.063	0.092	0.163	0.084
CO2	171.520	199.258	180.297	174.177	175.224
Total S (as SO2)	0.020	0.004	0.006	0.008	0.006
SO2/Total S	0.83	0.00	1.52	0.86	0.98
PM	1.312	0.238	0.581	0.983	0.484
PM10	1.298	0.226	0.552	0.970	0.460
PM2.5	1.239	0.185	0.465	0.917	0.386
MMAD	0.152	0.247	0.165	0.181	0.188
σ	4.707	13.521	9.475		

Mass Averaged

*stack gas velocity from carbon balance

Table 3.8.17. Carbon balance, Douglas fir slash*.

Fuel: Douglas Fir Date of Test: 30-Apr-93
 Configuration: Pile

Carbon Balance

	Traverse 1	Traverse 2	Traverse 3	Test 1	Test 2
Dry Fuel Consumption Rate (g/s)	4.44	0.95	14.08	4.06	5.29
Ash Fraction (%)	0.55	37.96	0.55	1.11	1.20
Ash Generation Rate (g/s)	0.02	0.36	0.08	0.04	0.06
Fuel Carbon Concentration† (%)	51.64	79.29	51.64	51.64	51.64
Residual Ash Carbon Concentration† (%)	0.00	45.40	0.00	25.10	30.95
Carbon Released to Stack (g/s)	2.29	0.59	7.27	2.09	2.71
Maximum CO2 emission factor (%)	189.36	227.54	189.36	188.35	188.01
Average CO2 concentration (ppmv)	1,256.52	500.47	3,842.85	1,499.56	1,807.74
Average CO concentration (ppmv)	78.65	63.87	124.32	82.49	103.06
Average THC concentration (ppmv)	27.53	6.33	33.70	19.76	21.54
PM concentration (mg/cubic meter)	17.67	1.09	22.57	14.30	8.24
PM Carbon concentration (%)	73.75	73.75	73.75	73.75	73.75
PM Carbon (mg/cubic meter)	13.03	0.80	16.65	10.55	6.07
PM Carbon molar concentration (ppm)	25.98	1.61	33.50	21.60	12.57
Estimated Average Stack Gas Velocity (m/s)	2.37	1.46	2.87	1.88	2.09
Closure (% , Average Basis)	100	100	100	100	100
Closure (% , Integrated Basis)	135	59	119	129	123

Mass Averaged

*stack gas velocity from carbon balance. Closure forced.

†Computed for traverse 2

Table 3.8.18. Mass concentrations (%) from DRI filter samples

Date	30-Apr-93		30-Apr-93		
Fuel	Douglas Fir Slash		Douglas Fir Slash		
	Traverse 1		Traverse 1		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT060		ABTT061		
Quartz Filter ID	ABTQ060		ABTQ061		
Teflon Field Sample Flag					
Quartz field sample field					
Teflon mass sample flag					
Quartz mass sample flag					
Anions sample flag					
Ammonium analysis flag					
Sodium ion analysis flag					
Magnesium ion analysis flag					
Potassium ion analysis flag					
Carbon analysis flag					
XRF analysis flag					
	±Uncertainty		±Uncertainty		
Teflon sample volume (m ³)	0.30	0.02	0.30	0.02	
Quartz sample volume (m ³)	0.30	0.02	0.30	0.02	
Teflon mass concentration (µg/m ³)	14,230	713	14,210	712	
	Concentration (%)	±Uncertainty	Concentration (%)	±Uncertainty	PM2.5/PM10
Cl-	0.1172	0.0185	0.1188	0.0186	0.99
NO3-	0.1848	0.0211	0.1879	0.0213	0.98
SO4=	0.7187	0.0543	0.7380	0.0556	0.97
NH4+	0.1506	0.0197	0.1404	0.0193	1.07
Na+	0.0934	0.0107	0.0909	0.0105	1.03
K+	0.8382	0.0633	0.9024	0.0681	0.93
C(org)	59.7647	5.7220	58.3405	5.5865	1.02
C(oh)	46.7082	7.0475	34.8856	5.2772	1.34
C(e)	12.2394	1.1570	15.4117	1.4584	0.79
C(eht)	0.7824	0.4773	1.9235	1.1741	0.41
C	72.0041		73.7522		0.98
Al	0.0109	0.0045	0.0418	0.0056	0.26
Si	0.0180	0.0124	0.0737	0.0135	0.24
P	0.0093	0.0031	0.0187	0.0035	0.50
S	0.2635	0.0189	0.2757	0.0198	0.96
Cl	0.1353	0.0111	0.1512	0.0122	0.89
K	0.9802	0.0697	1.0238	0.0728	0.96
Ca	0.0337	0.0061	0.2329	0.0176	0.14
Ti	0.0000	0.0161	0.0017	0.0163	0.00
V	0.0000	0.0070	0.0000	0.0071	
Cr	0.0000	0.0016	0.0000	0.0016	
Mn	0.0023	0.0008	0.0075	0.0009	0.31
Fe	0.0039	0.0028	0.0279	0.0034	0.14
Co	0.0000	0.0007	0.0000	0.0008	
Ni	0.0000	0.0007	0.0000	0.0007	
Cu	0.0000	0.0008	0.0000	0.0008	
Zn	0.0670	0.0069	0.0985	0.0070	0.98
Ga	0.0000	0.0014	0.0000	0.0014	
As	0.0047	0.0011	0.0046	0.0011	1.02
Se	0.0004	0.0009	0.0006	0.0009	0.67
Br	0.0040	0.0006	0.0038	0.0006	1.05
Rb	0.0033	0.0005	0.0034	0.0005	0.97
Sr	0.0001	0.0008	0.0011	0.0005	0.09
Y	0.0000	0.0010	0.0000	0.0010	
Zr	0.0000	0.0012	0.0000	0.0012	
Mo	0.0000	0.0020	0.0000	0.0021	
Pd	0.0000	0.0065	0.0009	0.0066	0.00
Ag	0.0017	0.0075	0.0020	0.0075	0.85
Cd	0.0008	0.0080	0.0000	0.0081	
In	0.0017	0.0092	0.0006	0.0092	2.83
Sn	0.0039	0.0118	0.0000	0.0116	
Sb	0.0000	0.0134	0.0000	0.0135	
Ba	0.0000	0.0482	0.0000	0.0487	
La	0.0000	0.0648	0.0000	0.0651	
Au	0.0000	0.0041	0.0000	0.0041	
Hg	0.0000	0.0018	0.0000	0.0019	
Tl	0.0000	0.0018	0.0000	0.0018	
Pb	0.0024	0.0015	0.0019	0.0024	1.26
U	0.0000	0.0018	0.0000	0.0018	
Sum of measured species	74.0100	5.8390	76.1435	5.7745	0.97

Table 3.8.19. Element ratios from DRI filter samples.

Date	30-Apr-93		30-Apr-93	
Fuel	Douglas Fir Slash		Douglas Fir Slash	
Configuration	Pile		Pile	
Size Fraction	PM2.5		PM10	PM2.5/PM10
Teflon Filter ID	ABTT060		ABTT061	
Quartz Filter ID	ABTQ060		ABTQ061	
Cl-/Cl	0.87		0.79	1.10
K+/K	0.86		0.88	0.97
Sulfate S/Total S	0.91		0.89	1.02
C(org)/C	0.83		0.79	1.05
Cl/K	0.14		0.15	0.93
Cl-/K+	0.14		0.13	1.06
Cl-/Na+	1.25		1.31	0.96
S/K	0.27		0.27	1.00
S/Na+	2.82		3.03	0.93
Al/Si	0.61		0.57	1.07

Table 3.8.20. Emission factors (mg/kg) from DRI filter samples.

Date	30-Apr-93		30-Apr-93		
Fuel	Douglas Fir Slash		Douglas Fir Slash		
	Traverse 1		Traverse 1		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT060		ABTT061		
Quartz Filter ID	ABTQ060		ABTQ061		
Start Time	10:23		10:23		
Stop Time	10:47		10:47		
Start Time	10:51		10:51		
End Time	10:57		10:57		
Elapsed Time (minutes)	30	Traverse 1	30	Traverse 1	
PM (mg/m ³ by total filter)	17.670		17.670		
PM10 (by total filter/impactor)	17.490		17.490		
PM2.5 (by total filter/impactor)	16.700		16.700		
PM emission factor (%)	1.312		1.312		
PM10 emission factor (%)	1.298		1.298		
PM2.5 emission factor (%)	1.239		1.239		
	<u>±Uncertainty</u>		<u>±Uncertainty</u>		
Teflon sample volume (m ³)	0.30	0.02	0.30	0.02	
Quartz sample volume (m ³)	0.30	0.02	0.30	0.02	
Teflon mass concentration (mg/m ³)	14.230	0.713	14.210	0.712	
Teflon mass/Total mass	0.852		0.812		
	<u>Emission (mg/kg)</u>	<u>±Uncertainty</u>	<u>Emission (mg/kg)</u>	<u>±Uncertainty</u>	<u>PM2.5/PM10</u>
Cl-	19.6204	2.2922	20.2516	2.4143	0.97
NO3-	30.9373	2.6143	32.0309	2.7647	0.97
SO4=	120.3174	6.7278	125.8051	7.2169	0.96
NH4+	25.2119	2.4408	23.9337	2.5051	1.05
Na+	15.6361	1.3257	15.4955	1.3629	1.01
K+	140.3229	7.8429	153.8300	8.8394	0.91
C(org)	10005.1970	708.9558	9945.1652	725.1277	1.01
C(oh)	7819.4109	873.1853	5946.8646	684.9806	1.31
C(e)	2048.9956	143.3523	2627.1956	189.0407	0.78
C(eht)	130.9814	59.1375	327.8944	152.3982	0.40
C	12054.1927	0.0000	12572.3608	0.0000	0.96
Al	1.8248	0.5576	7.1255	0.7269	0.26
Si	3.0134	1.5364	12.5635	1.7523	0.24
P	1.5569	0.3841	3.1877	0.4543	0.49
S	44.1125	2.3417	46.9979	2.5700	0.94
Cl	22.6505	1.3753	25.7747	1.5836	0.88
K	164.0951	8.6358	174.5247	9.4494	0.94
Ca	5.6417	0.7558	39.7019	2.2845	0.14
Ti	0.0000	1.9948	0.2898	2.1157	0.00
V	0.0000	0.8673	0.0000	0.9216	
Cr	0.0000	0.1982	0.0000	0.2077	
Mn	0.3850	0.0991	1.2785	0.1168	0.30
Fe	0.6529	0.3469	4.7560	0.4413	0.14
Co	0.0000	0.0867	0.0000	0.1038	
Ni	0.0000	0.0867	0.0000	0.0909	
Cu	0.0000	0.0991	0.0000	0.1038	
Zn	16.2388	0.8549	16.7911	0.9086	0.97
Ga	0.0000	0.1735	0.0000	0.1817	
As	0.7868	0.1363	0.7842	0.1428	1.00
Se	0.0670	0.1115	0.1023	0.1168	0.65
Br	0.6696	0.0743	0.6478	0.0779	1.03
Rb	0.5525	0.0620	0.5796	0.0649	0.95
Sr	0.0167	0.0991	0.1875	0.0649	0.09
Y	0.0000	0.1239	0.0000	0.1298	
Zr	0.0000	0.1487	0.0000	0.1558	
Mo	0.0000	0.2478	0.0000	0.2726	
Pd	0.0000	0.8054	0.1534	0.8567	0.00
Ag	0.2846	0.9293	0.3409	0.9735	0.83
Cd	0.1339	0.9912	0.0000	1.0514	
In	0.2846	1.1399	0.1023	1.1942	2.78
Sn	0.6529	1.4620	0.0000	1.5057	
Sb	0.0000	1.6603	0.0000	1.7523	
Ba	0.0000	5.9720	0.0000	6.3213	
La	0.0000	8.0287	0.0000	8.4500	
Au	0.0000	0.5080	0.0000	0.5322	
Hg	0.0000	0.2230	0.0000	0.2466	
Tl	0.0000	0.2230	0.0000	0.2336	
Pb	0.4018	0.1859	0.3239	0.3115	1.24
U	0.0000	0.2230	0.0000	0.2336	
Sum of measured species	12,390	723	12,980	715	0.95

Table 3.8.21. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Douglas Fir
 Date: 30-Apr-92
 Time: 10:37
 Filter ID: BJ-03

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	851,490	51,621	4,320
Na			13,815
Mg			5,292
Al			3,919
Si	33,205	3,878	3,219
P	4,622	1,551	3,234
S	28,246	2,942	3,407
Cl	131,631	8,093	3,517
K	213,723	11,591	2,186
Ca	60,713	5,248	1,595
Ti	3,459	1,337	1,426
V			1,243
Cr			1,021
Mn	2,035	585	940
Fe	9,207	1,011	942
Ni			671
Cu			680
Zn	20,989	1,247	610
As			589
Pb			1,599
Se			665
Br	1,271	345	706
Rb			1,106
Sr			1,157
Zr			1,868

Table 3.8.22. Element emission factors (mg/kg) from CNL filter samples.

Fuel: Douglas Fir
 Date: 30-Apr-92
 Time: 10:37
 Filter ID: BJ-03

Fuel rate (g/s) 4.44
 Stack gas flow rate (m³/s) 3.52
 Stack Temperature (°C) 38.46
 Ambient Temperature (°C) 24.00

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	643.7	39.0
Na		
Mg		
Al		
Si	25.1	2.9
P	3.5	1.2
S	21.4	2.2
Cl	99.5	6.1
K	161.6	8.8
Ca	45.9	4.0
Ti	2.6	1.0
V		
Cr		
Mn	1.5	0.4
Fe	7.0	0.8
Ni		
Cu		
Zn	15.9	0.9
As		
Pb		
Se		
Br	1.0	0.3
Rb		
Sr		
Zr		

Table 3.8.23. Element concentrations (ng/m³) from CNL filter samples.

Fuel: Douglas Fir
 Date: 30-Apr-92
 Time: 12:02
 Filter ID: BJ-04

Element	Concentration (ng/m ³)	±Uncertainty	MDL
H	74,695	10,960	3,201
Na			12,521
Mg	8,245	2,122	4,754
Al			3,478
Si	18,990	2,479	2,814
P	5,534	1,562	2,788
S	4,182	1,374	2,894
Cl	38,767	3,431	2,948
K	33,367	2,516	1,824
Ca	19,959	1,852	1,337
Ti	3,191	796	1,241
V			1,081
Cr			889
Mn	2,505	592	819
Fe	7,664	1,094	930
Ni			655
Cu			658
Zn	1,035	210	589
As			602
Pb			1,635
Se			681
Br	871	299	728
Rb			1,133
Sr			1,201
Zr			1,923

Table 3.8.24. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Douglas Fir	
Date:	30-Apr-92	
Time:	12:02	
Filter ID:	BJ-04	
Fuel rate (g/s)		0.95
Stack gas flow rate (m ³ /s)		2.17
Stack Temperature (°C)		33.92
Ambient Temperature (°C)		27.00
Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	166.8	24.5
Na		
Mg	18.4	4.7
Al		
Si	42.4	5.5
P	12.4	3.5
S	9.3	3.1
Cl	86.6	7.7
K	74.5	5.6
Ca	44.6	4.1
Ti	7.1	1.8
V		
Cr		
Mn	5.6	1.3
Fe	17.1	2.4
Ni		
Cu		
Zn	2.3	0.5
As		
Pb		
Se		
Br	1.9	0.7
Rb		
Sr		
Zr		

Table 3.8.25.
VOC Concentrations (ppbv)

Date	30-Apr-93	30-Apr-93
Fuel	Douglas Fir	Douglas Fir
Traverse	Traverse 1	Traverse 2
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	100.5	12.5
Dimethylbutane		
Hexane		
Phenol	45.9	
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	69.9	7.3
Benzonitrile		
Benzaldehyde		
Methylphenol (hydroxy toluene)		
Styrene	61.5	
Xylene		
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		
Naphthalene	78.4	5.2
C10H12	40.2	7.4
Alpha-pinene	72	
Camphene	134.5	
Δ^3 -Carene		
Limonene	244.3	
No match r.t. (6.7)		
No match r.t. (8.51)		
No match r.t. (8.71)		
No match r.t. (8.73)		
No match r.t.(6.4)		
No match r.t.(8.5)		

Table 3.8.26.
VOC Emission Factors (mg/kg)

Date	30-Apr-93	30-Apr-93
Fuel	Douglas Fir	Douglas Fir
Traverse	Traverse 1	Traverse 2
Fuel Consumption Rate (g/s d.b)	4.44	0.95
Stack Gas Mass Flow Rate* (kg/s)	4.00	2.50
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	244	89
Dimethylbutane		
Hexane		
Phenol	134	
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	200	61
Benzonitrile		
Benzaldehyde		
Methylphenol (hydroxy toluene)		
Styrene	199	
Xylene		
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		
Naphthalene	312	60
Unknown	165	89
Alpha-pinene	305	
Camphene	569	
Δ^3 -Carene		
Limonene	1,034	

*uses stack gas flow rate from carbon balance

Table 3.8.27. PAH emission factors, Douglas fir slash, 30 April 1993, measured stack gas velocity (zero indicates not detected).

	Traverse 1 Filter	Traverse 3 Filter	Trap	Traverse 1 Sorbent	Traverse 3 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 3	Total Average
	µg/kg dry fuel								
Naphthalene	104	59	1	11,905	4,542	16	12,026	4,618	8,322
2-Methyl-naphthalene	22	13	0	2,482	585	4	2,508	582	1,545
Acenaphthylene	18	8	0	2,052	910	0	2,070	918	1,494
Acenaphthene	0	0	0	2,094	1,036	0	2,094	1,036	1,565
Fluorene	0	0	0	819	215	0	819	215	517
Phenanthrene	294	95	0	3,699	577	6	3,999	678	2,338
Anthracene	59	18	0	669	110	1	729	130	430
Fluoranthene	739	169	0	901	334	0	1,640	503	1,072
Pyrene	612	104	0	773	288	0	1,385	392	888
Benz[a]-anthracene	81	45	1	145	31	0	227	78	152
Chrysene	77	62	1	114	12	0	192	74	133
Benzo[b]-fluoranthene	0	7	0	59	0	0	59	7	33
Benzo[k]-fluoranthene	11	19	0	131	0	0	142	19	80
Benzo[a]pyrene	10	6	0	25	0	0	35	6	21
Benzo[e]pyrene	14	3	0	43	3	0	57	6	32
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	0	3	0	0	0	0	0	3	2
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	2,041	613	4	25,912	8,622	27	27,983	9,265	18,624

Table 3.6.28. PAH emission factors, Douglas fir slash, 30 April 1993, stack gas velocity from carbon balance.

	Traverse 1 Filter	Traverse 3 Filter	Trap	Traverse 1 Sorbent	Traverse 3 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 3	Total Average
µg/kg dry fuel									
Naphthalene	180	79	2	20,746	6,079	23	20,951	6,184	13,567
2-Methyl-naphthalene	39	17	1	4,325	756	6	4,370	779	2,575
Acenaphthylene	31	11	0	3,575	1,217	0	3,607	1,229	2,418
Acenaphthene	0	0	0	3,650	1,387	0	3,650	1,387	2,518
Fluorene	0	1	0	1,427	288	0	1,427	288	857
Phenanthrene	513	127	0	6,445	772	9	6,967	908	3,938
Anthracene	103	25	0	1,165	148	2	1,271	175	723
Fluoranthene	1,287	228	1	1,571	446	0	2,859	673	1,766
Pyrene	1,066	139	0	1,347	386	0	2,413	525	1,469
Benz[a]-anthracene	141	60	2	253	42	0	396	104	250
Chrysene	135	83	1	199	15	0	335	99	217
Benzo[b]-fluoranthene	0	9	0	103	0	0	103	9	56
Benzo[k]-fluoranthene	19	25	0	228	0	0	248	25	136
Benzo[a]pyrene	18	8	0	43	0	0	61	8	35
Benzo[e]pyrene	24	4	0	75	4	0	99	9	54
Perylene	0	0	0	0	0	0	0	0	0
Benzo[ghi]-perylene	0	5	0	0	0	0	0	5	5
Indeno[1,2,3-cd]-pyrene	0	0	0	0	0	0	0	0	0
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	3,556	820	5	45,153	11,540	41	48,755	12,406	30,583

Figure 3.8.1. Air temperature and relative humidity from CIMIS station.

Fuel: Douglas Fir Date of Test: 30-Apr-93

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

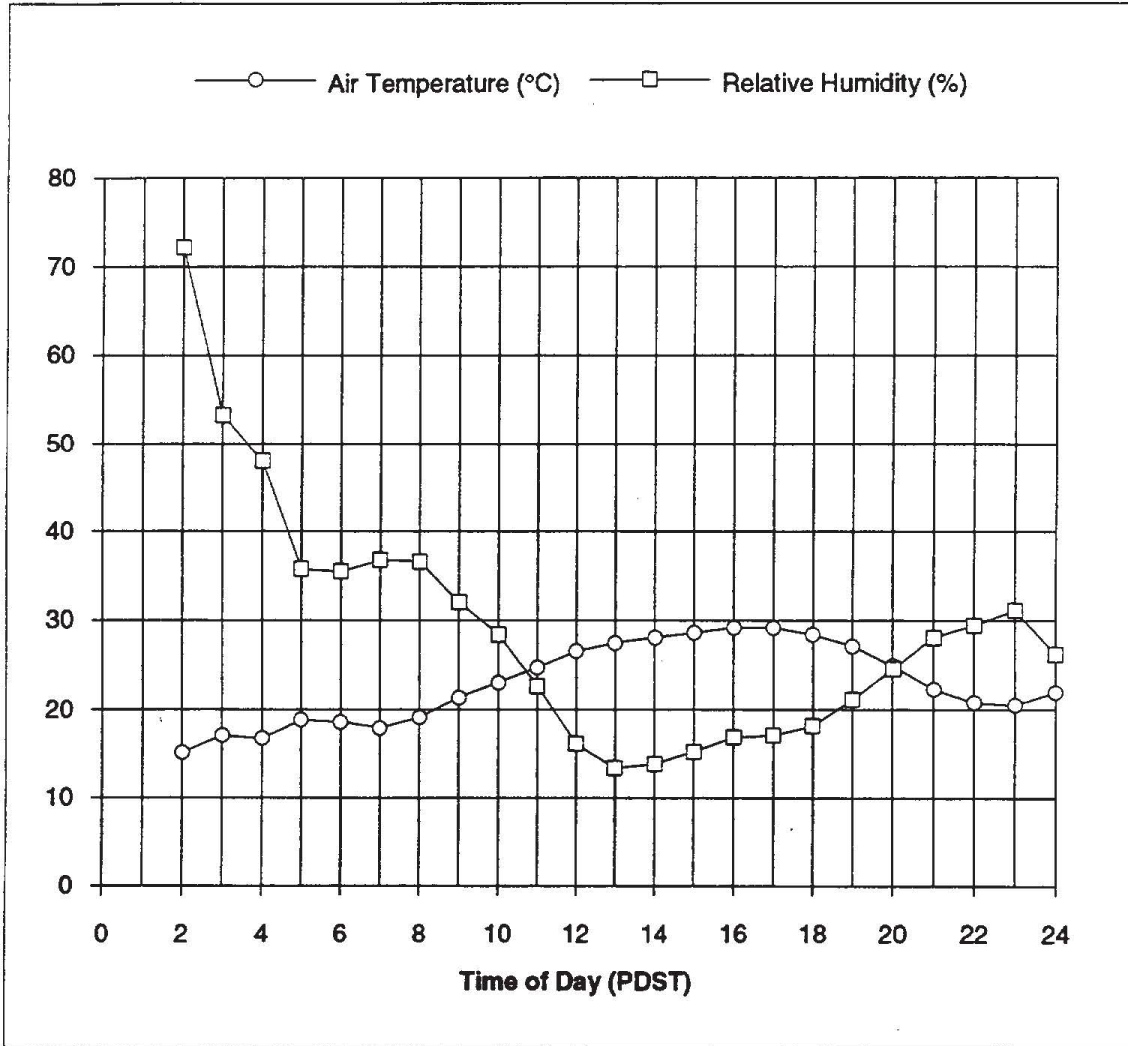


Figure 3.8.2. Wind speed from CIMIS station.

Fuel: Douglas Fir

Date of Test:

30-Apr-93

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

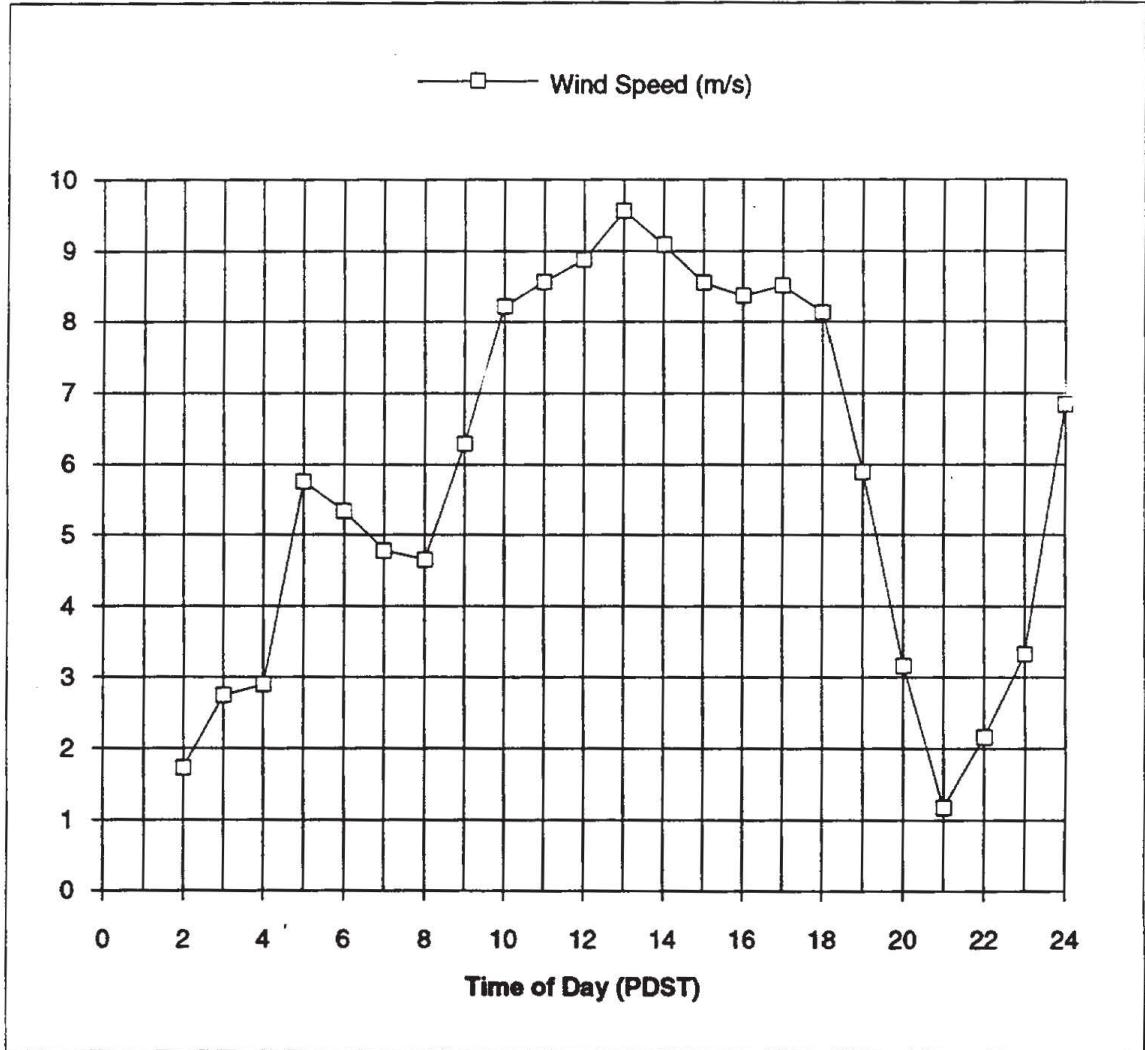


Figure 3.8.3. Wind direction and solar radiation from CIMIS station.

Fuel: Douglas Fir Date of Test: 30-Apr-93

Configuration: Pile

Hourly Average CIMIS Data for Davis, California

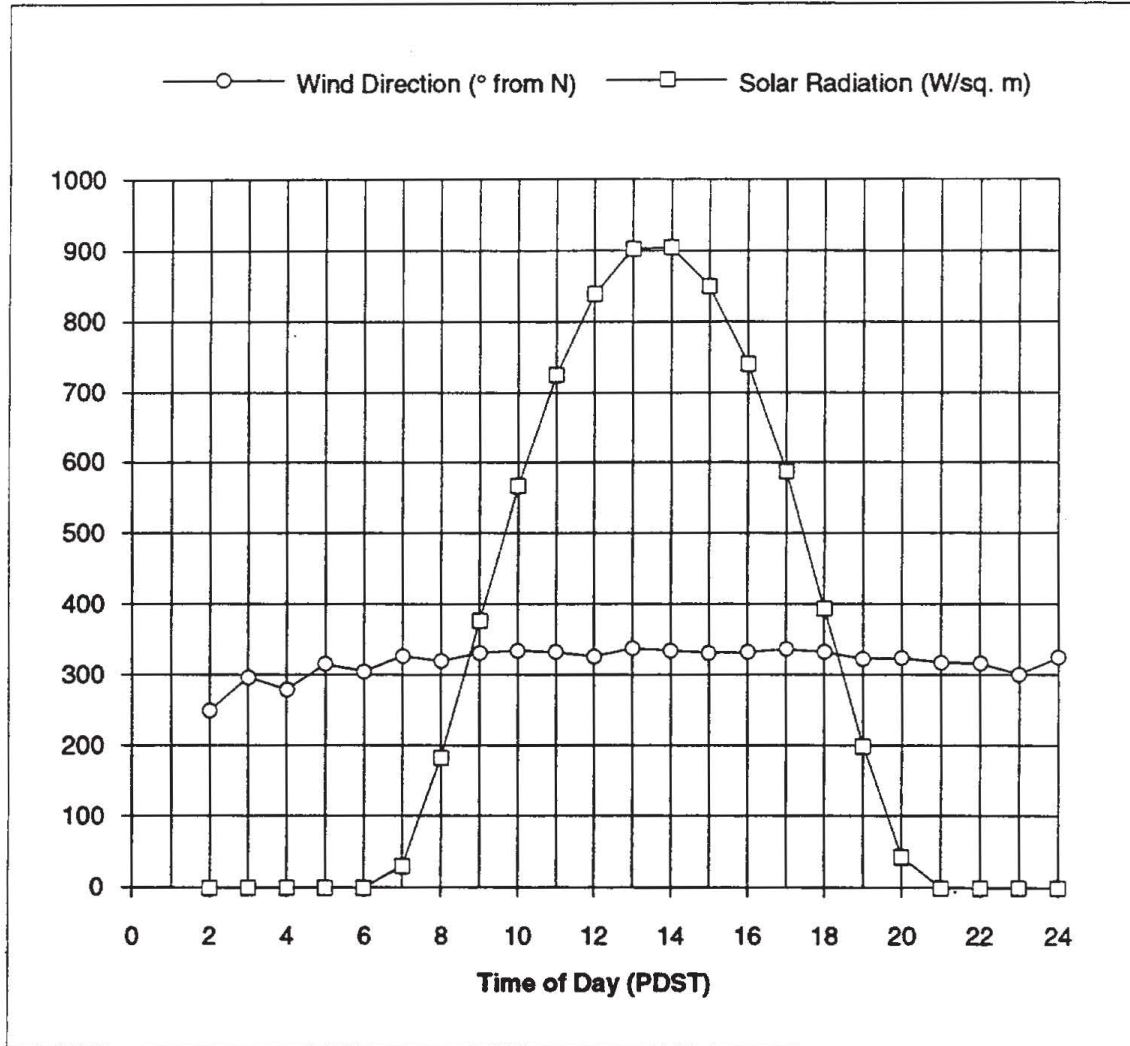


Figure 3.8.4. Inlet air, stack gas, and impinger temperatures, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date 30-Apr-93

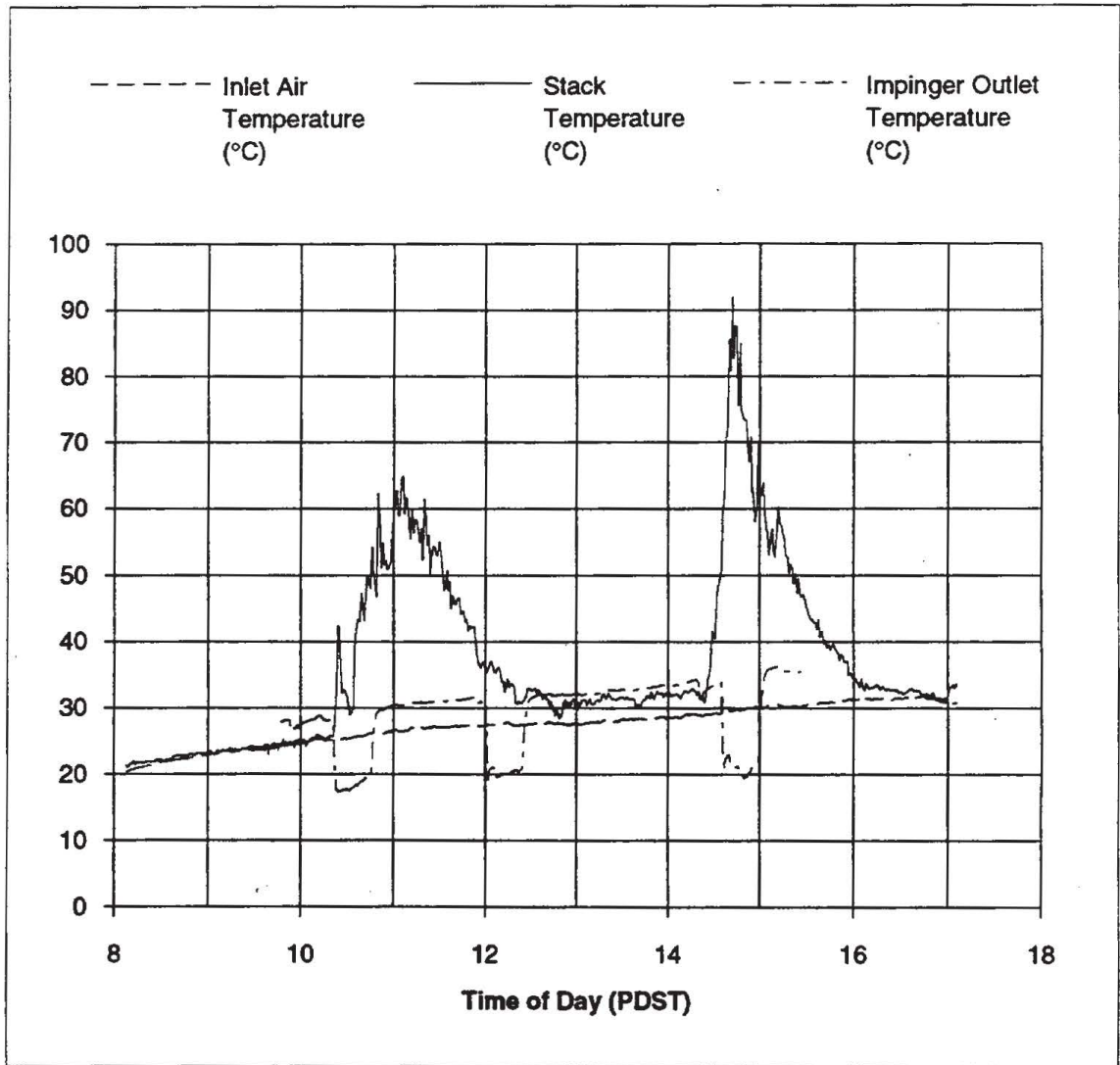


Figure 3.8.5. Stack gas velocity, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date 30-Apr-93

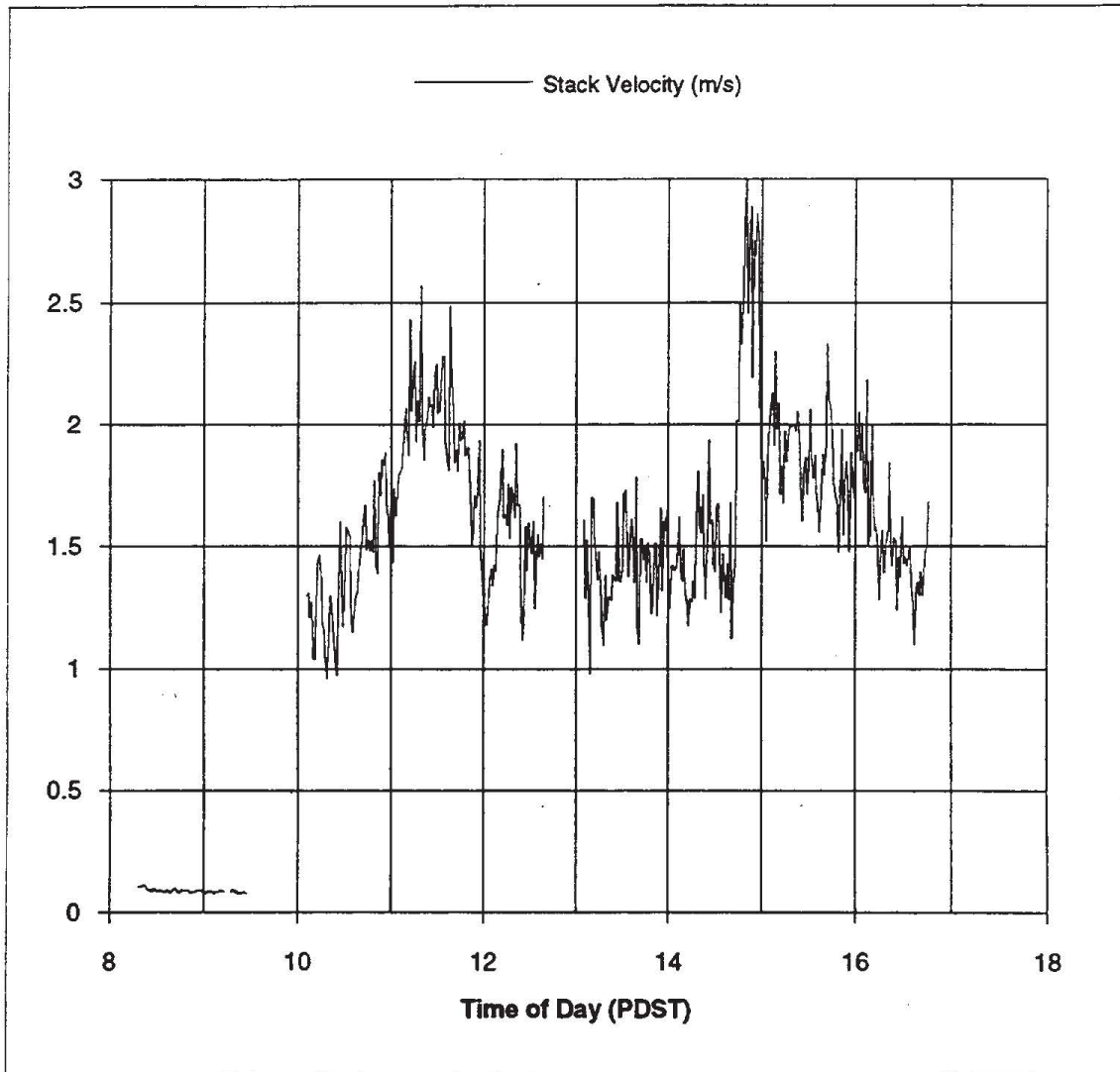


Figure 3.8.6. CO concentration in stack gas, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date 30-Apr-93

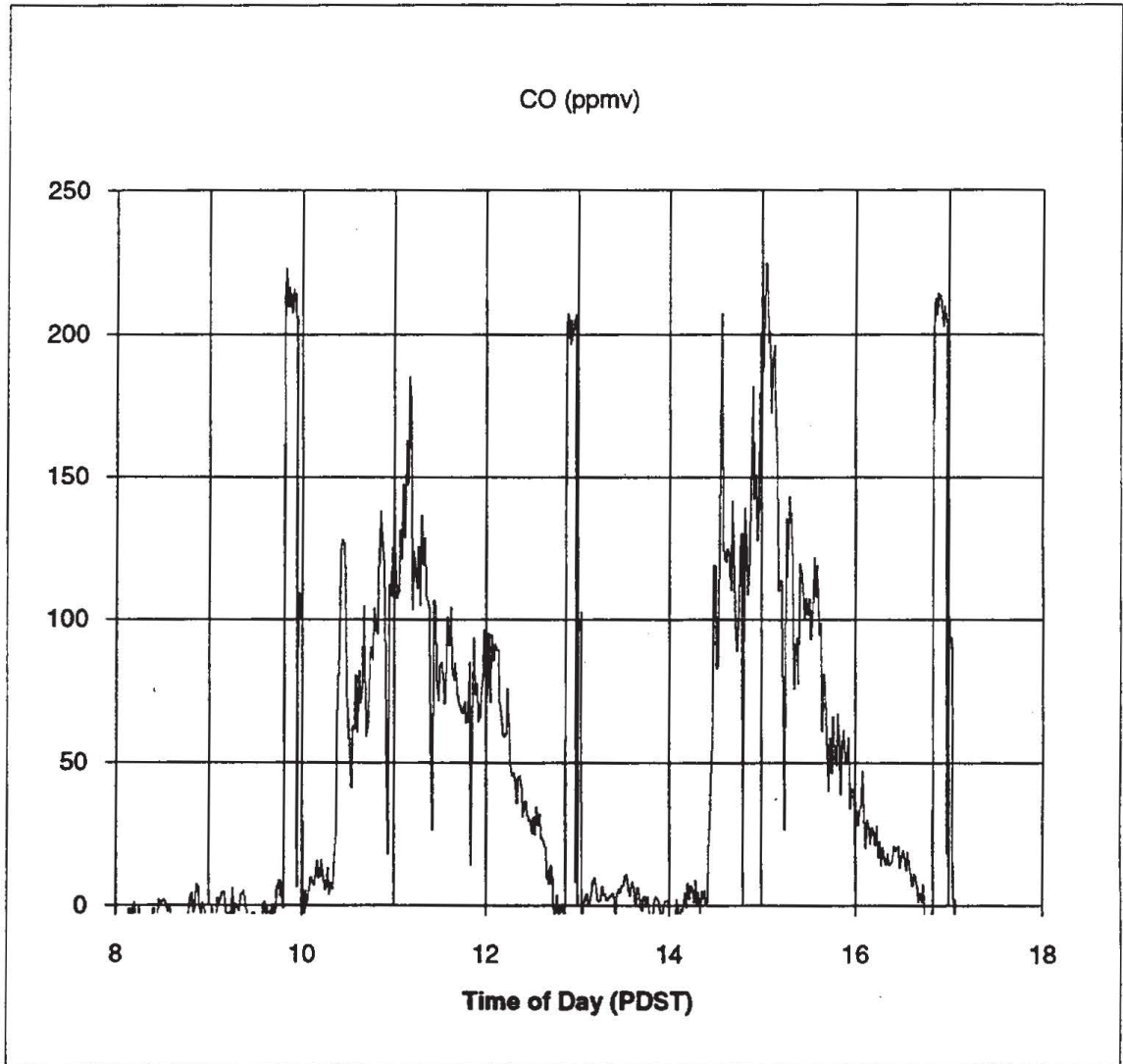


Figure 3.8.7. NO and NOx concentrations in stack gas, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date: 30-Apr-93
Figure No.: 5

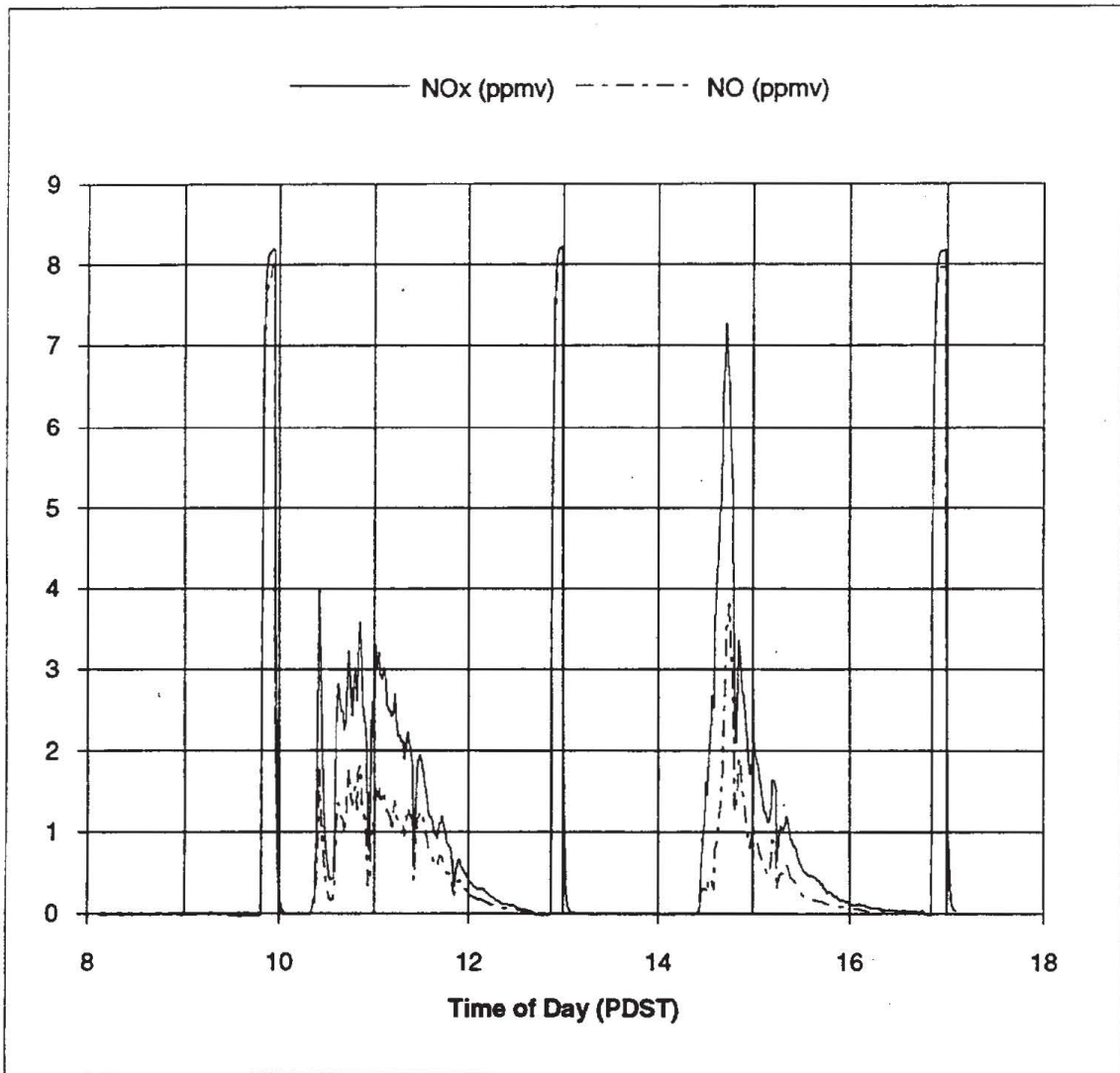


Figure 3.8.8. SO2 concentration in stack gas, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date

30-Apr-93

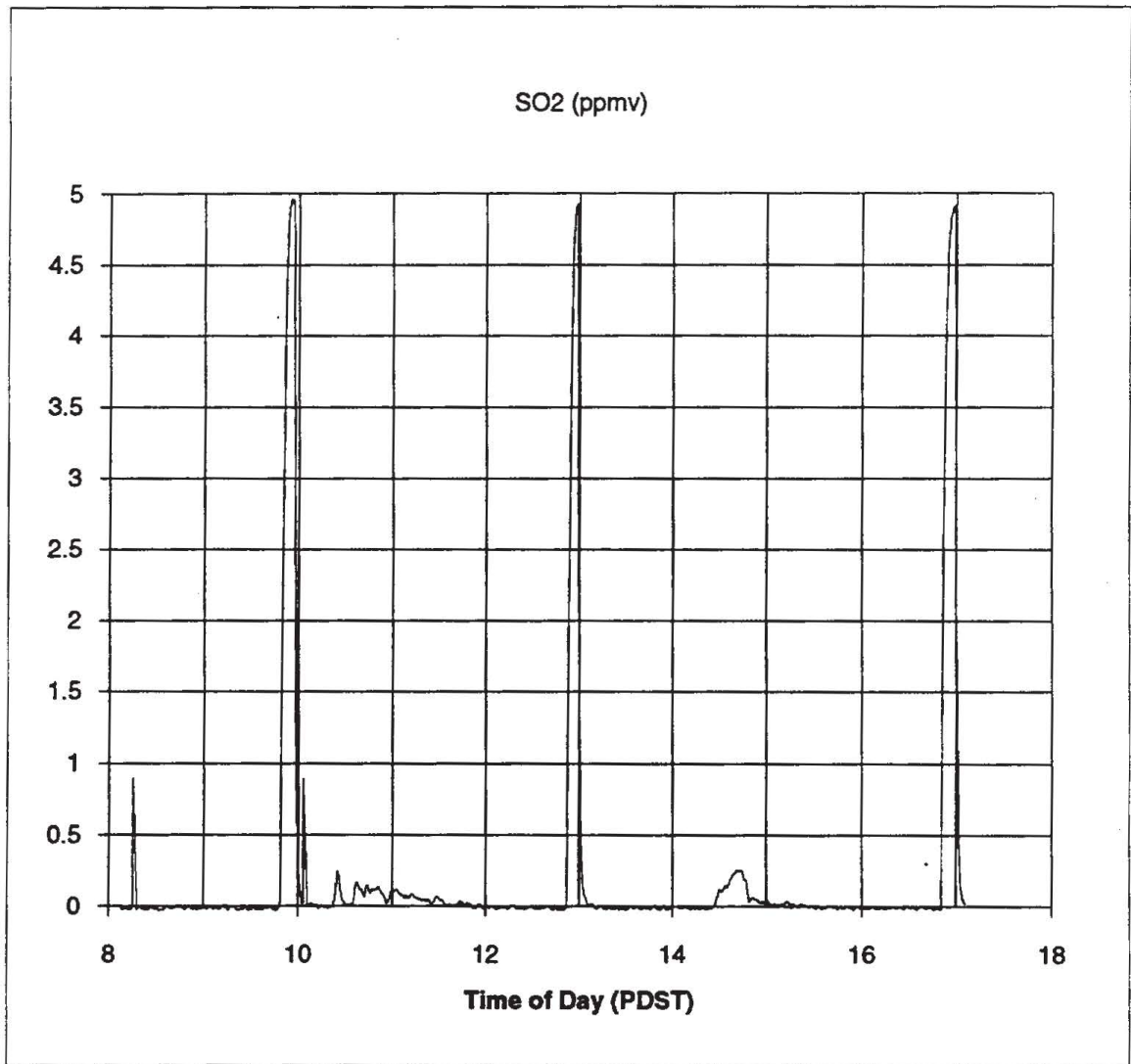


Figure 3.8.9. Total sulfur concentration in stack gas, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date 30-Apr-93

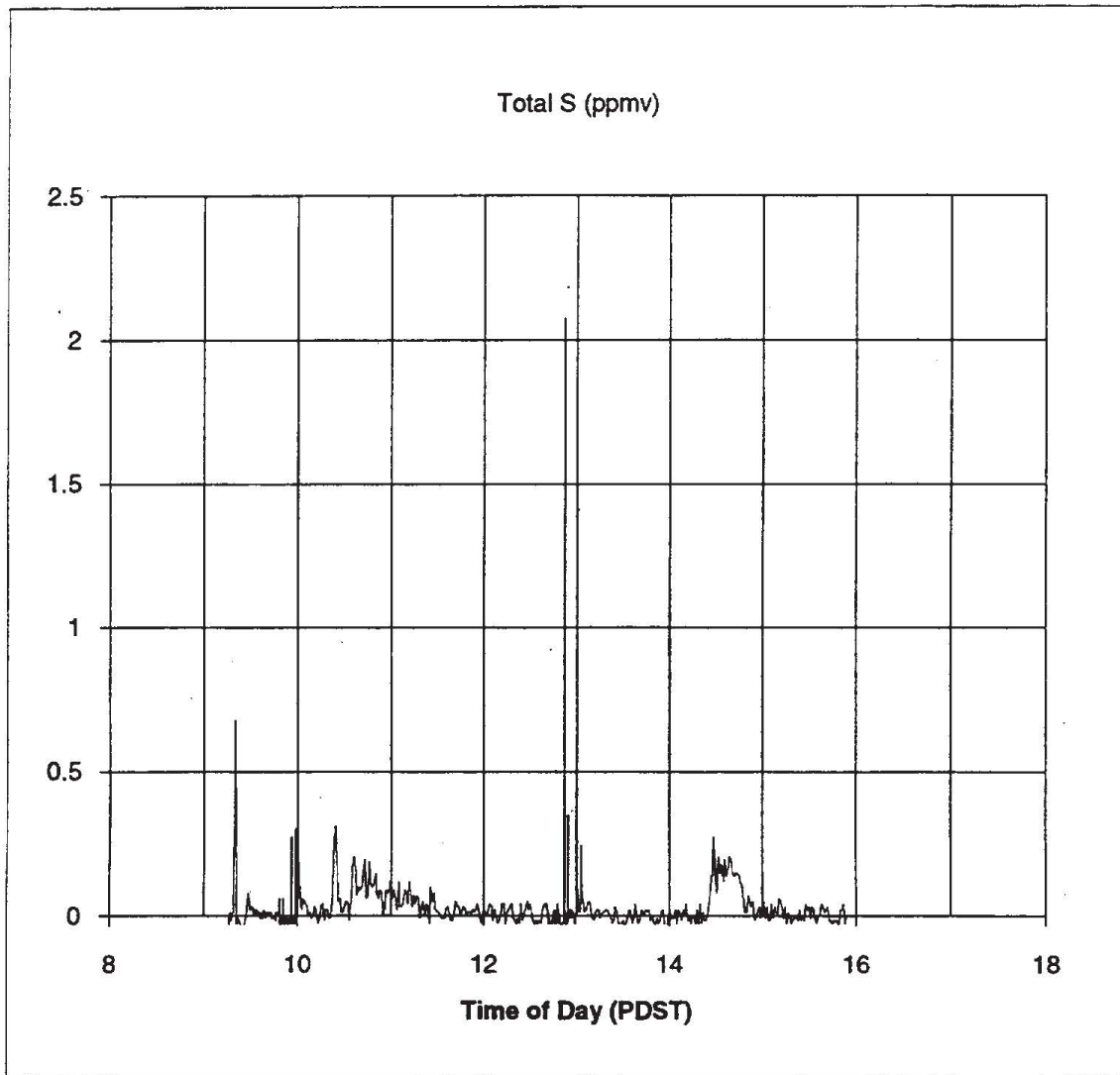


Figure 3.8.10. THC concentration in stack gas, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date 30-Apr-93

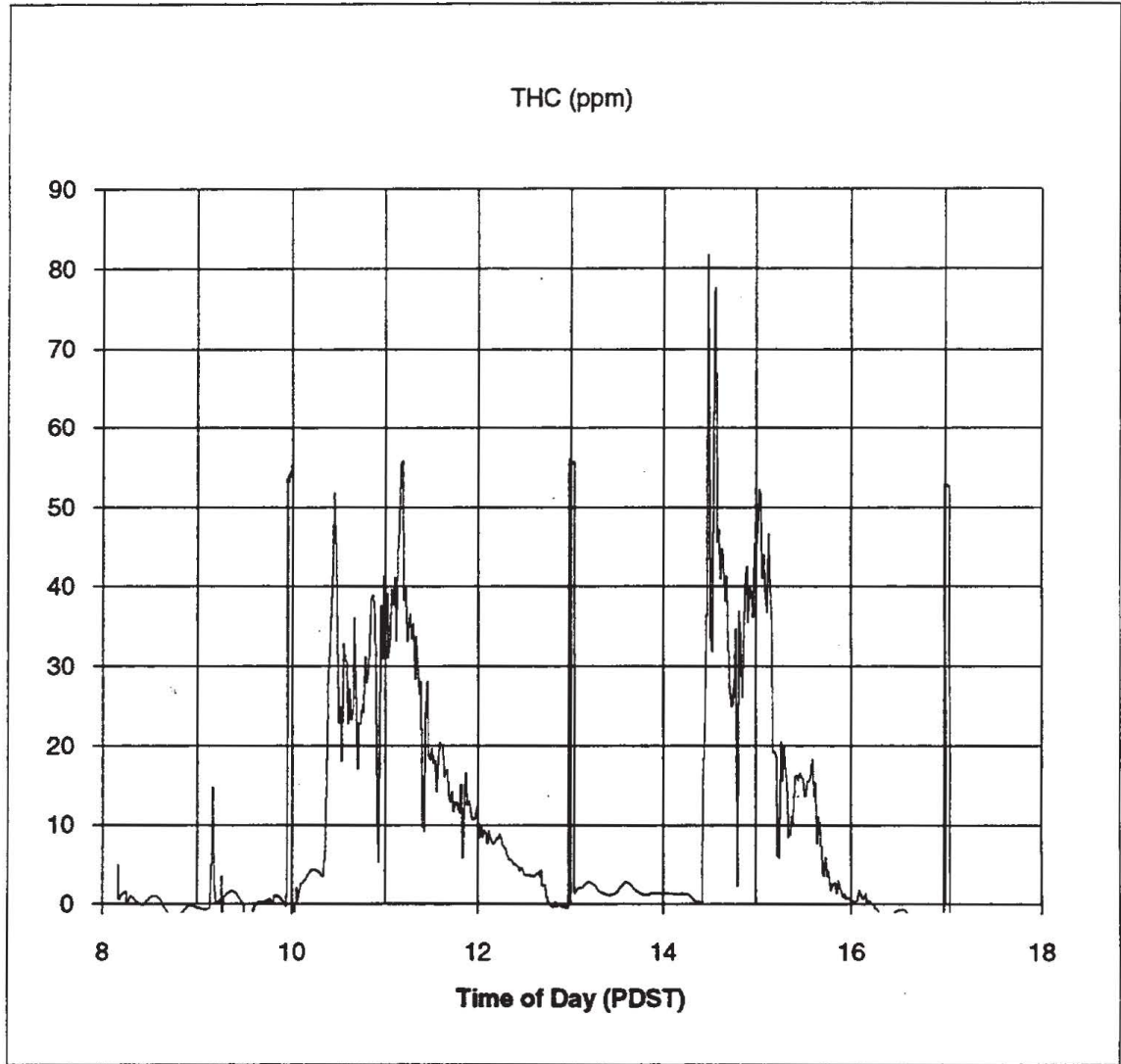


Figure 3.8.11. CO2 concentration in stack gas, 30 April 93.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date 30-Apr-93

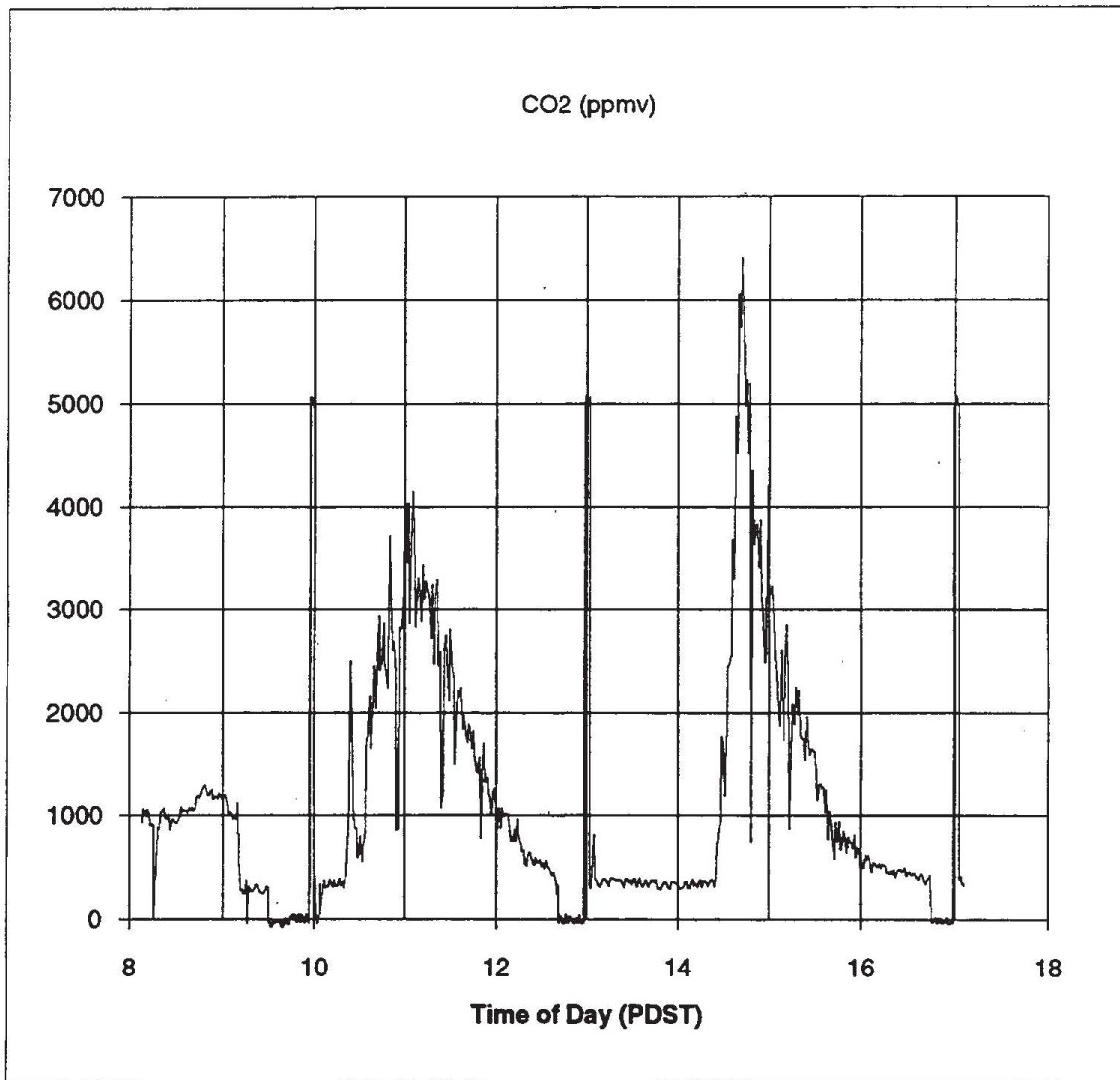


Figure 3.8.12. Particle size distribution, traverse 1, 30 April 93.

Fuel: Douglas Fir Date of Test: 30-Apr-93

Configuration: Pile

Particle Size Distribution

Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.76	0.13	8.06	1.000
2	7.71	0.16	7.93	0.984
3	4.11	0.18	7.77	0.964
4	2.17	0.19	7.59	0.942
5	1.25	0.24	7.4	0.918
6	0.74	0.87	7.16	0.888
7	0.38	0.96	6.29	0.780
filter	0.00	5.33	5.33	0.661

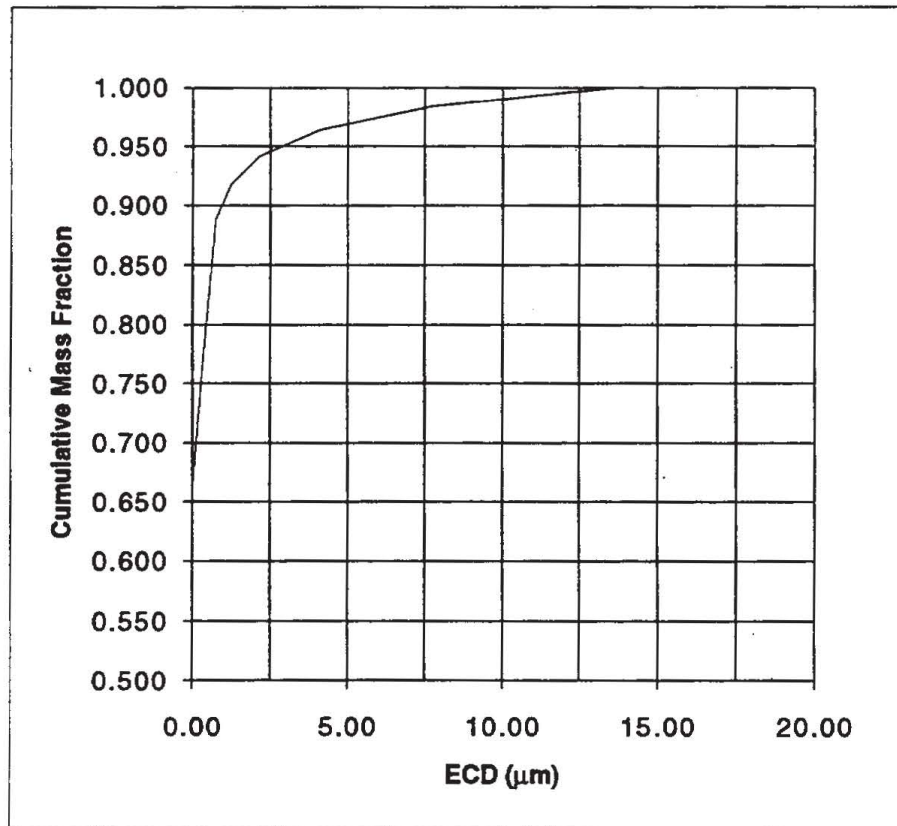


Figure 3.8.13. Particle size distribution, traverse 2, 30 April 93.

Fuel: Douglas Fir Date of Test: 30-Apr-93
Configuration: Pile

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.74	0.06	0.71	1.000
2	7.70	0.05	0.65	0.915
3	4.10	0.05	0.6	0.845
4	2.17	0.05	0.55	0.775
5	1.25	0.04	0.5	0.704
6	0.73	0.05	0.46	0.648
7	0.38	0.05	0.41	0.577
filter	0.00	0.36	0.36	0.507

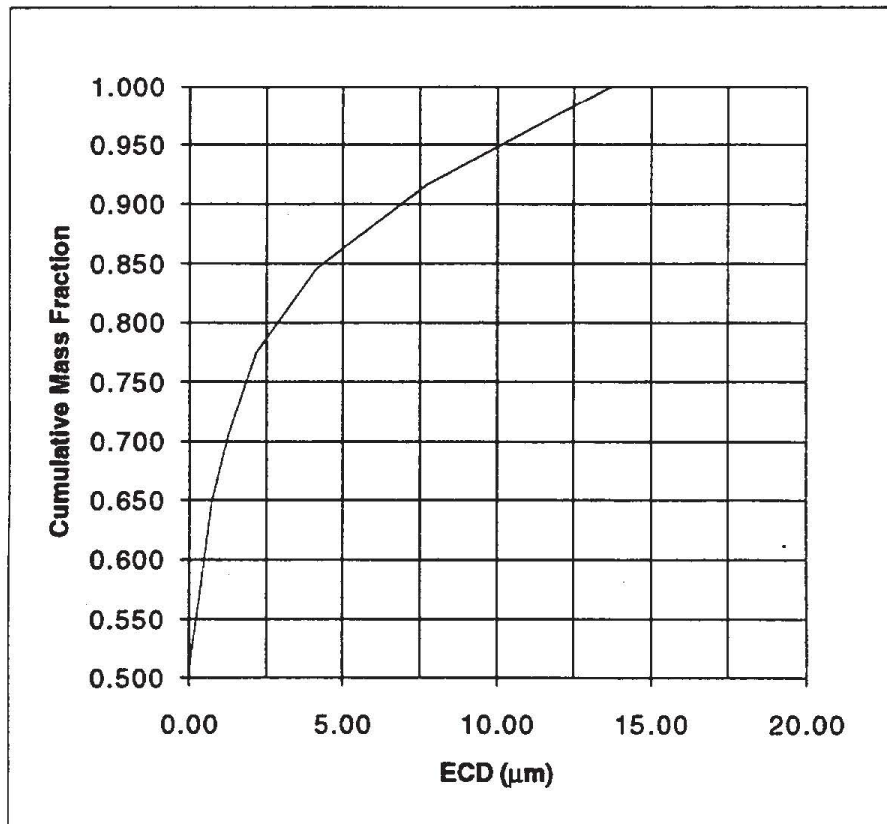


Figure 3.8.14. Particle size distribution, traverse 3, 30 April 93.

Fuel: Douglas Fir Date of Test: 30-Apr-93
Configuration: Pile

Particle Size Distribution
Traverse 3:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.80	0.52	6.14	1.000
2	7.71	0.39	5.62	0.915
3	4.11	0.4	5.23	0.852
4	2.17	0.41	4.83	0.787
5	1.25	0.4	4.42	0.720
6	0.74	0.78	4.02	0.655
7	0.38	1.05	3.24	0.528
filter	0.00	2.19	2.19	0.357

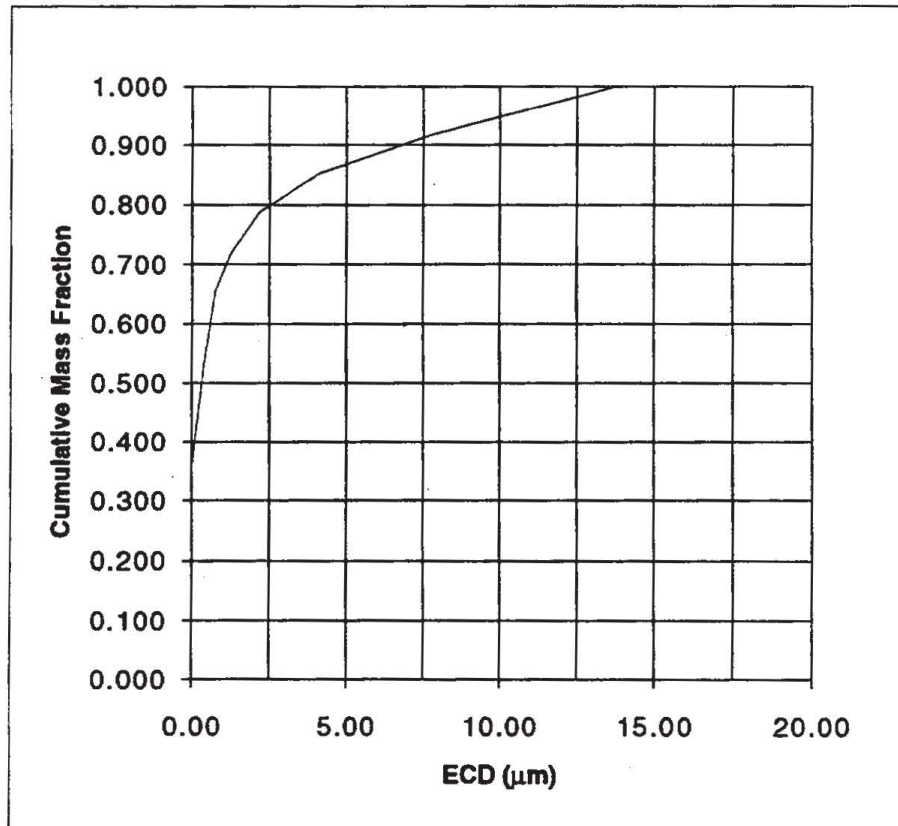


Figure 3.8.15. Weight on burning platform, Douglas fir slash burns.

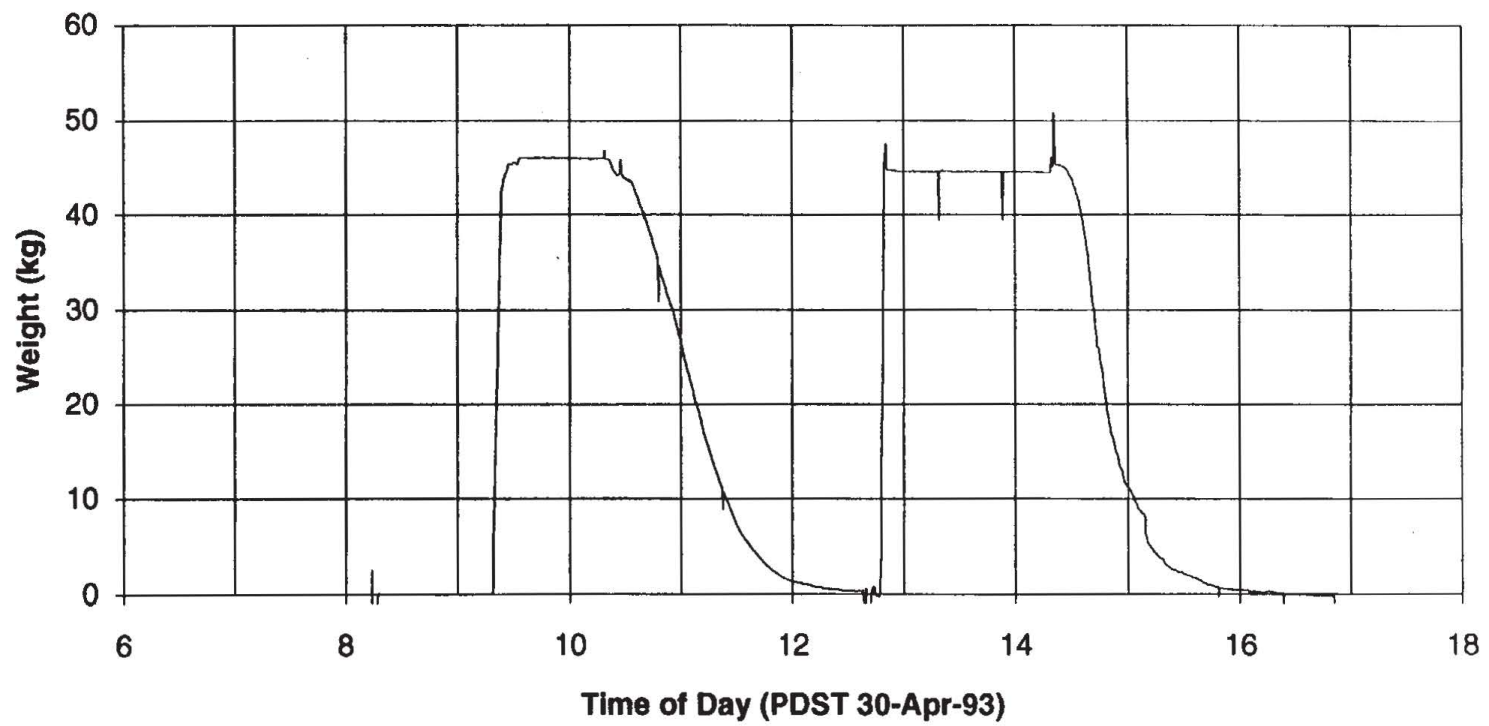


Figure 3.8.16. Residual weight profiles for Douglas fir slash burns.

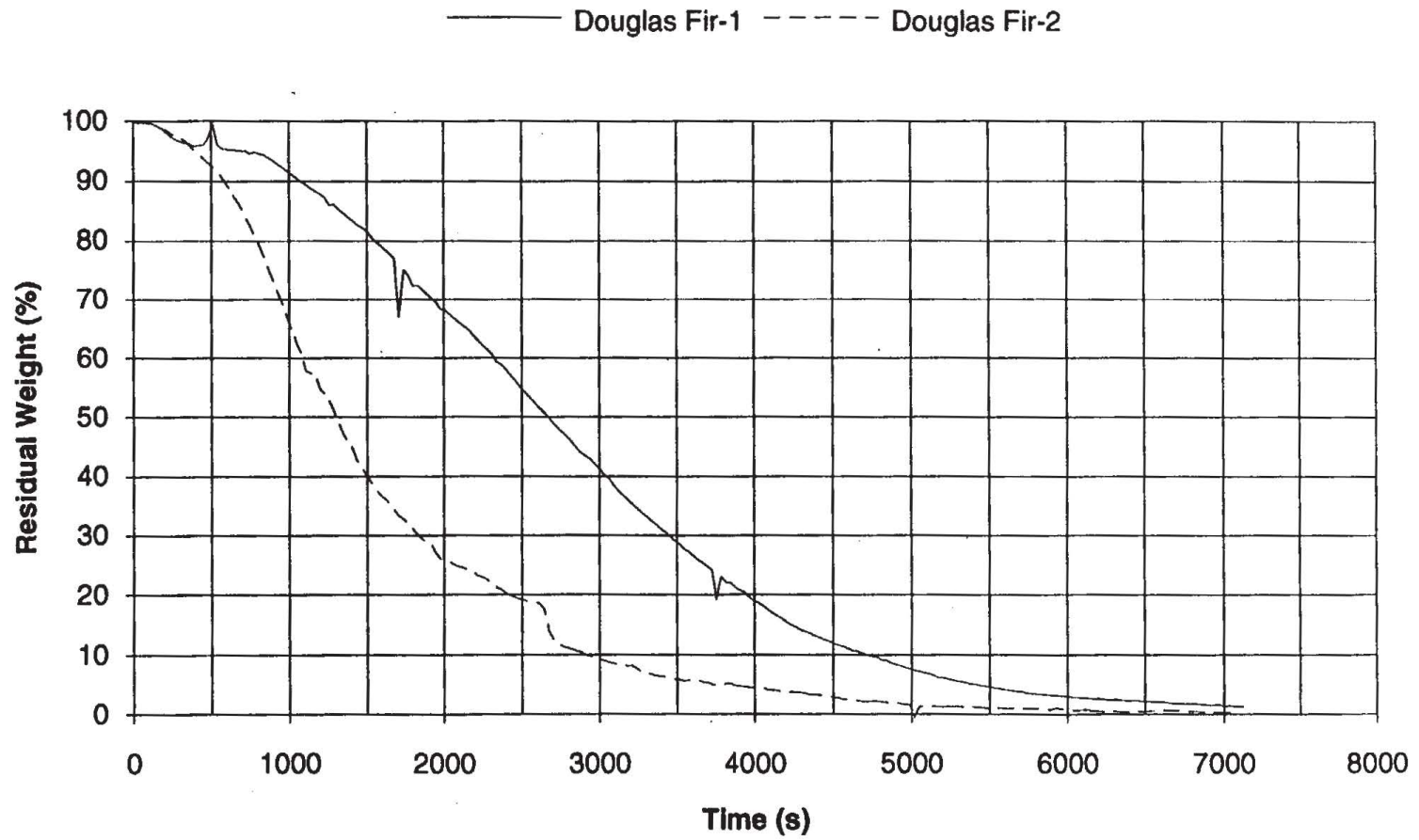


Figure 3.8.17. Rates of weight loss for Douglas fir slash.

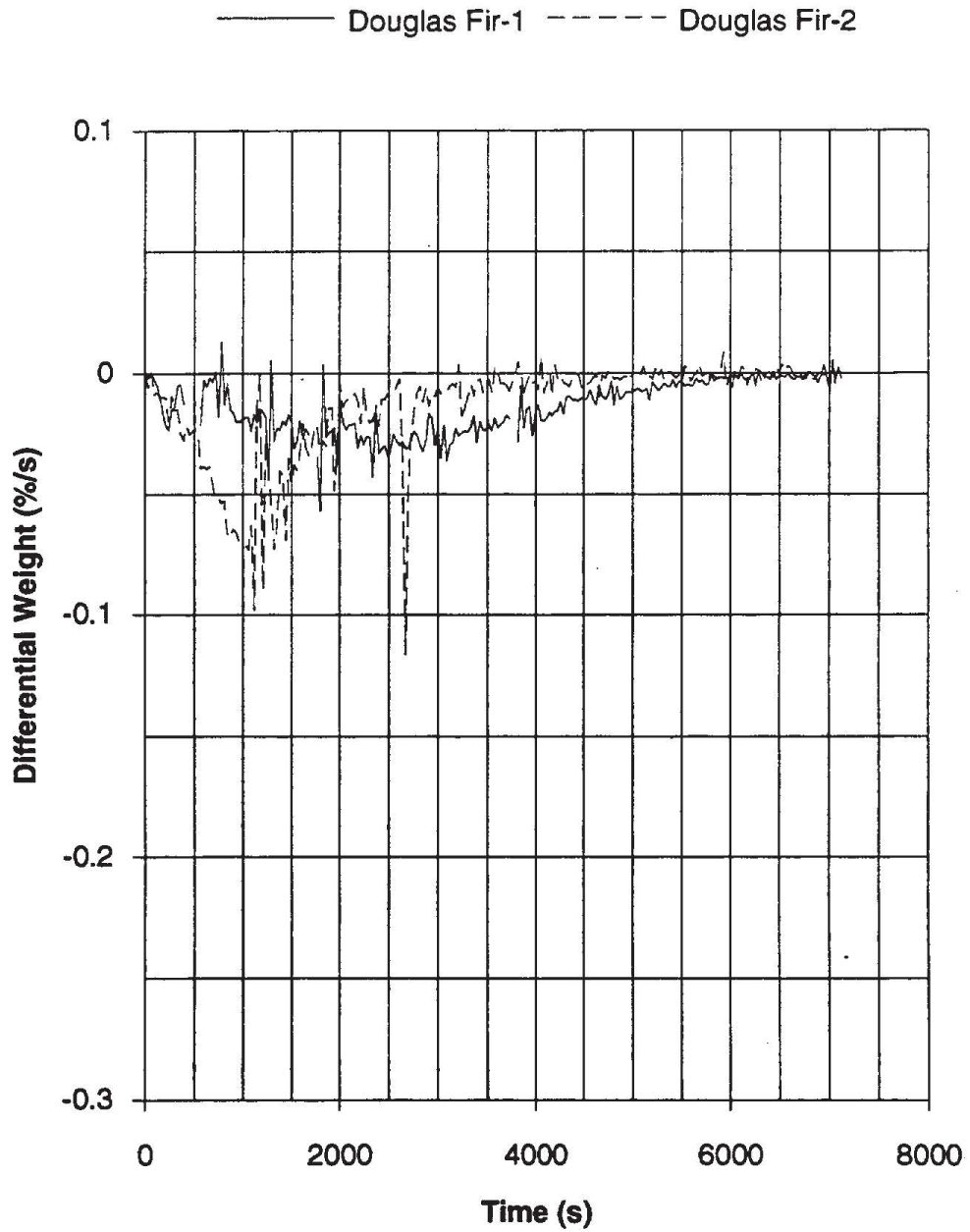


Figure 3.8.18. Residual weight profiles for Ponderosa pine and Douglas fir slash burns.

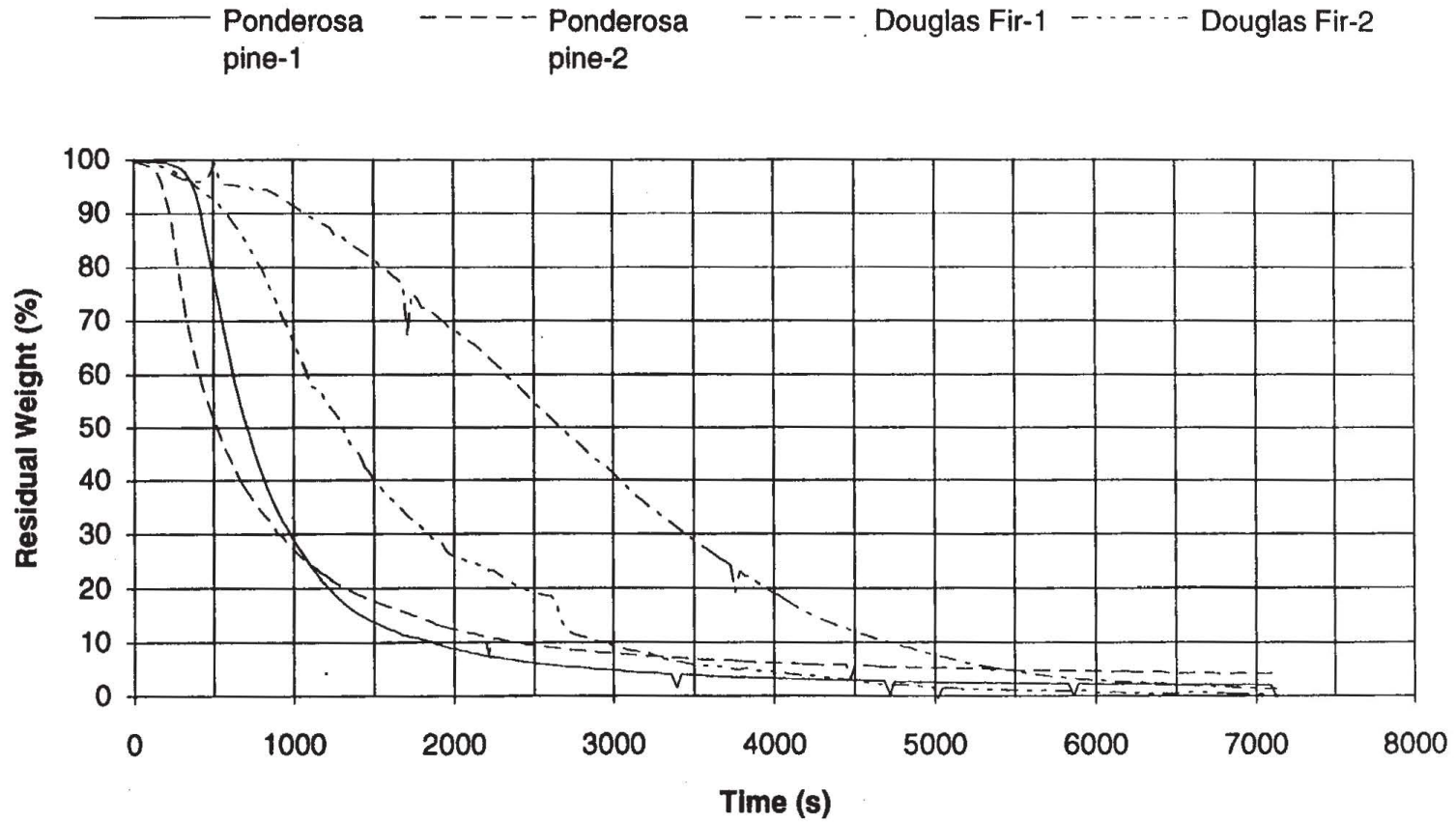


Figure 3.8.19. Nitrogen balance.

Date of Test:
Fuel

30-Apr-93
Douglas Fir
Average Tests 1, 2

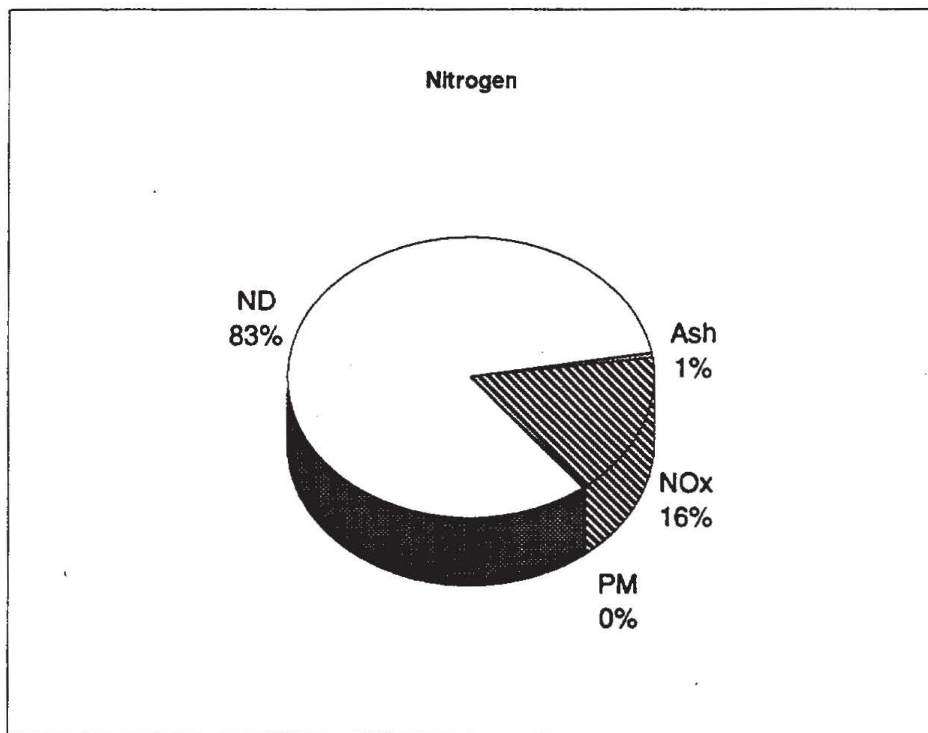


Figure 3.8.20. Sulfur balance.
Date of Test:
Fuel

30-Apr-93
Douglas Fir
Average Tests 1, 2

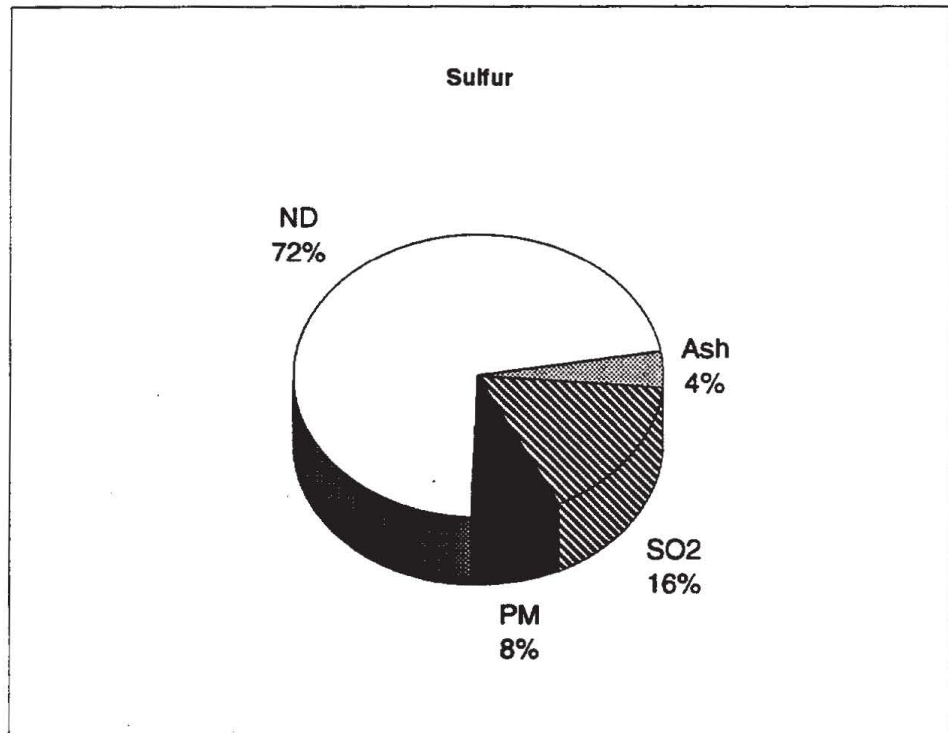
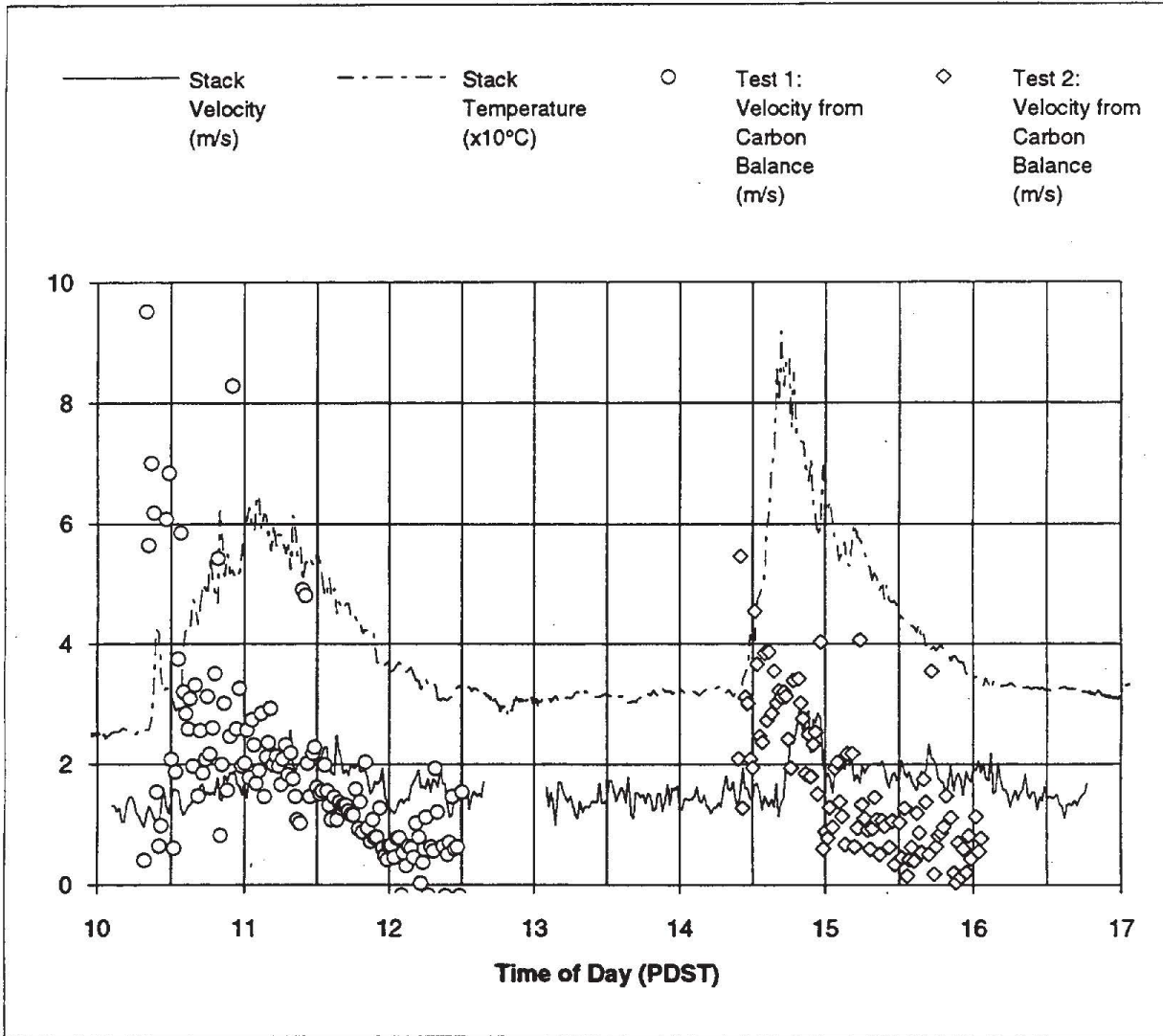


Figure 3.8.21. Comparison of estimated and measured stack gas velocities.

Fuel Type: Douglas Fir
Configuration: Pile

Test Date 30-Apr



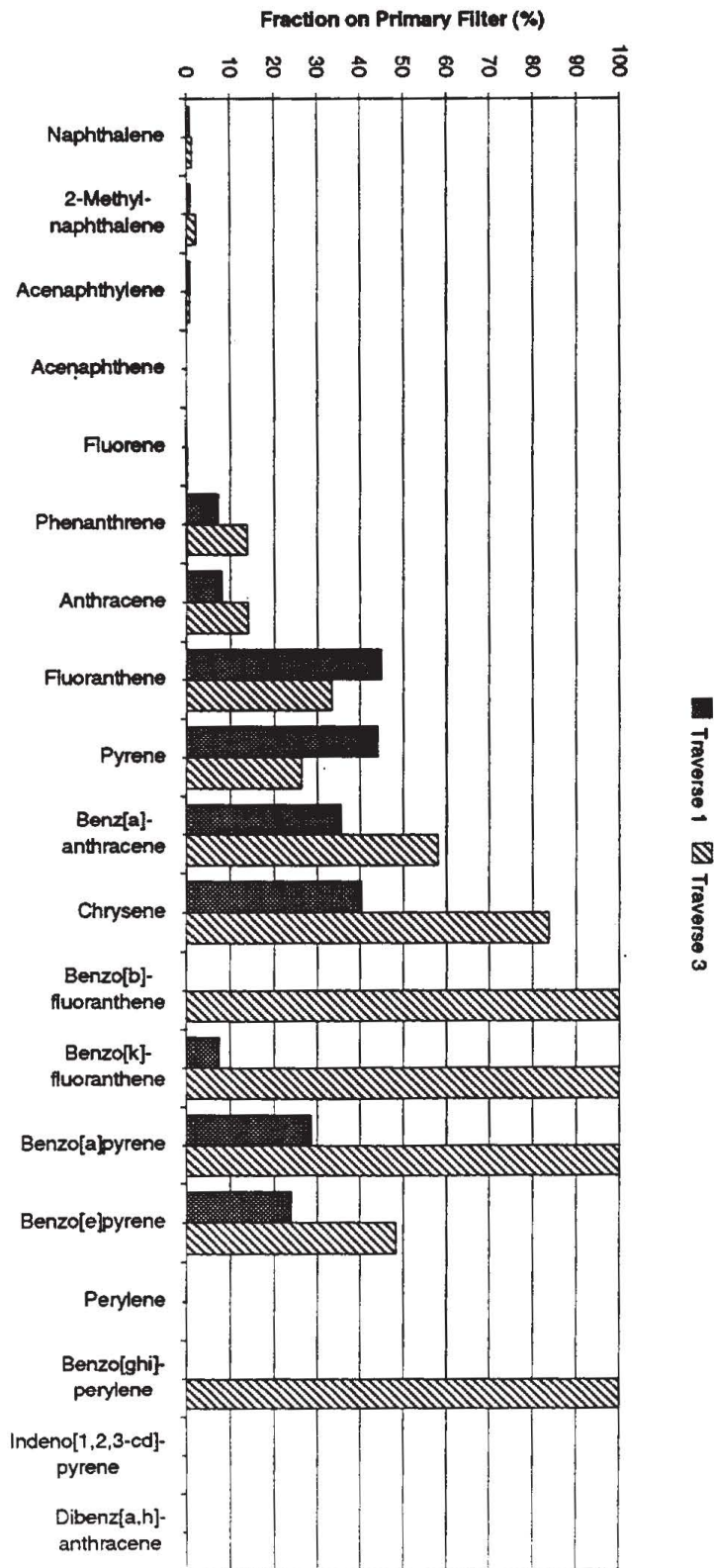


Figure 3.8.22. Mass fraction of PAH on primary filter samples, 30 April 1993, douglas fir slash (measured stack gas velocity).

