Figure 3.1.5.4. Wind direction and solar radiation from CIMIS station.

Fuel: Rice Straw Date of Test: 25-Aug-92

Configuration: CEWF

Hourly Average CIMIS Data for Davis, California

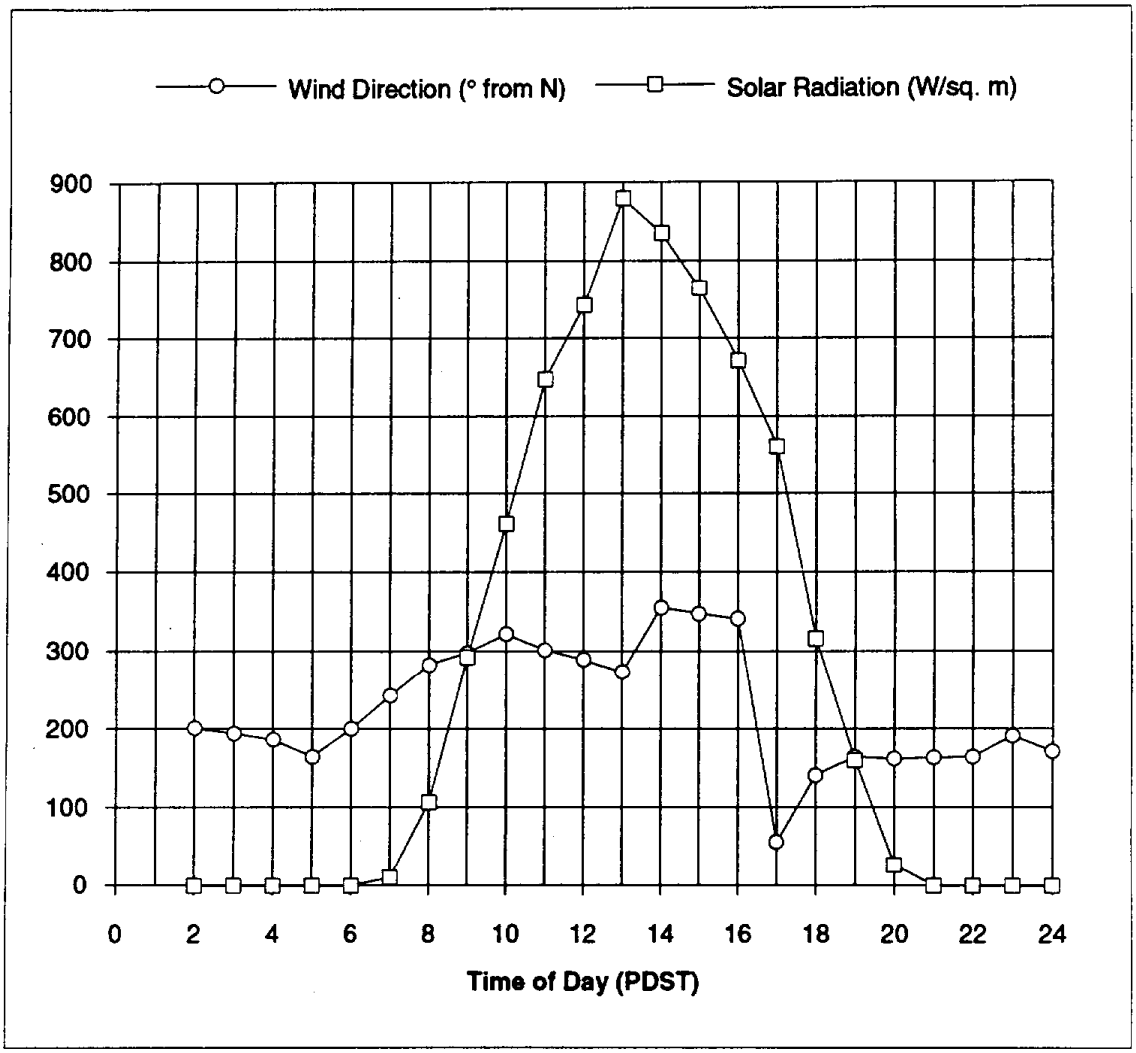

Figure 3.1.5.5. Inlet air and stack gas temperatures, 25 August 92.

Fuel Type: Rice Straw
Configuration: CEWF

Test Date 25-Aug-92

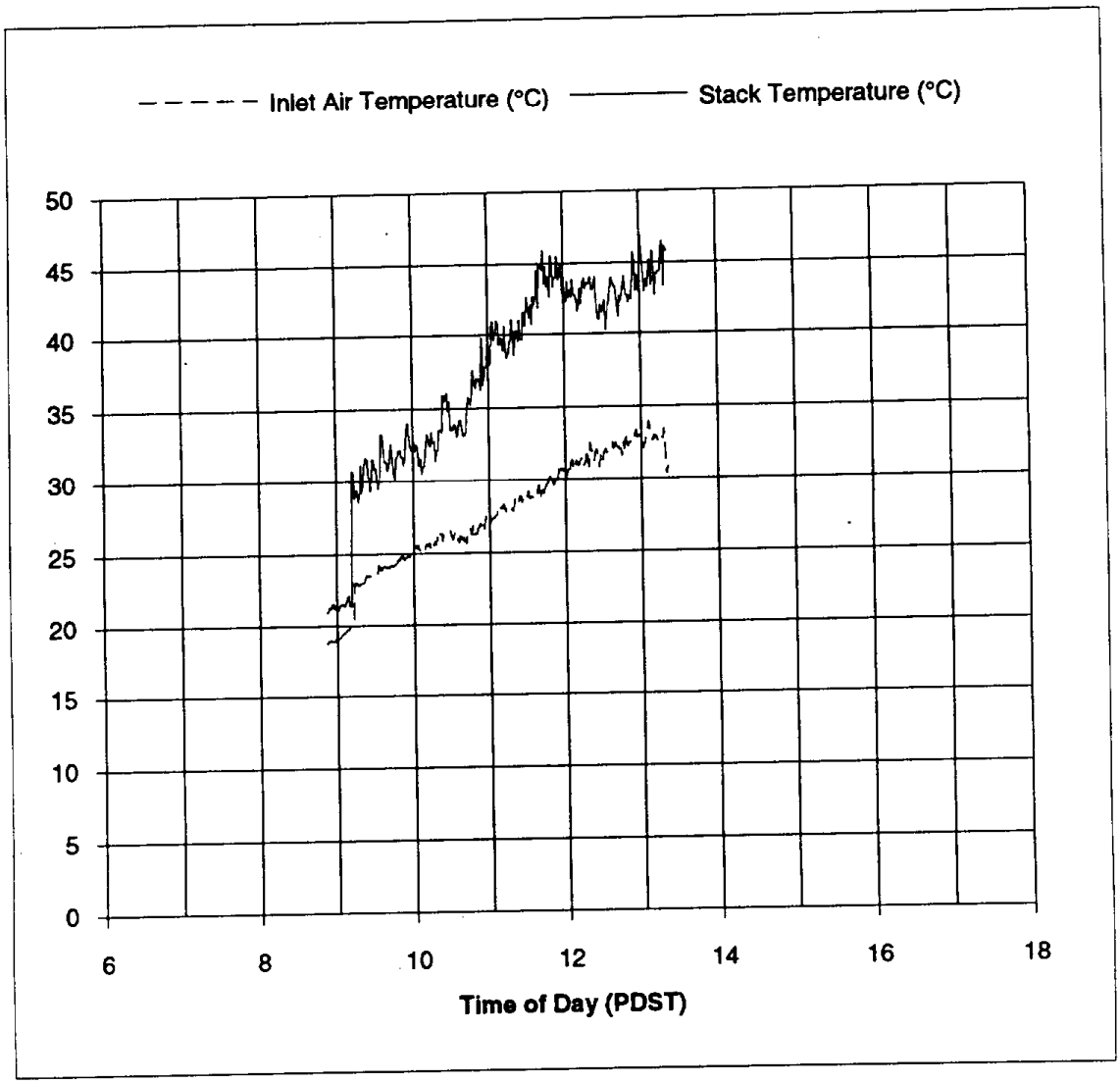

Figure 3.1.5.6. Conveyor speed and stack gas velocity, 25 August 92.

Fuel Type: Rice Straw
Configuration: CEWF
Test Date 25-Aug-92

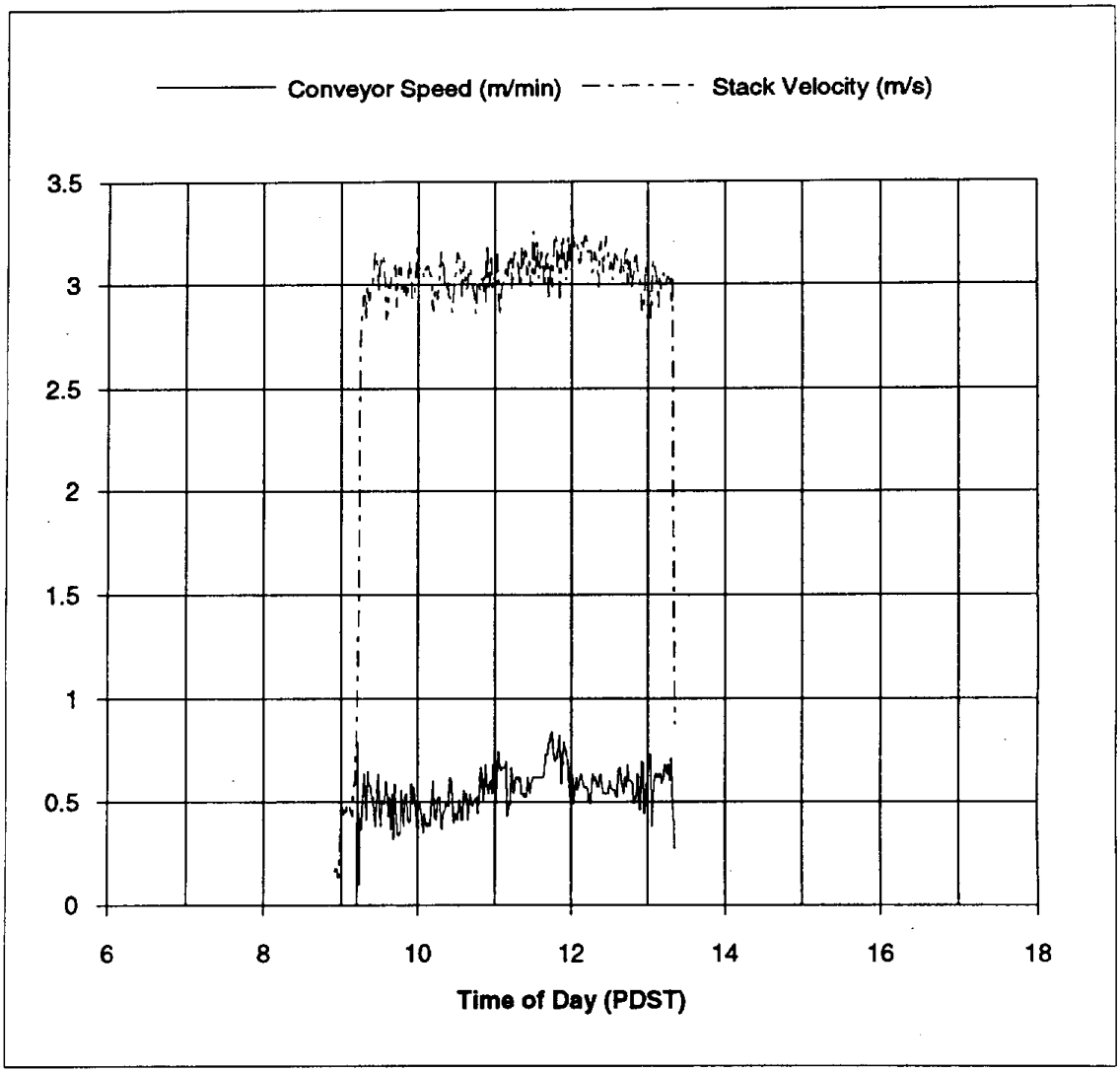

Figure 3.1.5.7. Conveyor speed with 10 min moving average, 25 August 92.

Fuel Type: Rice Straw
Configuration: CEWF

Test Date 25-Aug-92

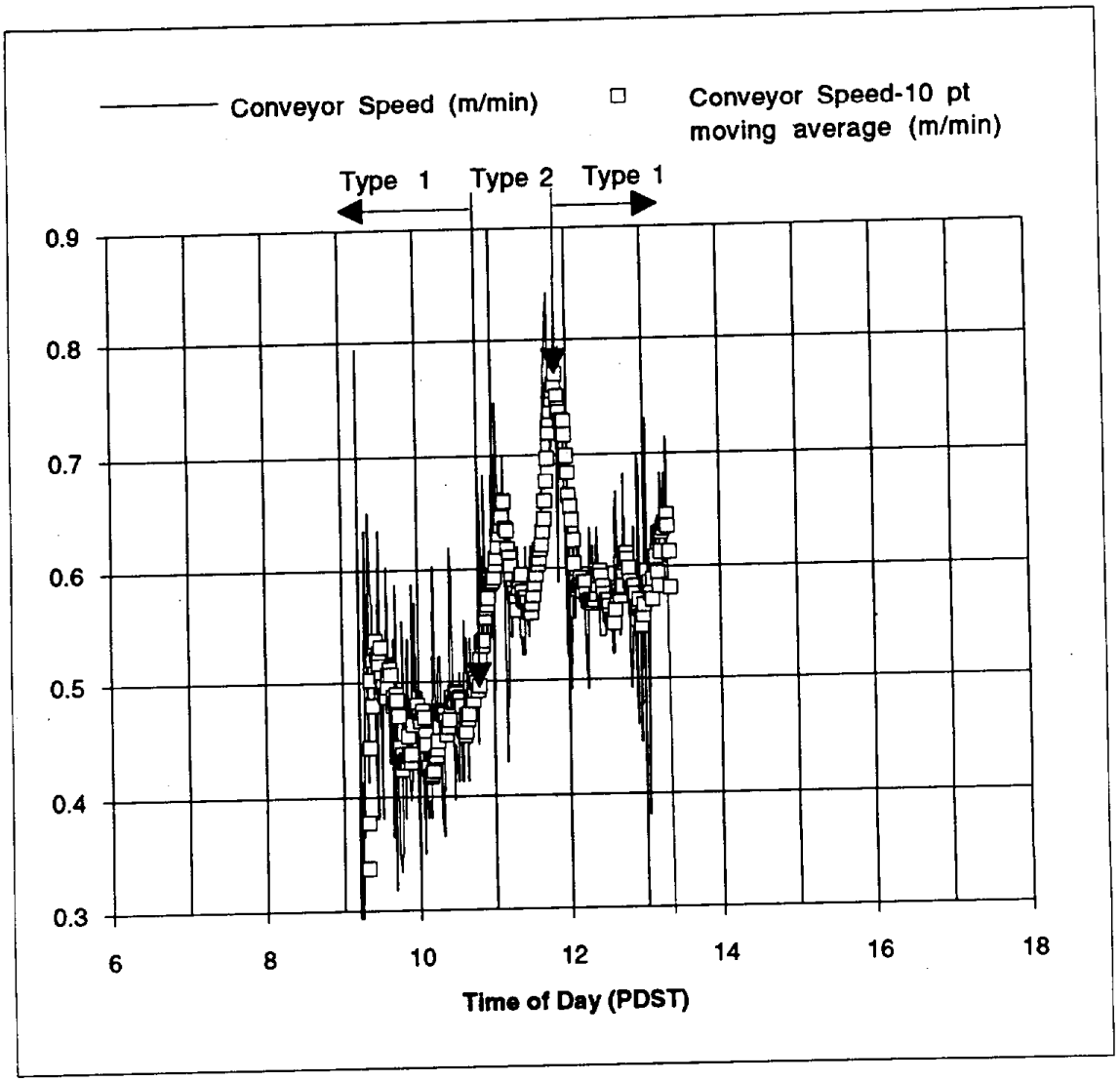

Figure 3.1.5.8. Conveyor travel, 25 August 92.

Fuel Type: Rice Straw Test Date 25-Aug-92
Configuration: CEWF

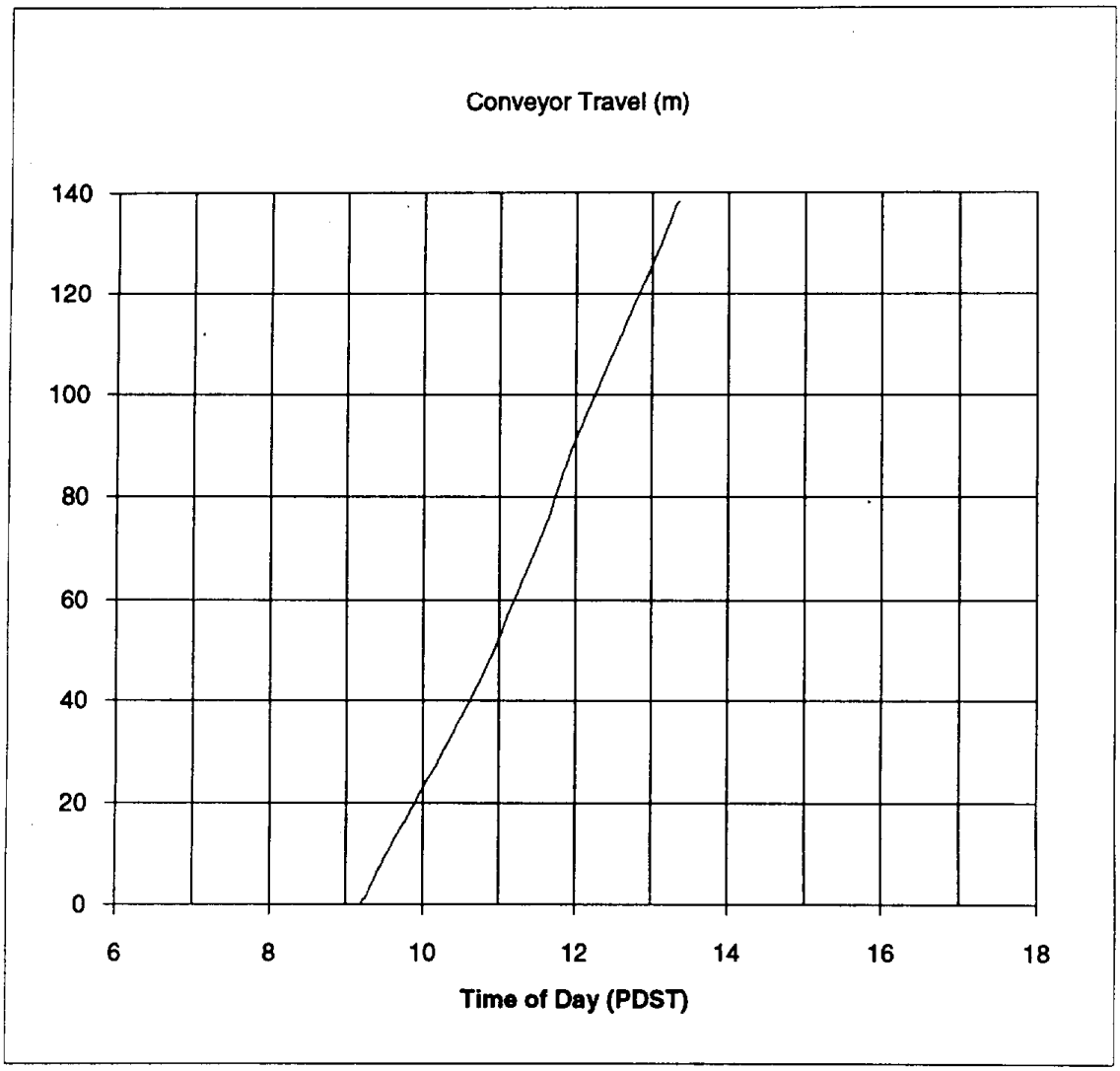

Table 3.1.6.1

Fuel and Ash Analyses

Run Date	2-Sep-92	2-Sep-92	2-Sep-92	2-Sep-92
Fuel Type	Rice Straw	Rice Straw	Rice Straw	Rice Straw
Sample Type	Fuel	Fuel	Ash	Ash
	Type 1	Type 2	Type 1	Type 2
Ultimate Analysis				
(% dry weight)				
C	39.94	39.06	12.65	8.46
H	5.46	5.33	0.77	0.54
N	0.53	0.65	0.52	0.20
Elemental Analysis				
(% by weight dry basis)				
N	0.67	0.73	0.44	0.38
P	0.07	0.06	0.28	0.26
K	2.15	0.85	9.03	3.17
Ca	0.31	0.31	1.36	1.40
Mg	0.30	0.18	0.99	0.68
Na	0.22	0.08	0.72	0.46
Cl	0.96	0.22	3.09	0.70
(mg/kg dry weight)				
S	1,090	805	2,100	1,470
B	50	7	151	21
Zn	22	26	71	92
Mn	735	737	3,240	3,410
Fe	279	209	1,160	1,440
Cu	8	13	13	12
Si				
Total (% dry weight)	50.30	47.00	30.00	16.69
Proximate Analysis				
(% dry weight)				
Ash	16.62	17.18	80.05	85.21
Volatiles	68.93	70.54	13.60	10.16
Fixed Carbon	14.44	12.28	6.34	4.63
Higher Heating Value				
(MJ/kg dry weight)	15.8597	15.7993	4.1775	2.7824

Type 1 straw: 1987 crop year in large rectangular bales.
Type 2 straw: 1991 crop year in small rectangular bales.

Table 3.1.6.2. Operating conditions and concentrations, rice straw, 2 September 92.

Fuel:	Rice Straw		Date of Test:	2-Sep-92
			Configuration:	CEWF

	Type 1	Type 2
Fuel Loading Rate (g/sq.m w.b.):	618	635
Total Fuel Consumption (kg w.b.)	44.5	74.9
Total Ash Recovered (kg w.b.)	8.9	13.8
Ash Fraction (w.b.)	0.20	0.18

	Type 1		Type 2	
	Traverse 1	Traverse 2	Traverse 3	Traverse 4
Mean Values				
Air Temperature (°C)	17.87	21.35	26.54	28.86
Air Relative Humidity (%)	79.16	67.38	50.21	41.77
Inlet Air Temperature (°C)	21.06	24.27	29.13	31.45
Stack Temperature (°C)	26.37	32.07	43.69	42.79
Impinger Outlet Temperature (°C)	13.59	16.00	17.41	16.56
Fire Spreading Rate (m/min)	0.37	0.43	0.71	0.55
Stack Gas Velocity (m/s)	2.95	3.11	3.96	3.49
Gas and PM Concentrations (less background)				
CO (ppmv)	45.15	40.33	40.00	55.35
NO (ppmv)	0.66	0.87	2.06	1.49
NOx (ppmv)	0.96	1.21	2.63	1.98
SO2 (ppmv)	0.16	0.21	0.36	0.28
THC (ppmv as CH4)	8.55	4.53	4.33	5.41
HC (ppmv as CH4 by GC)	3.28	3.46	3.33	3.47
CH4 (ppmv)	1.75	1.76	2.08	1.86
NMHC (ppmv as CH4)	6.80	2.77	2.25	3.55
NMHC (ppmv as CH4, by GC)	1.53	1.70	1.25	1.61
CO2 (ppmv by GC)	501	809	1,023	1,054
Total S (ppmv as SO2)	0.21	0.29	0.40	0.34
PM (mg/cu.m)	4.05	4.57	3.71	3.46
PM10 (mg/cu.m)	3.73	4.52	3.64	3.39
PM2.5 (mg/cu.m)	2.96	4.43	3.43	3.25

Table 3.1.6.3. Mass balance, rice straw, 2 September 92.

Fuel: Rice Straw Date of Test: 2-Sep-92

Configuration: CEWF

Mass Balance

	Type 1		Type 2	
	Traverse 1	Traverse 2	Traverse 3	Traverse 4
Total Conveyor Travel (m)	17.64	20.75	34.08	26.30
Fuel Moisture Content (% w.b.)	8.0	8.0	8.0	8.0
Fuel Loading Rate (g/sq.m d.b.)	569	569	584	584
Total Fuel Consumption (g w.b.)	13,294	15,639	26,378	20,358
Total Fuel Consumption (g d.b.)	12,231	14,388	24,267	18,729
Residual Ash (g w.b.)	2,655	3,123	4,850	3,743
Fuel Vaporized (g w.b.)	10,639	12,516	21,528	16,615
Fuel Consumption Rate (g/s w.b.)	4.62	5.43	9.16	7.07
Fuel Consumption Rate (g/s d.b.)	4.25	5.00	8.43	6.50
Ash Generation Rate (g/s w.b.)	0.92	1.08	1.68	1.30
Fuel Vaporization Rate (g/s w.b.)	3.69	4.35	7.47	5.77
Stack Gas Density (kg/cu.m)	1.1800	1.1580	1.1155	1.1187
Stack Gas Flow Rate (cu.m/s)	4.39	4.63	5.88	5.19
Stack Gas Mass Flow Rate (kg/s)	5.18	5.36	6.56	5.81
Inlet Air Mass Flow Rate (kg/s)	5.18	5.36	6.55	5.80
Overall Air-Fuel Ratio (w.b.)	1121.59	986.39	715.17	821.06
Overall Air-Fuel Ratio (d.b.)	1219.12	1072.16	777.36	892.45

Table 3.1.6.4. Emission factors, rice straw, 2 September 92 (integrated basis).

Fuel: Rice Straw Date of Test: 2-Sep-92

Configuration: CEWF

Emission Factors (% fuel dry weight)

Integrated Basis

	Type 1		Type 2		Type 1	Type 2
	Traverse 1	Traverse 2	Traverse 3	Traverse 4	Average	Average
CO	5.302	3.587	3.006	4.766	4.445	3.886
NO	0.084	0.089	0.165	0.137	0.086	0.151
NOx (as NO2)	0.186	0.191	0.324	0.278	0.188	0.301
SO2	0.042	0.047	0.061	0.054	0.045	0.058
THC (as CH4)	0.575	0.213	0.185	0.267	0.394	0.226
HC (as CH4 by GC)	0.220	0.205	0.143	0.171	0.213	0.157
CH4 (by GC)	0.118	0.104	0.089	0.091	0.111	0.090
NMHC (as CH4)	0.457	0.109	0.095	0.175	0.283	0.135
NMHC (as CH4 by GC)	0.103	0.101	0.054	0.080	0.102	0.067
CO2 (by GC)	92.755	131.644	120.818	142.806	112.199	131.812
Total S (as SO2)	0.055	0.061	0.069	0.066	0.058	0.068
SO2/Total S	0.77	0.78	0.88	0.82	0.774	0.850
PM	0.401	0.401	0.237	0.253	0.401	0.245
PM10	0.369	0.397	0.233	0.248	0.383	0.240
PM2.5	0.293	0.389	0.220	0.238	0.341	0.229
MMAD	0.056	0.184	0.135	0.084	0.120	0.109
σ	2.331	4.020	4.568	3.736		

Table 3.1.6.5. Emission factors, rice straw, 2 September 92 (average basis).

Fuel: Rice Straw Date of Test: 2-Sep-92

Configuration: CEWF

Emission Factors (% fuel dry weight)

Average Basis

	Type 1		Type 2		Type 1	Type 2
	Traverse 1	Traverse 2	Traverse 3	Traverse 4	Average	Average
CO	5.319	4.178	3.006	4.774	4.748	3.890
NO	0.084	0.097	0.166	0.137	0.090	0.152
NOx (as NO2)	0.186	0.206	0.325	0.280	0.196	0.302
SO2	0.043	0.051	0.061	0.055	0.047	0.058
THC (as CH4)	0.576	0.268	0.186	0.266	0.422	0.226
HC (as CH4 by GC)	0.220	0.205	0.143	0.171	0.213	0.157
CH4 (by GC)	0.118	0.104	0.089	0.091	0.111	0.090
NMHC (as CH4)	0.458	0.164	0.096	0.175	0.311	0.136
NMHC (as CH4 by GC)	0.103	0.101	0.054	0.080	0.102	0.067
CO2 (by GC)	92.755	131.644	120.818	142.806	112.199	131.812
Total S (as SO2)	0.055	0.069	0.070	0.067	0.062	0.068
SO2/Total S	0.77	0.74	0.88	0.82	0.75	0.85
PM	0.401	0.401	0.237	0.253	0.401	0.245
PM10	0.369	0.397	0.233	0.248	0.383	0.240
PM2.5	0.293	0.389	0.220	0.238	0.341	0.229
MMAD	0.056	0.184	0.135	0.084	0.120	0.109
σ	2.331	4.020	4.568	3.736		

Table 3.1.6.6. Carbon balance.

Date of Test:	2-Sep-92	2-Sep-92	2-Sep-92	2-Sep-92
Fuel	Rice Straw Type 1 Traverse 1	Rice Straw Type 1 Traverse 2	Rice Straw Type 2 Traverse 1	Rice Straw Type 2 Traverse 2
Carbon Balance				
Dry Fuel Consumption Rate (g/s)	4.25	5.00	8.43	6.50
Ash Generation Rate (g/s)	0.92	1.08	1.68	1.30
Ash Fraction (% dry basis)	21.65	21.60	19.93	20.00
Fuel Carbon Concentration (%)	39.94	39.94	39.06	39.06
Residual Ash Carbon Concentration (%)	12.65	12.65	8.46	8.46
Carbon released to stack (g/s)	1.58	1.86	3.15	2.43
Maximum CO2 emission factor (%)	136.41	136.43	137.04	137.02
Stack Gas Density (kg/cubic meter)	1.18	1.16	1.12	1.12
Average CO2 concentration (ppmv)	501	809	1,023	1,054
Average CO concentration (ppmv)	45.15	40.33	40.00	55.35
Average THC concentration (ppmv as CH4)	8.55	4.53	4.33	5.41
PM Concentration (mg/cubic meter)	4.05	4.57	3.71	3.46
PM Carbon Concentration* (%)	40	40	40	40.00
PM Carbon (mg/cubic meter)	1.62	1.83	1.48	1.38
Stack Gas Temperature (°C)	26.37	32.07	43.69	42.79
Impinger Temperature (°C)	13.59	16.00	17.41	16.56
PM molar concentration (ppm)	3.18	3.61	2.95	2.74
Estimated Average Stack Gas Velocity (m/s)	3.90	3.05	4.29	3.16
Emission Factors (% Average Basis):				
CO2	92.755	131.644	120.818	142.806
CO	5.319	4.178	3.006	4.774
THC (as CH4)	0.576	0.268	0.186	0.266
PM	0.401	0.401	0.237	0.253
Emission Factors (% Integrated Basis):				
CO2	92.755	131.644	120.818	142.806
CO	5.302	3.587	3.006	4.766
THC (as CH4)	0.575	0.213	0.185	0.267
PM	0.401	0.401	0.237	0.253
Closure (% Average Basis)	76	102	92	111
Closure (% Integrated Basis)	75	101	92	110

*estimated

Table 3.1.6.7. Nitrogen balance

Date of Test:	2-Sep-92	2-Sep-92	2-Sep-92	2-Sep-92
Fuel	Rice Straw Type 1	Rice Straw Type 1	Rice Straw Type 2	Rice Straw Type 2
Nitrogen Balance				
Fuel Nitrogen Concentration (% dry weight)	0.67	0.67	0.73	0.73
Ash Nitrogen Concentration (% weight)	0.44	0.44	0.38	0.38
Emission Factors (% Average Basis):				
NOx (as NO2)	0.186	0.206	0.325	0.280
PM	0.401	0.401	0.237	0.253
Emission Factors (% Integrated Basis):				
NOx (as NO2)	0.186	0.191	0.324	0.278
NO3- Concentration of PM* (% weight)	0.2	0.2	0.2	0.200
NH4+ Concentration of PM* (% weight)	2	2	2	2.000
Nitrogen Concentration of PM (%)	1.601	1.601	1.601	1.601
Fuel Nitrogen (mg/s)	28.48	33.50	61.54	47.45
Ash Nitrogen (mg/s)	4.05	4.75	6.38	4.94
Nitrogen as NOx (mg/s Average Basis)	2.41	3.13	8.34	5.54
Nitrogen as NOx (mg/s Integrated Basis)	2.41	2.91	8.31	5.50
Nitrogen as PM (mg/s Average Basis)	0.27	0.32	0.32	0.26
Nitrogen as NOx+PM (mg/s Average Basis)	2.68	3.46	8.66	5.80
Nitrogen as NOx+PM (mg/s Integrated Basis)	2.68	3.23	8.63	5.76
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.094	0.103	0.141	0.122
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.094	0.096	0.140	0.121
Ash Nitrogen/Fuel Nitrogen	0.142	0.142	0.104	0.104
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.236	0.245	0.244	0.226
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.236	0.238	0.244	0.226

*estimated

Table 3.1.6.8. Sulfur balance.

Date of Test:	2-Sep-92	2-Sep-92	2-Sep-92	2-Sep-92
Fuel	Rice Straw Type 1	Rice Straw Type 1	Rice Straw Type 2	Rice Straw Type 2
Sulfur Balance				
Fuel Sulfur Concentration (mg/kg dry weight)	1,090	1,090	805	805
Ash Sulfur Concentration (mg/kg weight)	2,100	2,100	1,470	1,470
Emission Factors (% Average Basis)				
SO2	0.043	0.051	0.061	0.055
PM	0.401	0.401	0.237	0.253
Emission Factors (% Integrated Basis)				
SO2	0.042	0.047	0.061	0.054
Sulfur Concentration of PM* (% weight)	1	1	1	1.000
Fuel Sulfur (mg/s)	4.63	5.45	6.79	5.23
Ash Sulfur (mg/s)	1.93	2.27	2.47	1.91
Sulfur as SO2 (mg/s Average Basis)	0.91	1.28	2.57	1.79
Sulfur as SO2 (mg/s Integrated Basis)	0.89	1.18	2.57	1.76
Sulfur as PM (mg/s Average Basis)	0.17	0.20	0.20	0.16
Sulfur as SO2+PM (mg/s Average Basis)	1.08	1.48	2.77	1.95
Sulfur as SO2+PM (mg/s Integrated Basis)	1.06	1.38	2.77	1.92
SO2+PM Sulfur/Fuel Sulfur (Average Basis)	0.234	0.271	0.408	0.373
SO2+PM Sulfur/Fuel Sulfur (Integrated Basis)	0.229	0.252	0.408	0.367
Ash Sulfur/Fuel Sulfur	0.417	0.416	0.364	0.365
Closure (% Average Basis)	65	69	77	74
Closure (% Integrated Basis)	65	67	77	73

*estimated

Table 3.1.6.9. Water balance.

Estimated Stack Humidity

Fuel	Rice Straw
Configuration	CEWF
Date of Test	2-Sep-92

	Traverse 1	Traverse 2	Traverse 3	Traverse 4
Ambient Air Temperature °C)	18	21	27	29
Ambient Air Relative Humidity (%)	79	67	50	42
Air Temperature (K)	291	295	300	302
Saturation Pressure (Pa)	2,047	2,542	3,472	3,976
Vapor Pressure (Pa)	1,621	1,713	1,743	1,661
Air Dew Point Temperature (°C)	14.2	15.1	15.4	14.6
Ambient Volume Fraction Water Vapor	0.0160	0.0169	0.0172	0.0164
Ambient Mass Fraction Water Vapor	0.0099	0.0105	0.0107	0.0102
Fuel Burning Rate (g/s wet basis)	4.62	5.43	9.16	7.07
Fuel Moisture Content (%)	8.0	8.0	8.0	8.0
Ash Fraction (wet basis)	0.20	0.20	0.18	0.18
Fuel Hydrogen Content (%)	5.46	5.46	5.33	5.33
Ash Hydrogen Content (%)	0.77	0.77	0.54	0.54
Moisture Evaporated (g/s)	0.37	0.43	0.73	0.57
Water of Combustion (g/s)	2.02	2.38	3.96	3.06
Total Fuel Water Added (g/s)	2.39	2.81	4.70	3.62
Inlet Air Mass Flowrate (g/s)	5,180	5,360	6,550	5,800
Inlet Air Water Vapor Flowrate (g/s)	51	56	70	59
Total Stack Water Vapor Flowrate (g/s)	54	59	75	63
Stack Gas Mass Flowrate (g/s)	5,184	5,364	6,558	5,806
Mass Fraction Water Vapor in Stack	0.0104	0.0110	0.0114	0.0108
Volume Fraction Water Vapor in Stack	0.0167	0.0177	0.0183	0.0174
Stack Vapor Pressure (Pa)	1,695	1,797	1,858	1,761
Stack Temperature (°C)	26	32	44	43
Stack Temperature (K)	300	305	317	316
Stack Saturation Pressure (Pa)	3,437	4,777	8,965	8,555
Stack Relative Humidity (%)	49	38	21	21
Stack Dew Point Temperature (°C)	14.9	15.8	16.4	15.5
Impinger Outlet Temperature (°C)	13.6	16.0	17.4	16.6
Volume Stack Gas Sampled for PM (L)	617	661	796	726
Estimated Impinger/Desiccant Weight Gain (g)	7.9	8.9	11.0	9.5

Totals:

	Estimated	Measured
Total Impinger/Desiccant Weight Gain (g)	37.4	29.0
Estimated/Measured Weight Gain	1.29	

Table 3.1.6.10. Power balance.

Date of Test:	2-Sep-92		2-Sep-92	
Fuel	Rice Straw Type 1		Rice Straw Type 2	
	Traverse 1	Traverse 2	Traverse 1	Traverse 2
Power Balance				
Fuel Heating Value (MJ/kg dry weight)	15.8597	15.8597	15.7993	15.7993
Ash Heating Value (MJ/kg dry weight)	4.1775	4.1775	2.7824	2.7824
Average Energy Release Rate (kW)	63.6	74.8	128.5	99.1
Products of Incomplete Combustion (kW)				
CO	2.3	2.1	2.6	3.1
THC (as CH4)	1.4	0.7	0.9	1.0
PM	0.2	0.3	0.3	0.2
Heat Release Rate (kW)	59.7	71.7	124.8	94.8
Fireline Intensity (kW/m)	49.0	58.8	102.4	77.7
Stack Gas Flow (kg/s)	5.18	5.36	6.56	5.81
Stack Gas Temperature (°C)	26.37	32.07	43.69	42.79
Inlet Temperature (°C)	21.06	24.27	29.13	31.45
Sensible Power at Top of Stack (kW)	27.7	42.1	96.1	66.3
Tunnel Dissipation (kW)	32.0	29.6	28.7	28.5

Figure 3.1.6.1. Ambient air conditions, 2 September 92.

Fuel Type: Rice Straw
Configuration: CEWF

Test Date 2-Sep-92

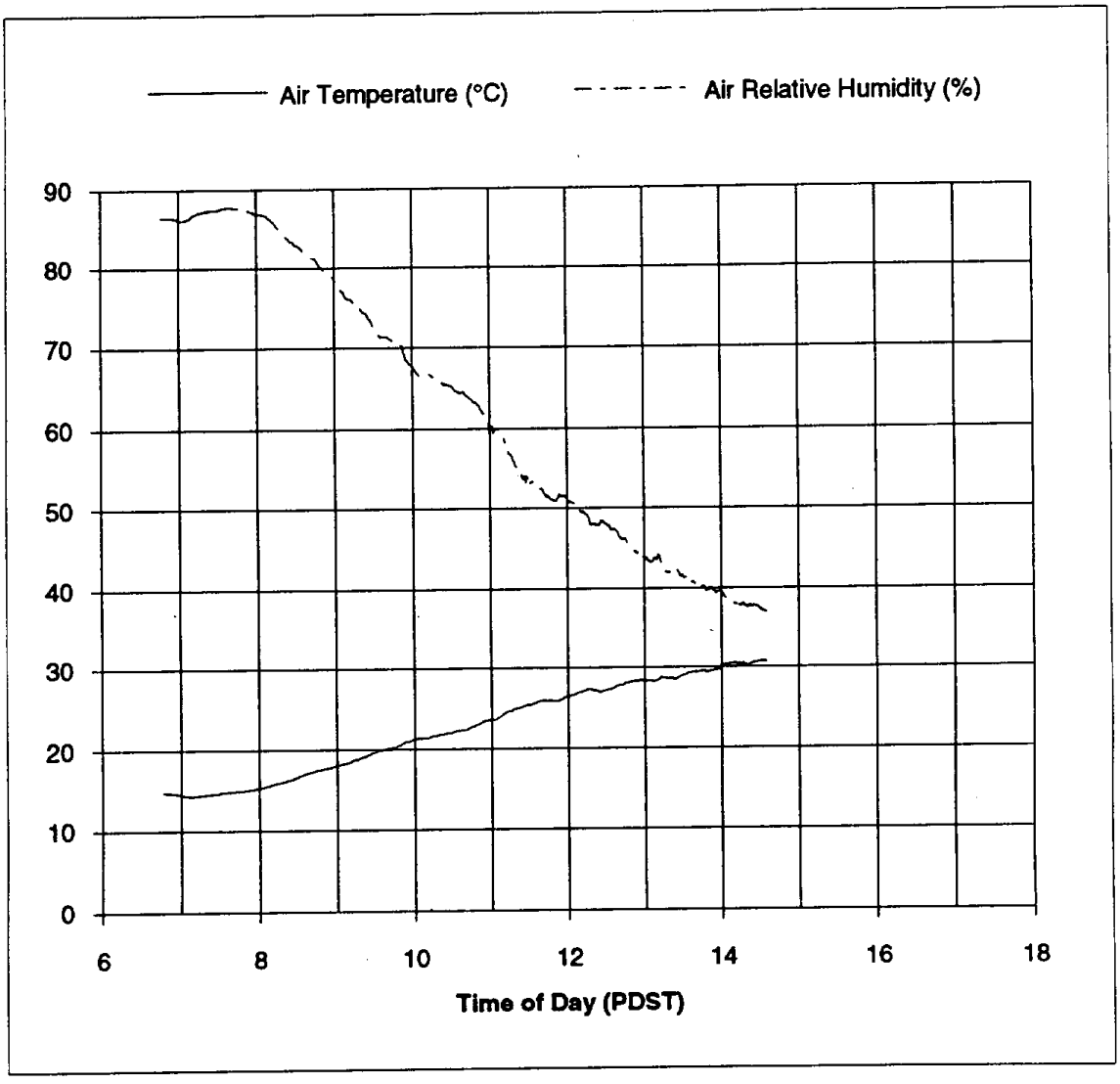

Figure 3.1.6.2. Air temperature and relative humidity from CIMIS station.

Fuel: Rice Straw Date of Test: 2-Sep-92

Configuration: CEWF

Hourly Average CIMIS Data for Davis, California

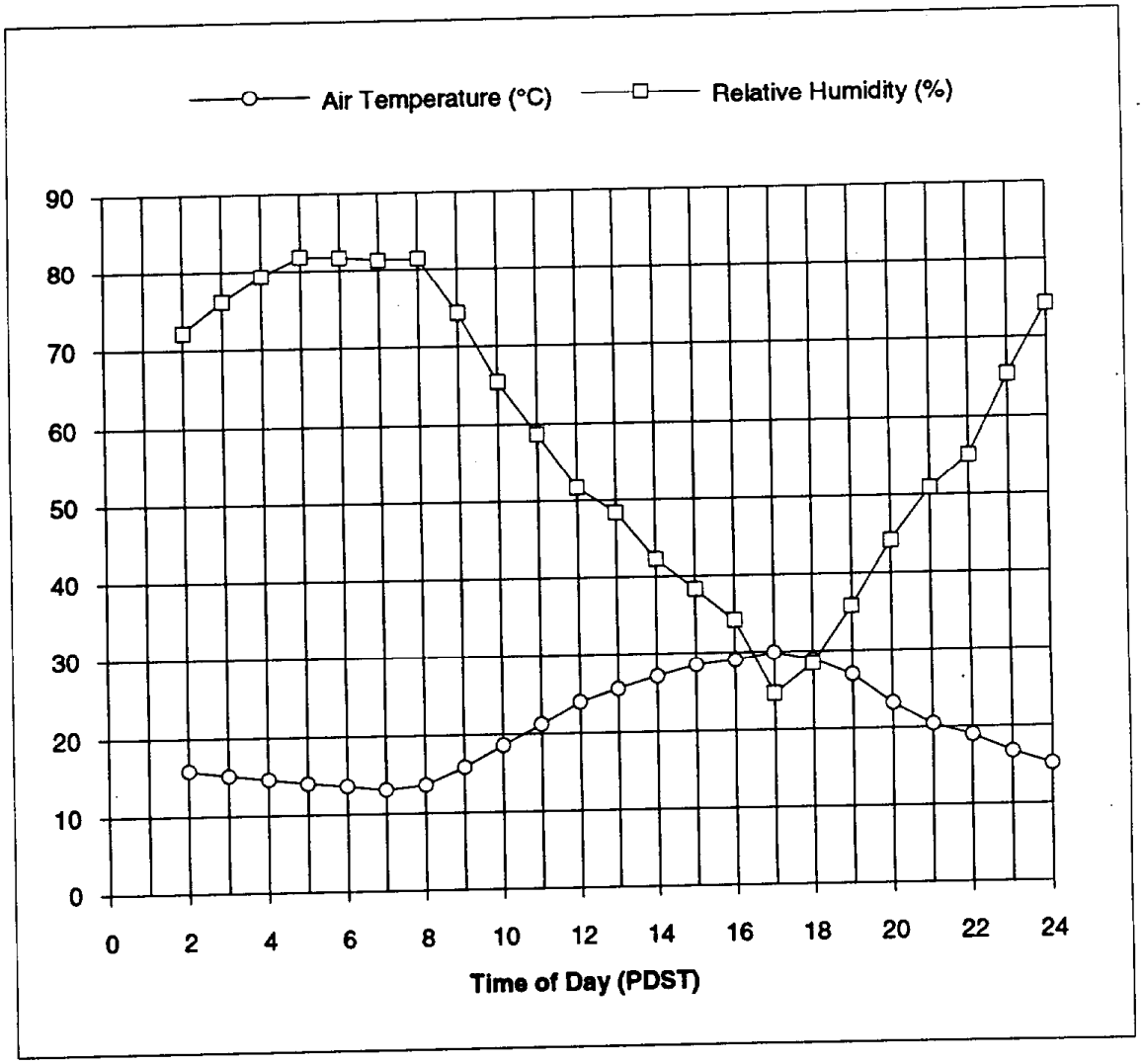

Figure 3.1.6.3. Wind speed from CIMIS station.

Fuel: Rice Straw Date of Test: 2-Sep-92

Configuration: CEWF

Hourly Average CIMIS Data for Davis, California

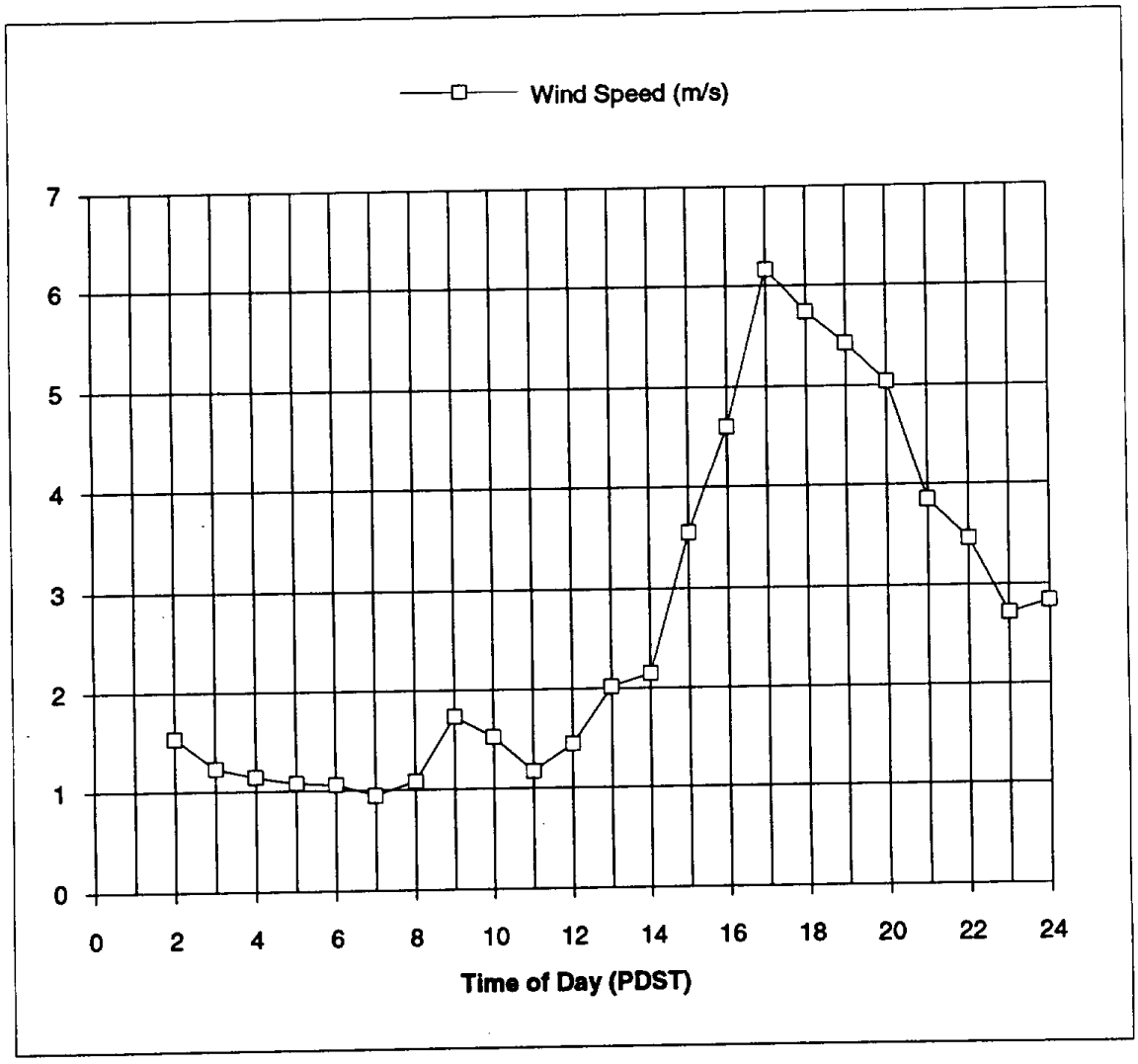

Figure 3.1.6.4. Wind direction and solar radiation from CIMIS station.

Fuel: Rice Straw Date of Test: 2-Sep-92

Configuration: CEWF

Hourly Average CIMIS Data for Davis, California

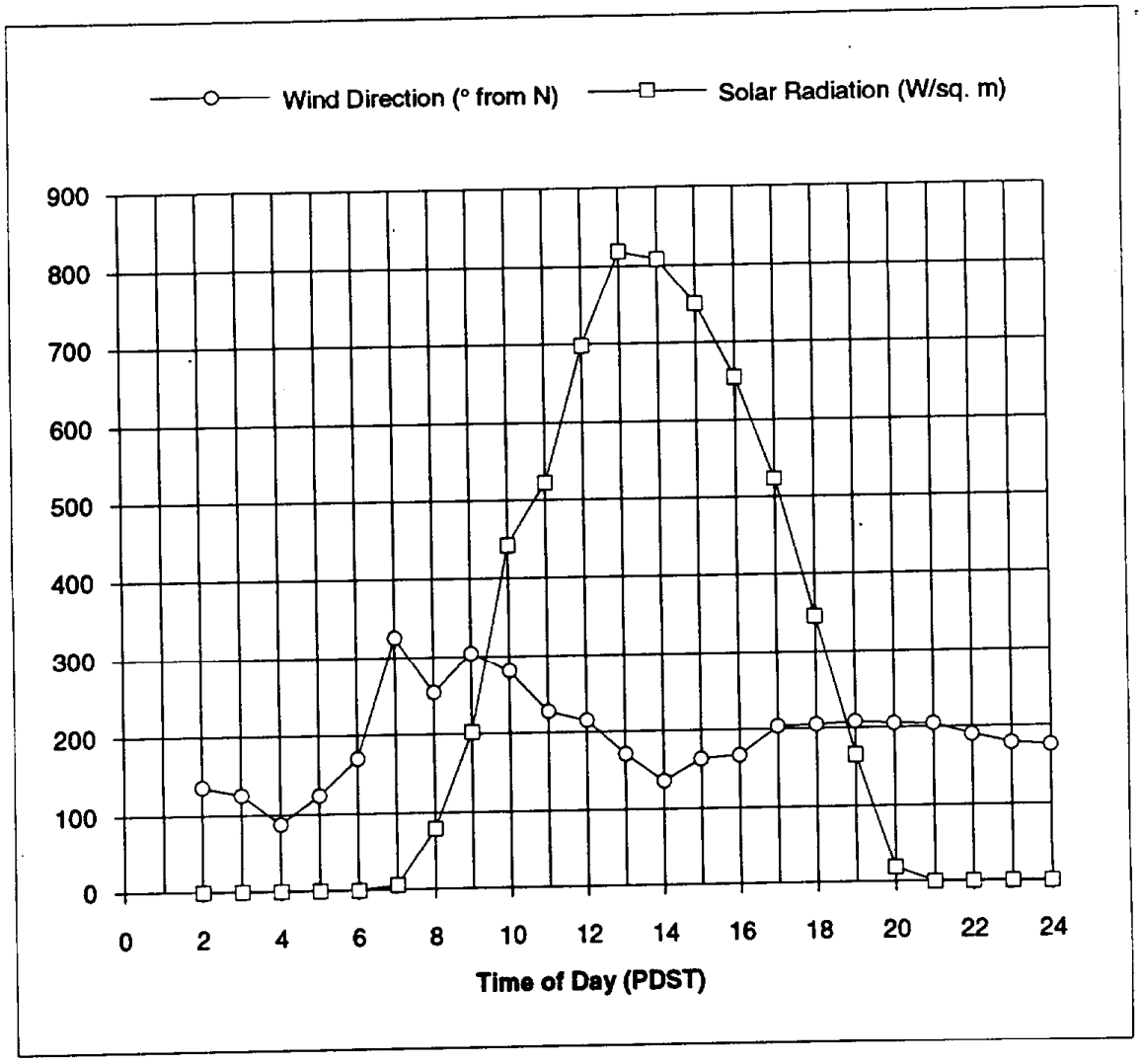

Figure 3.1.6.5. Inlet air, stack gas, and impinger temperatures, 2 September 92.

Fuel Type:	Rice Straw	Test Date	2-Sep-92
Configuration:	CEWF		

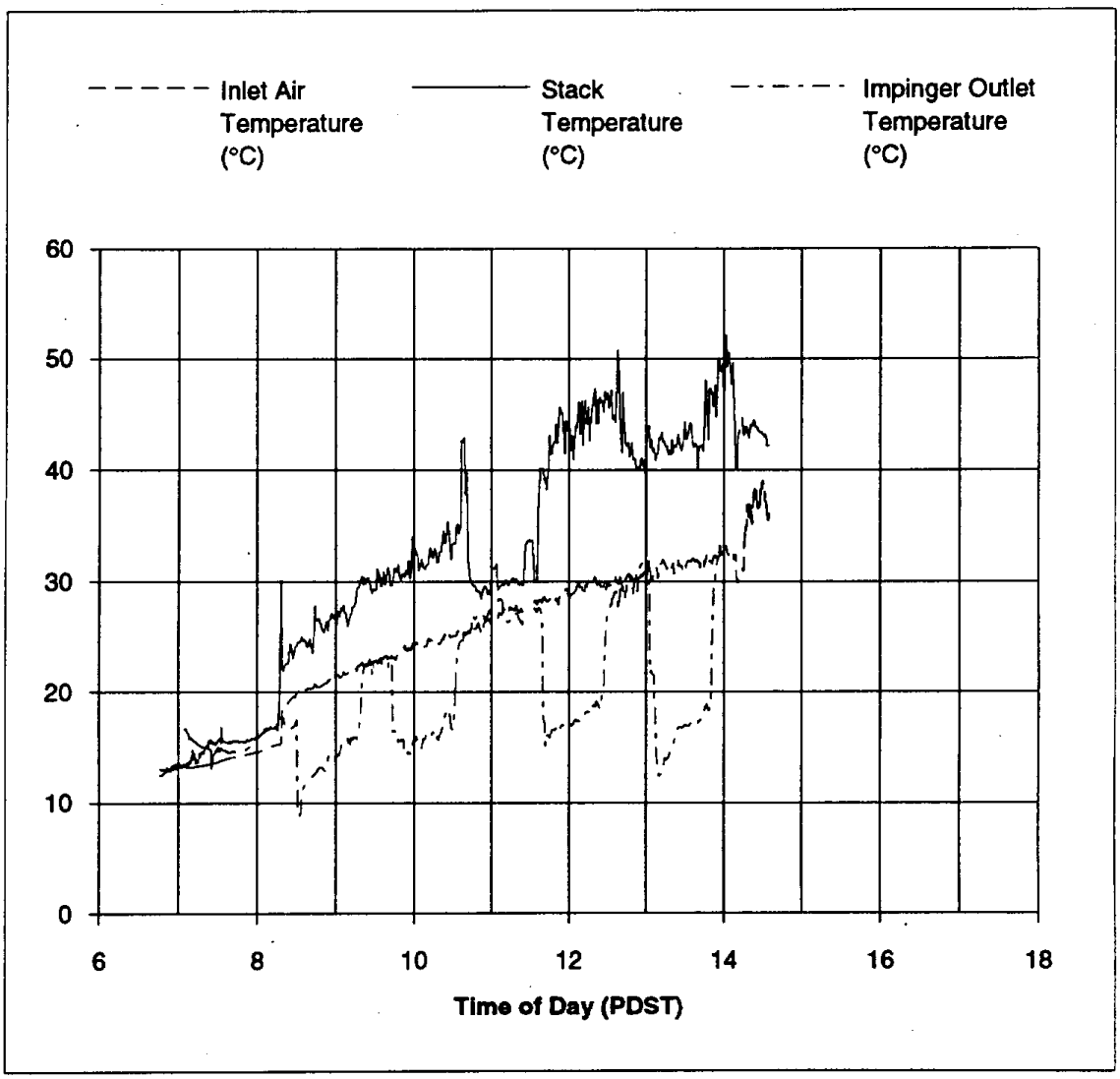

Figure 3.1.6.6. Conveyor speed and stack gas velocity, 2 September 92.

Fuel Type: Rice Straw
Configuration: CEWF

Test Date 2-Sep-92

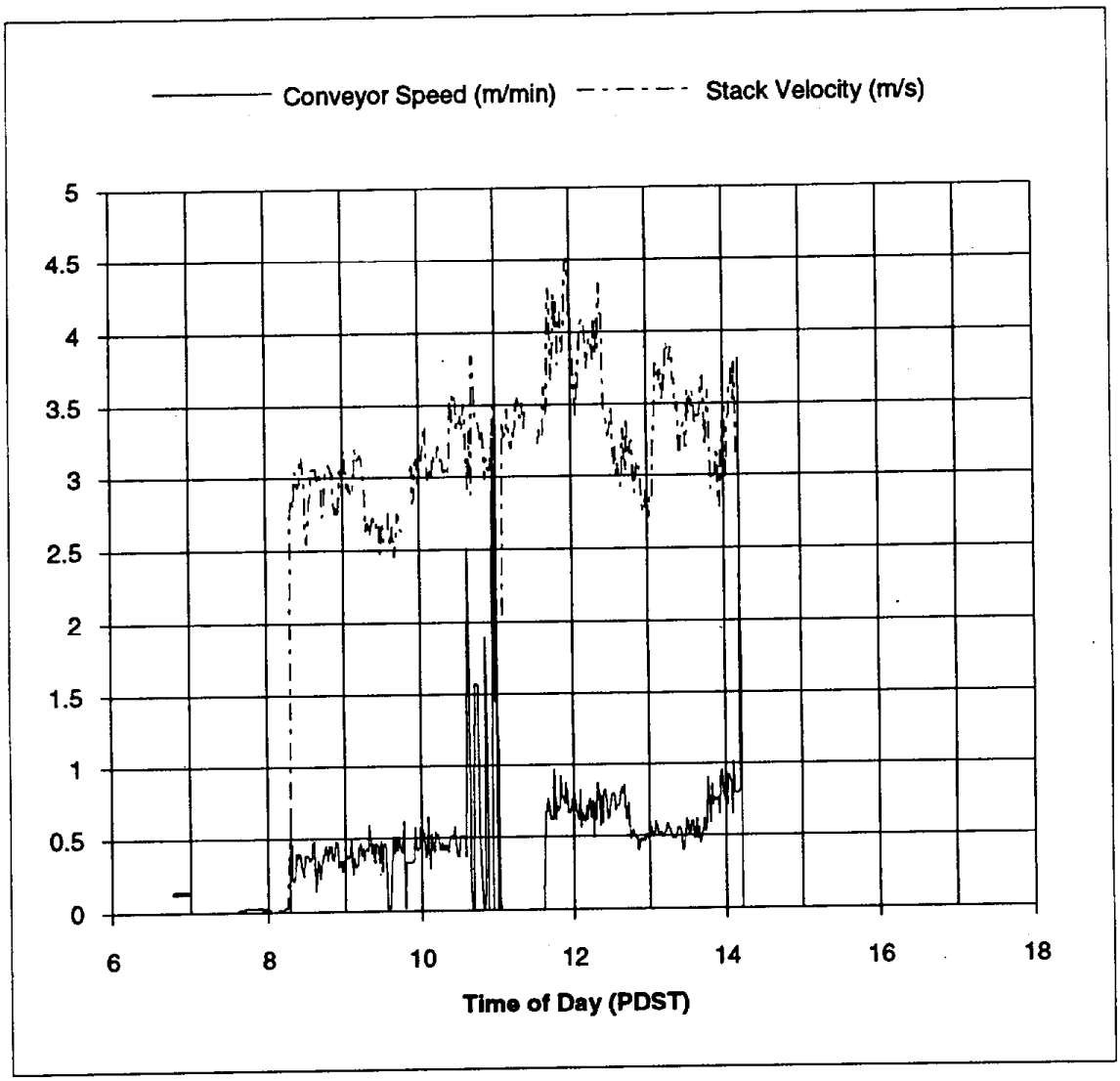

Figure 3.1.6.7. Conveyor speed with 10 min moving average, 2 September 92.

Fuel Type:	Rice Straw	Test Date	2-Sep-92
Configuration:	CEWF		

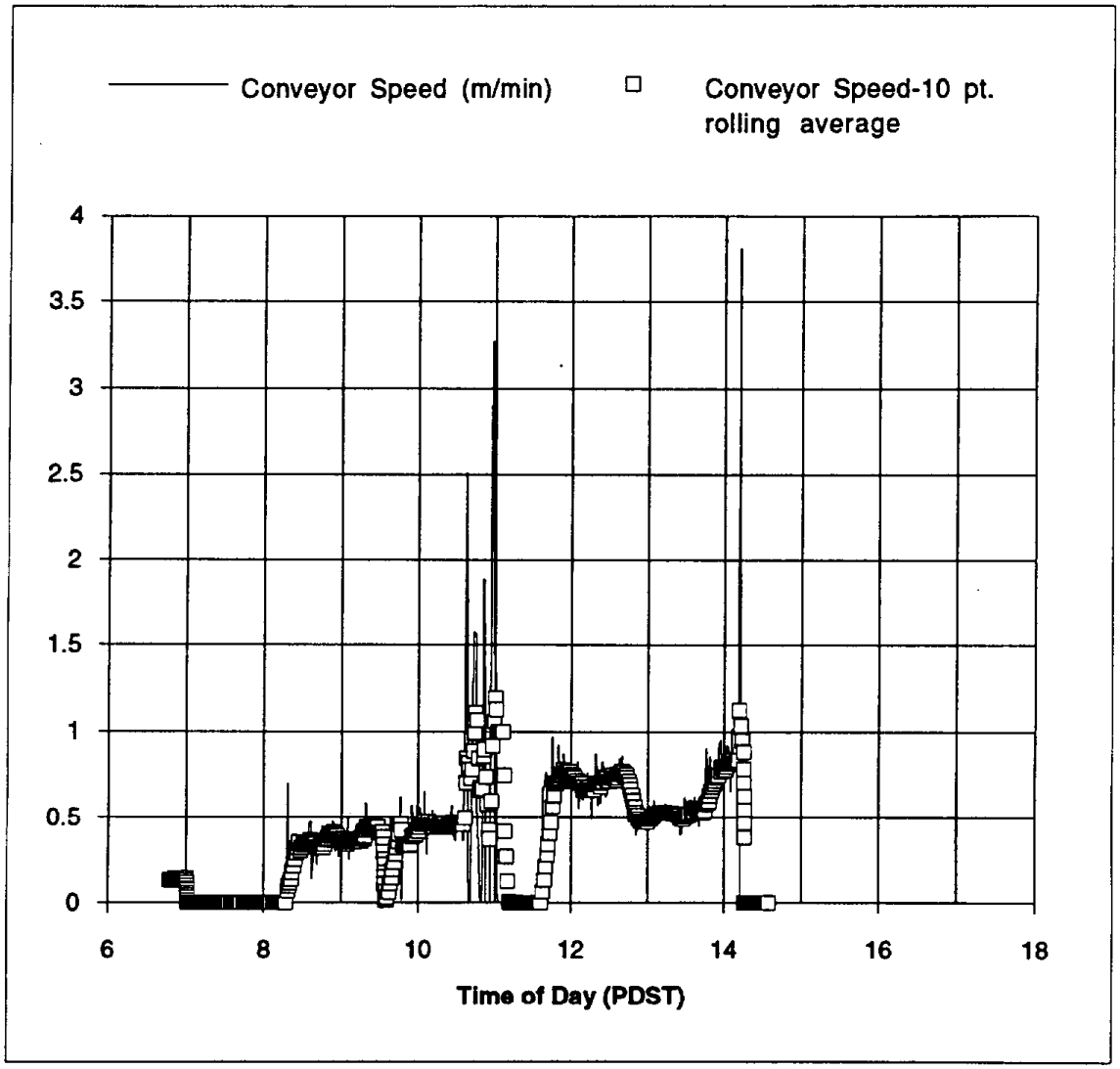

Figure 3.1.6.8. Conveyor travel, 2 September 92.

Fuel Type: Rice Straw
Configuration: CEWF

Test Date 2-Sep-92

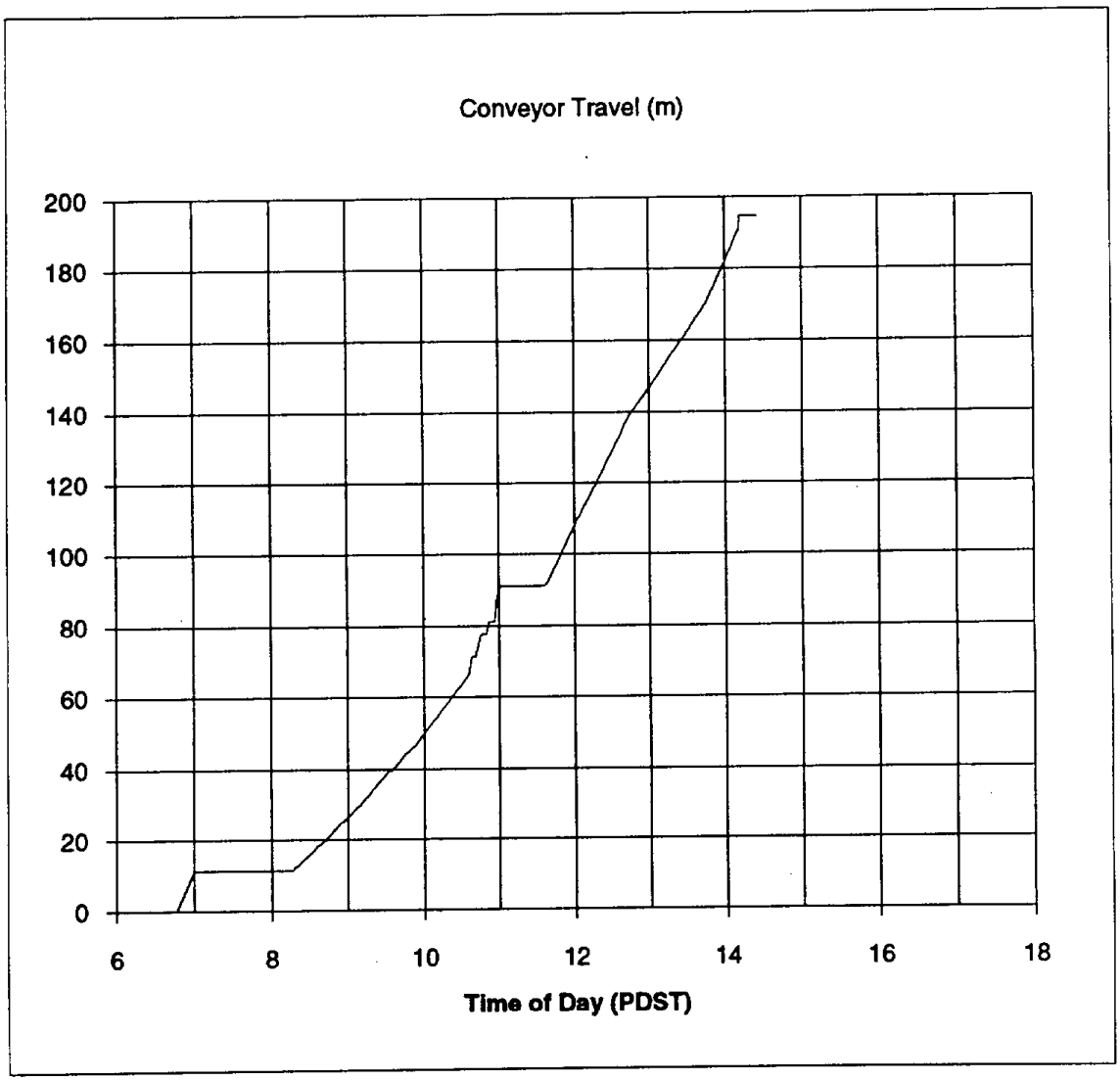

Figure 3.1.6.9. CO concentration in stack gas, 2 September 92.

Fuel Type:
Configuration: Rice Straw
CEWF

Test Date 2-Sep-92

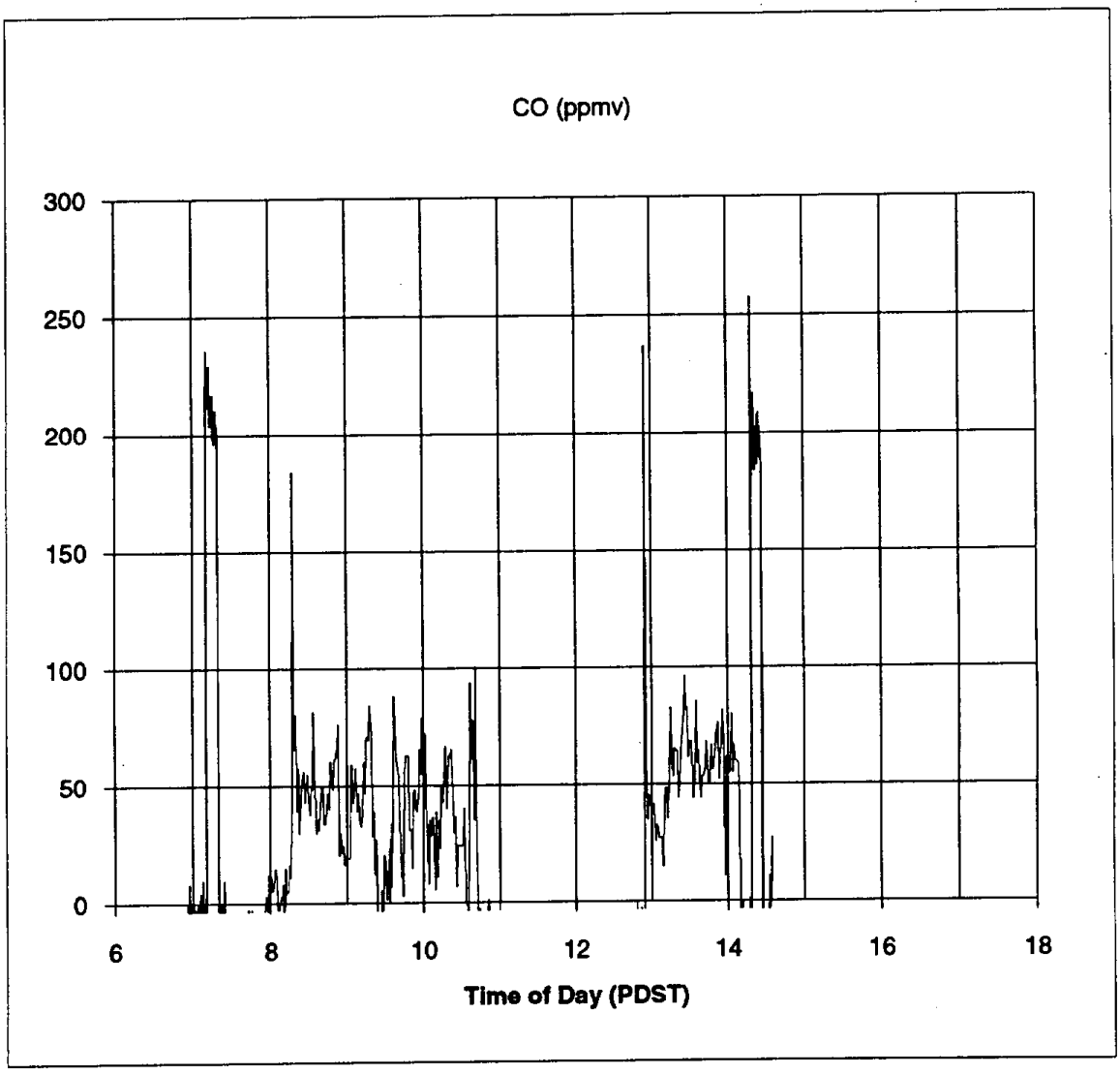

Figure 3.1.6.10. NO and NOx concentrations in stack gas, 2 September 92.

Test Date 2-Sep-92

Fuel Type: Rice Straw
Configuration: CEWF

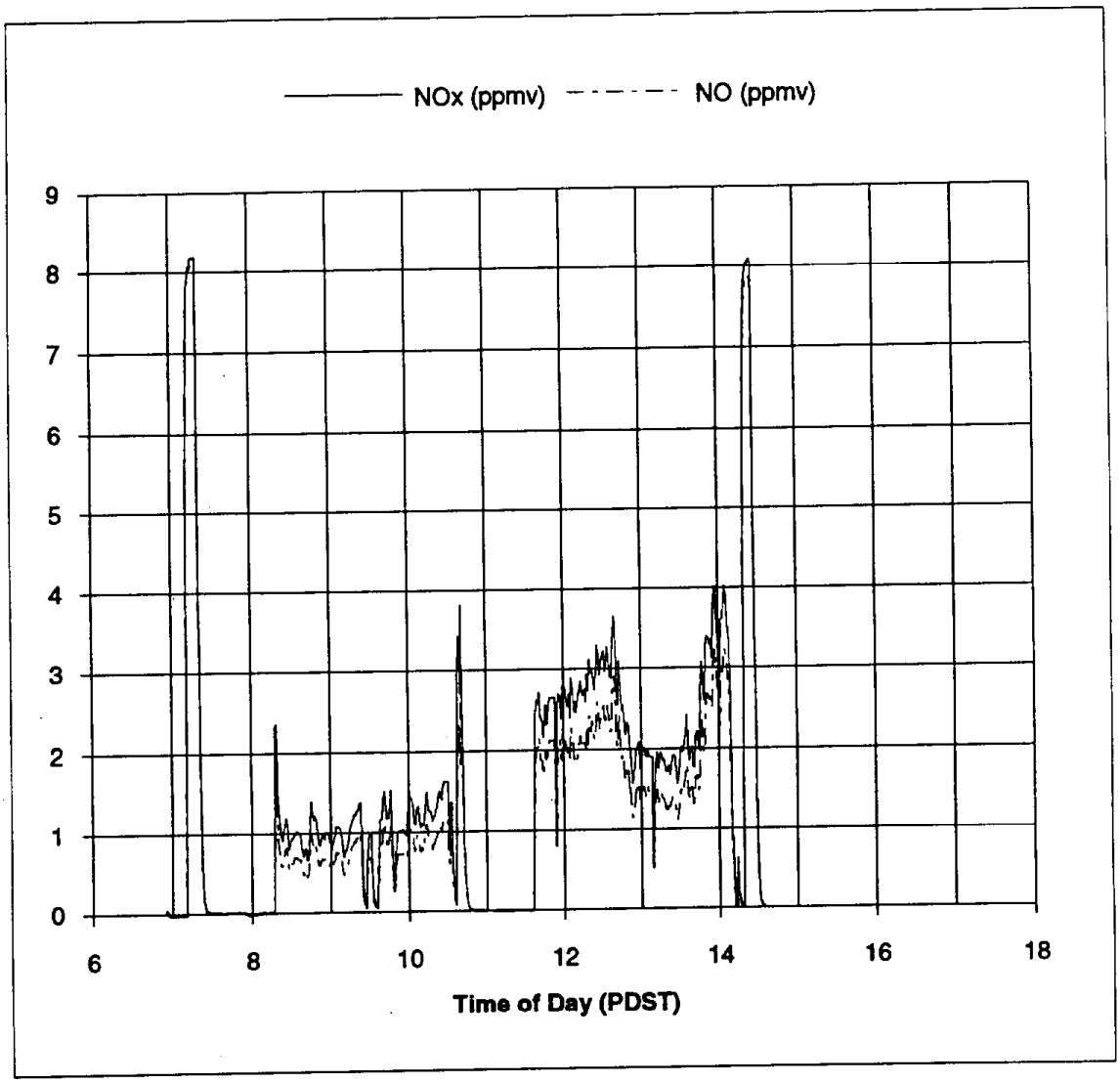

Figure 3.1.6.11. SO2 concentration in stack gas, 2 September 92.

Fuel Type:	Rice Straw	Test Date	2-Sep-92
Configuration:	CEWF		

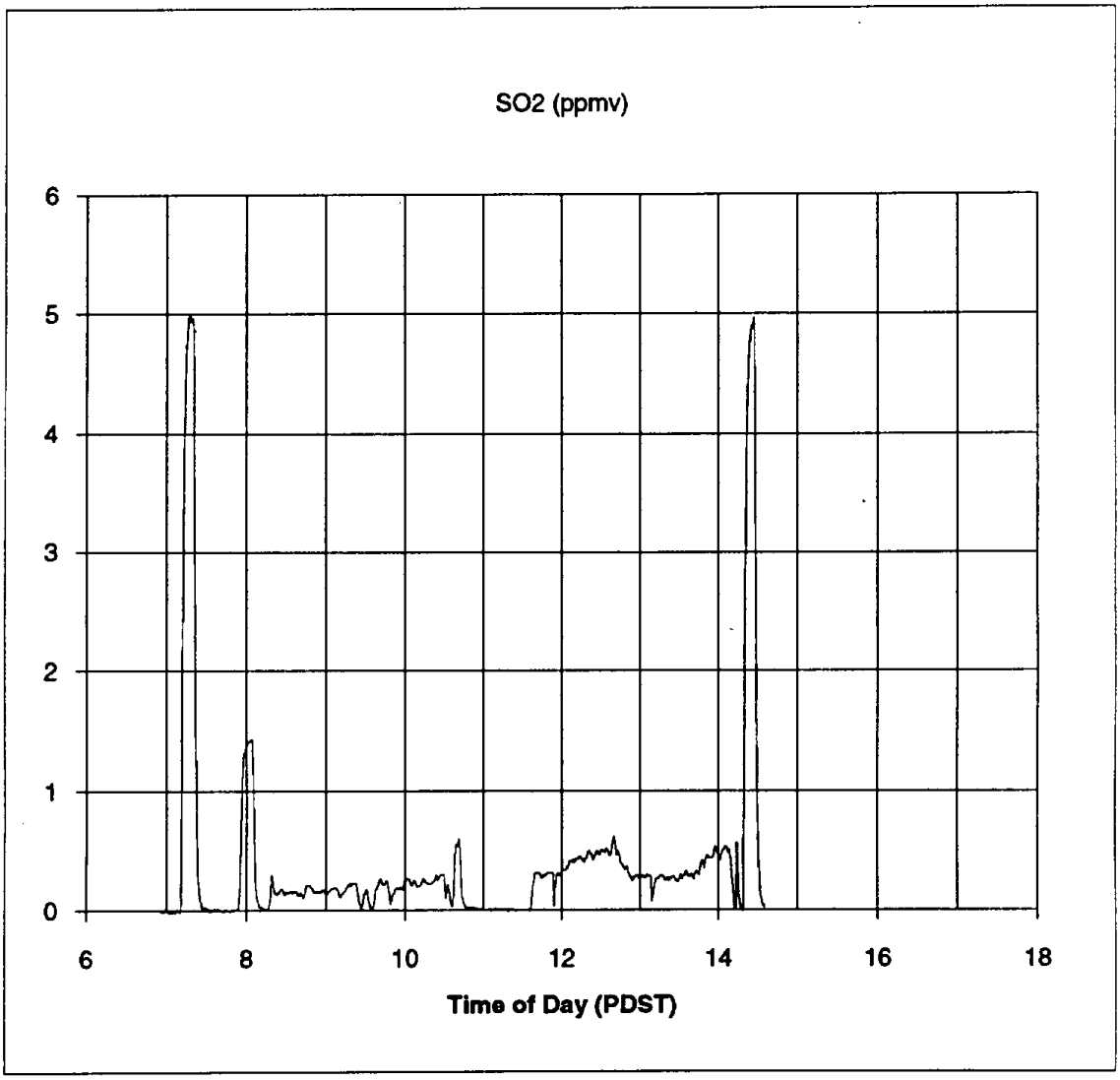

Figure 3.1.6.12. Total sulfur concentration in stack gas, 2 September 92.

Fuel Type: Rice Straw
Configuration: CEWF

Test Date 2-Sep-92

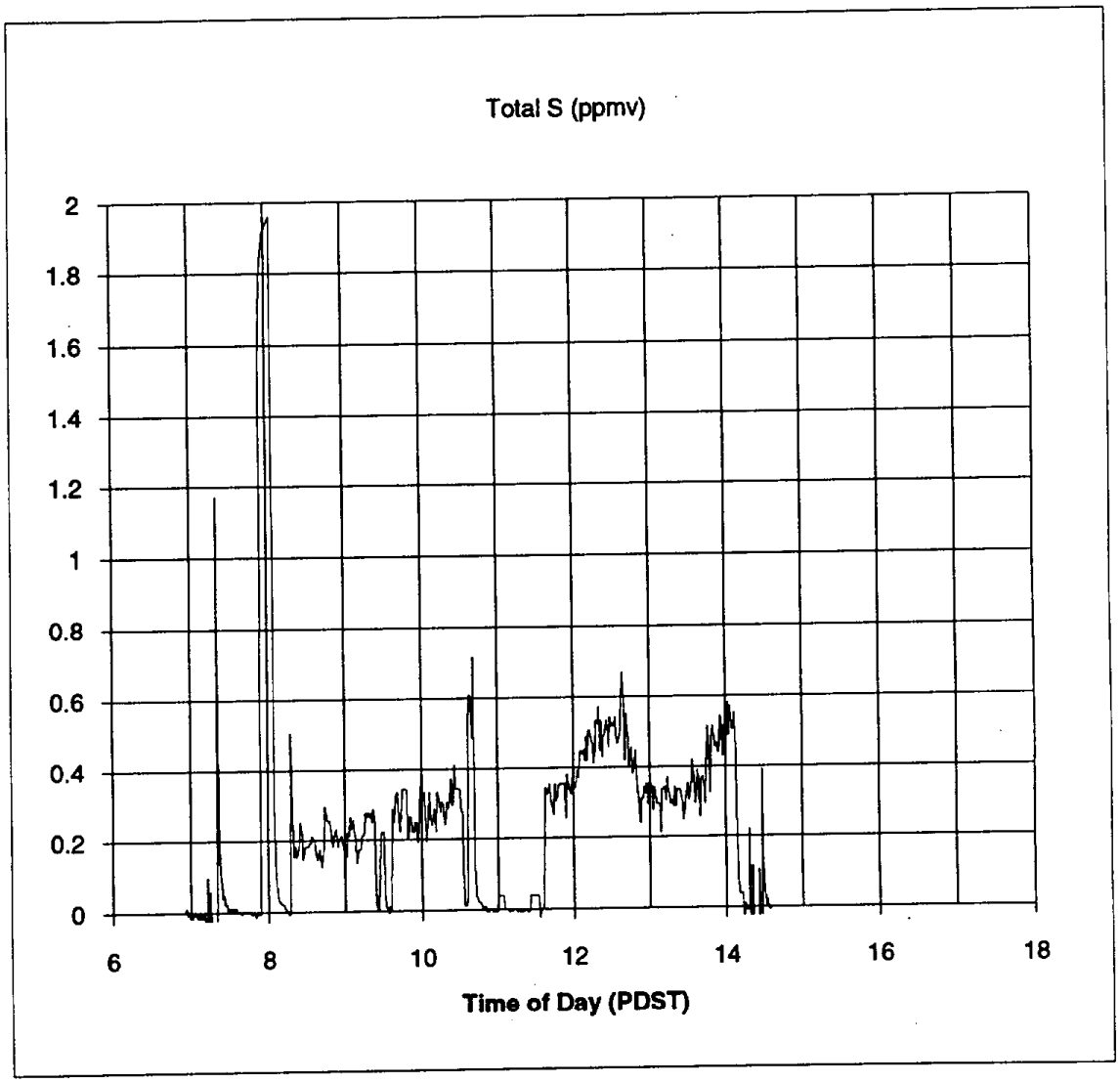

Figure 3.1.6.13. THC concentration in stack gas, 2 September 92.

Fuel Type: Rice Straw Test Date 2-Sep-92
Configuration: CEWF

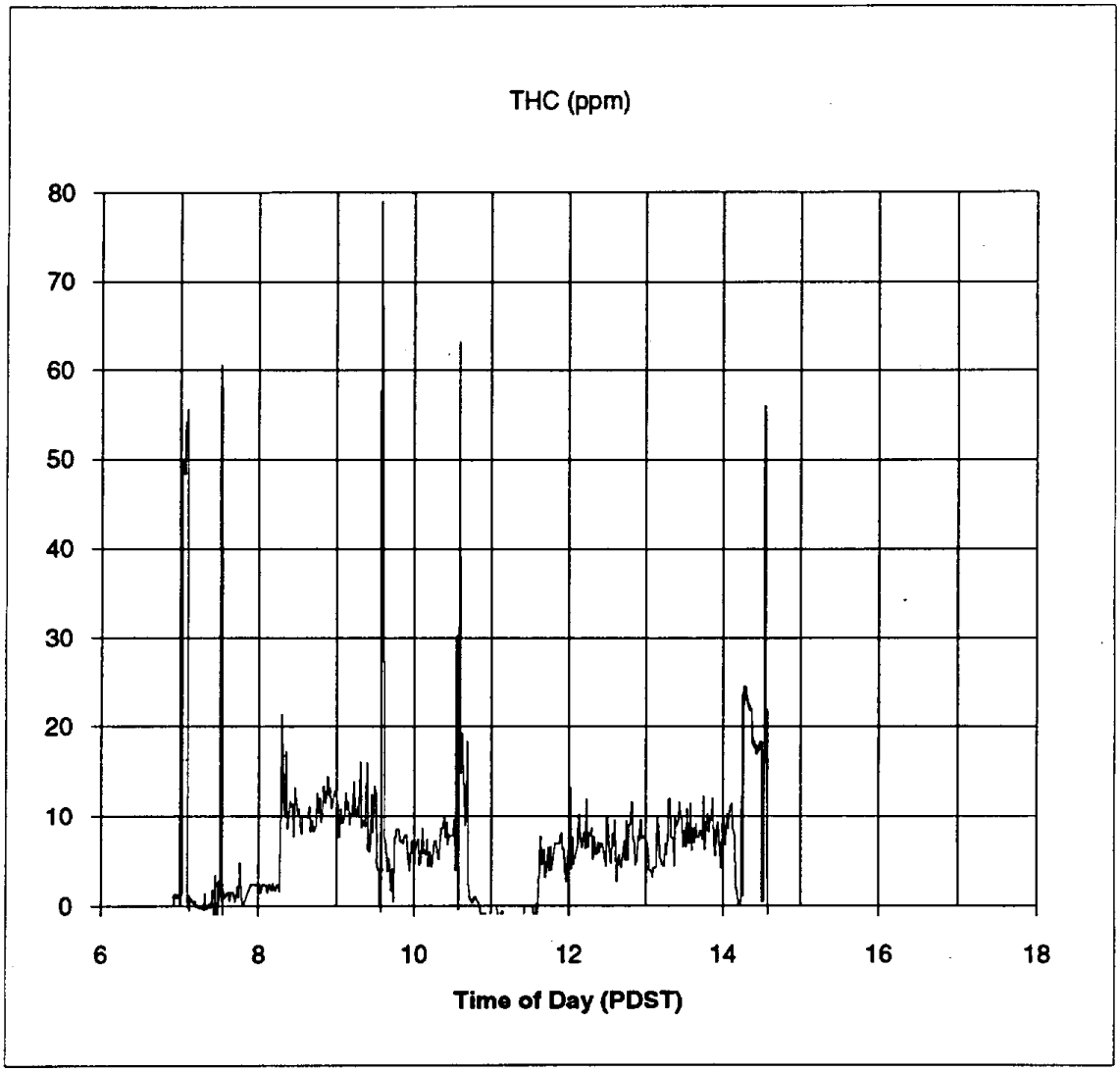

Figure 3.1.6.14. Particle size distribution, traverse 1, 2 September 92.

Fuel: Rice Straw

Date of Test: 2-Sep-92

Configuration: CEWF

Particle Size Distribution
Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.70	0.52	3.75	1.000
2	7.67	0.5	3.23	0.861
3	4.09	0	2.73	0.728
4	2.16	0.07	2.73	0.728
5	1.25	0.07	2.66	0.709
6	0.73	0	2.59	0.691
7	0.38	0.03	2.59	0.691
filter	0.00	2.56	2.56	0.683

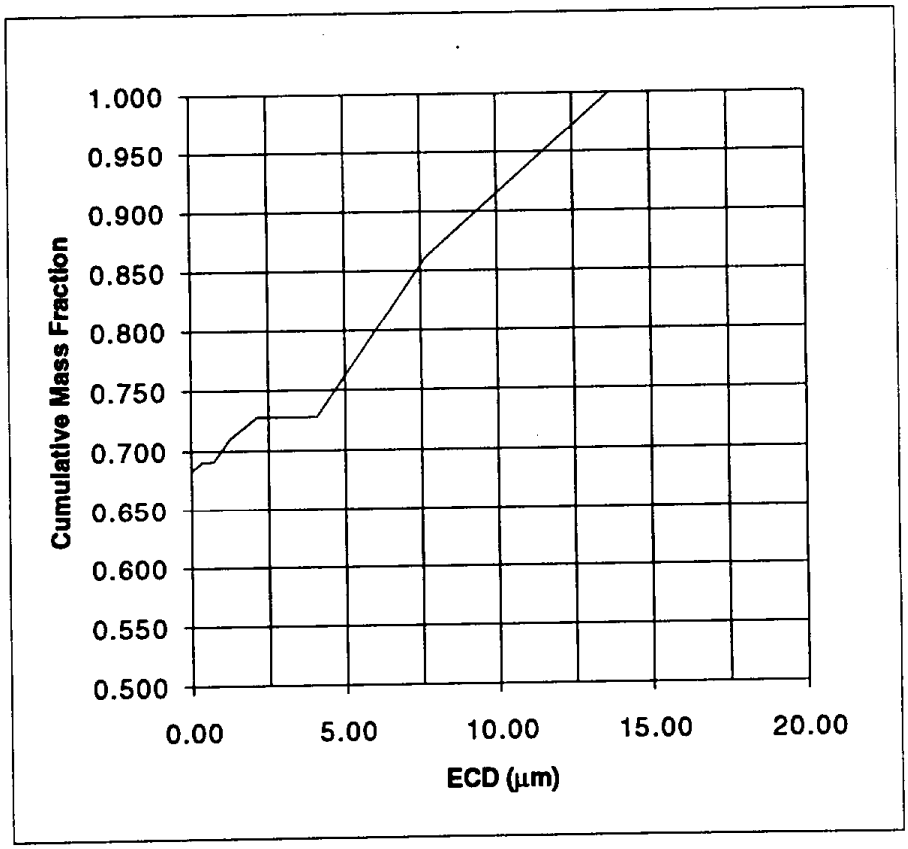

Figure 3.1.6.15. Particle size distribution, traverse 2, 2 September 92.

Fuel: Rice Straw

Date of Test: 2-Sep-92

Configuration: CEWF

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	14.76	0.02	4.44	1.000
2	8.27	0.07	4.42	0.995
3	4.41	0.06	4.35	0.980
4	2.33	0.08	4.29	0.966
5	1.34	0.16	4.21	0.948
6	0.79	0.55	4.05	0.912
7	0.41	0.56	3.50	0.788
filter	0.00	2.94	2.94	0.662

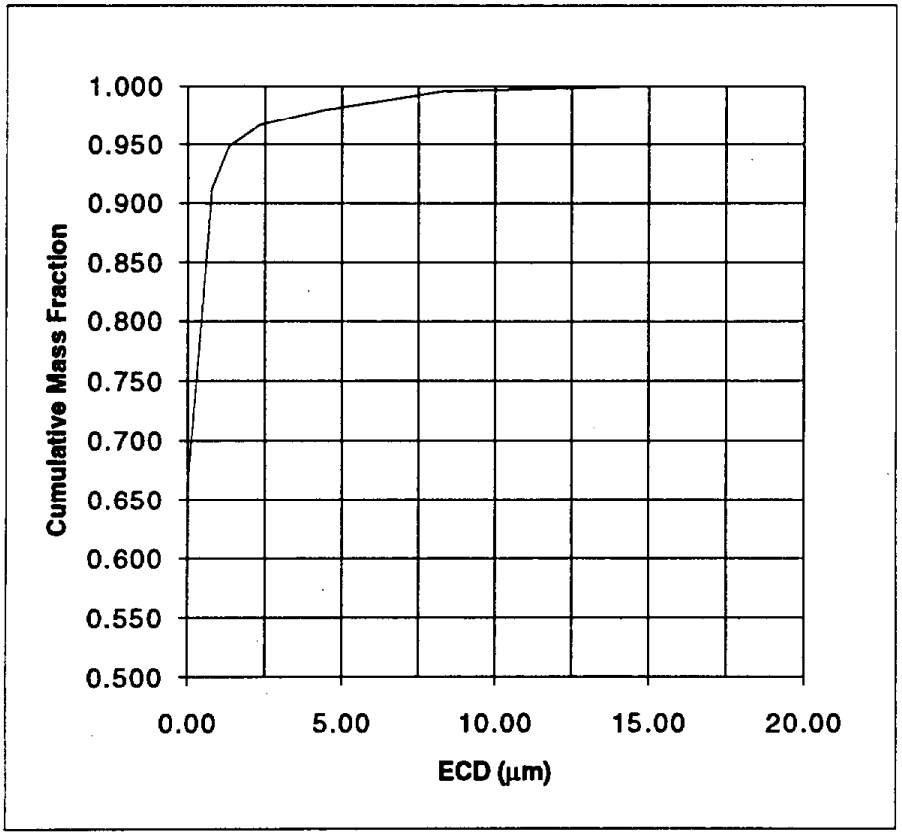

Figure 3.1.6.16. Particle size distribution, traverse 3, 2 September 92.

Fuel: Rice Straw

Date of Test: 2-Sep-92
Configuration: CEWF

Particle Size Distribution
Traverse 3:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.69	0.1	3.5	1.000
2	7.67	0.1	3.4	0.971
3	4.09	0.07	3.3	0.943
4	2.16	0.12	3.23	0.923
5	1.24	0.15	3.11	0.889
6	0.73	0.32	2.96	0.846
7	0.38	0.28	2.64	0.754
filter	0.00	2.36	2.36	0.674

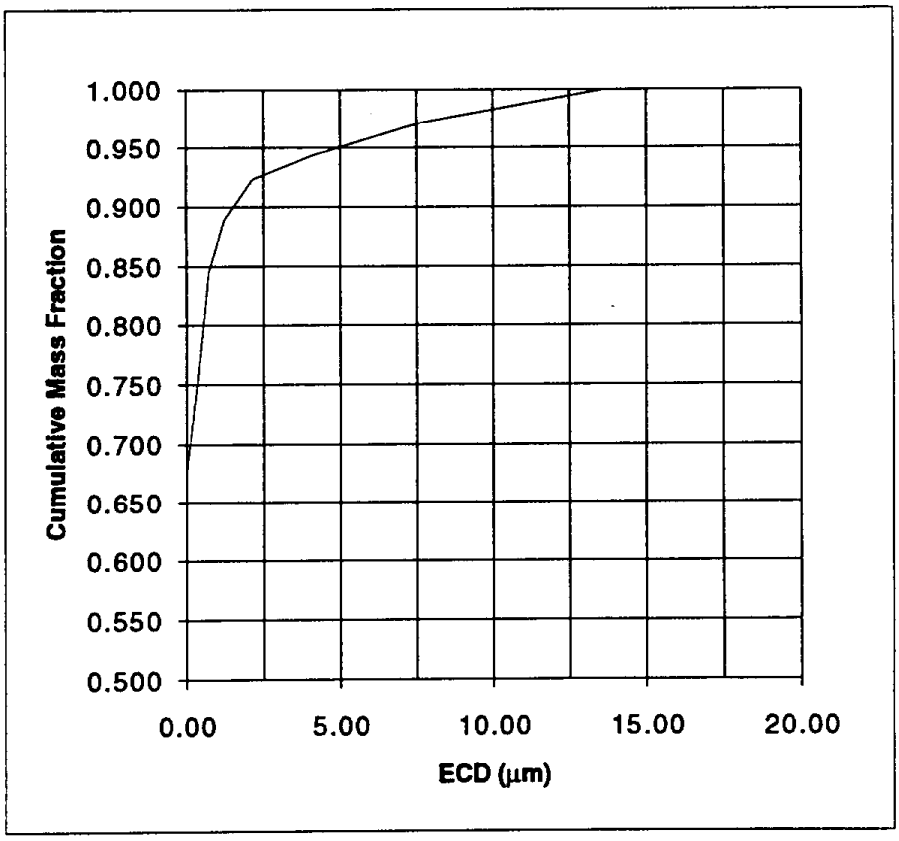

Figure 3.1.6.17. Particle size distribution, traverse 4, 2 September 92.

Fuel:	Rice Straw	Date of Test:	2-Sep-92
		Configuration:	CEWF

Particle Size Distribution
Traverse 4:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	14.76	0.05	2.87	1.000
2	8.27	0.07	2.82	0.983
3	4.41	0.05	2.75	0.958
4	2.33	0.08	2.7	0.941
5	1.34	0.02	2.62	0.913
6	0.79	0.24	2.6	0.906
7	0.41	0.15	2.36	0.822
filter	0.00	2.21	2.21	0.770

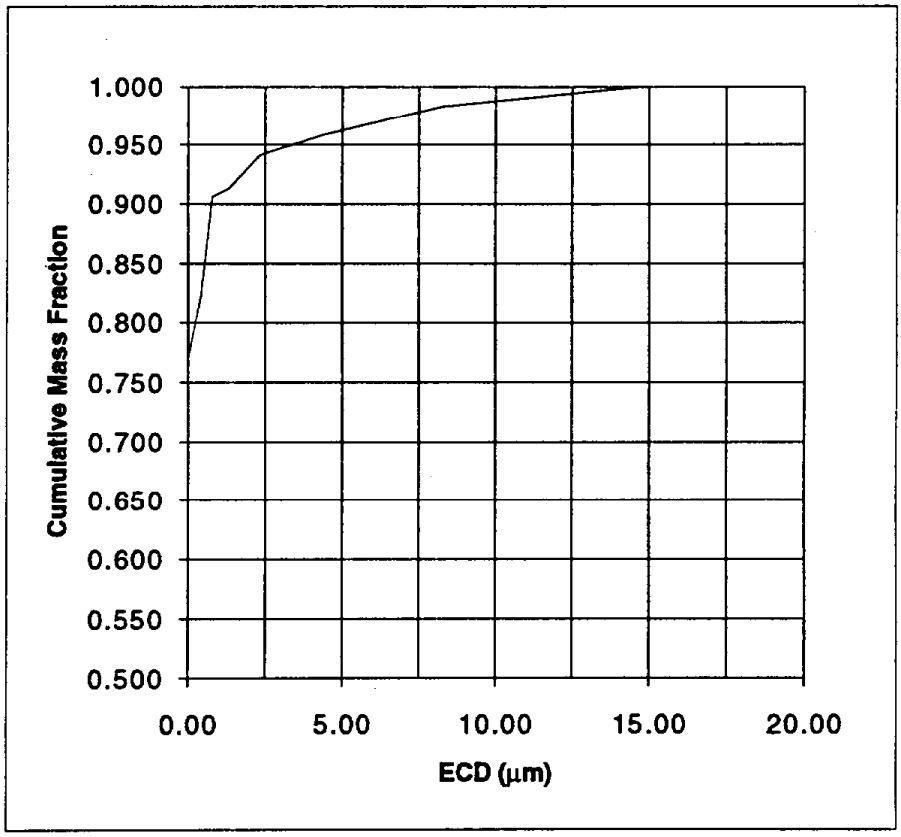

Figure 3.1.6.18. Nitrogen balance.
Date of Test: 2-Sep-92
Fuel Rice Straw
Type 1

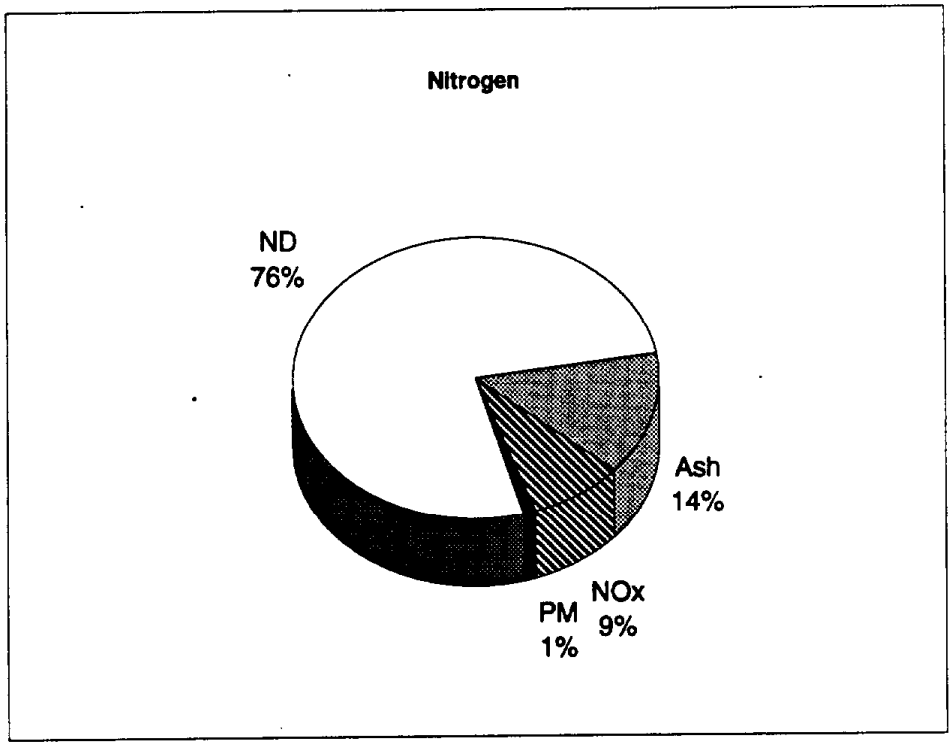

Figure 3.1.6.19. Nitrogen balance.
Date of Test: 2-Sep-92
Fuel Rice Straw
Type 2

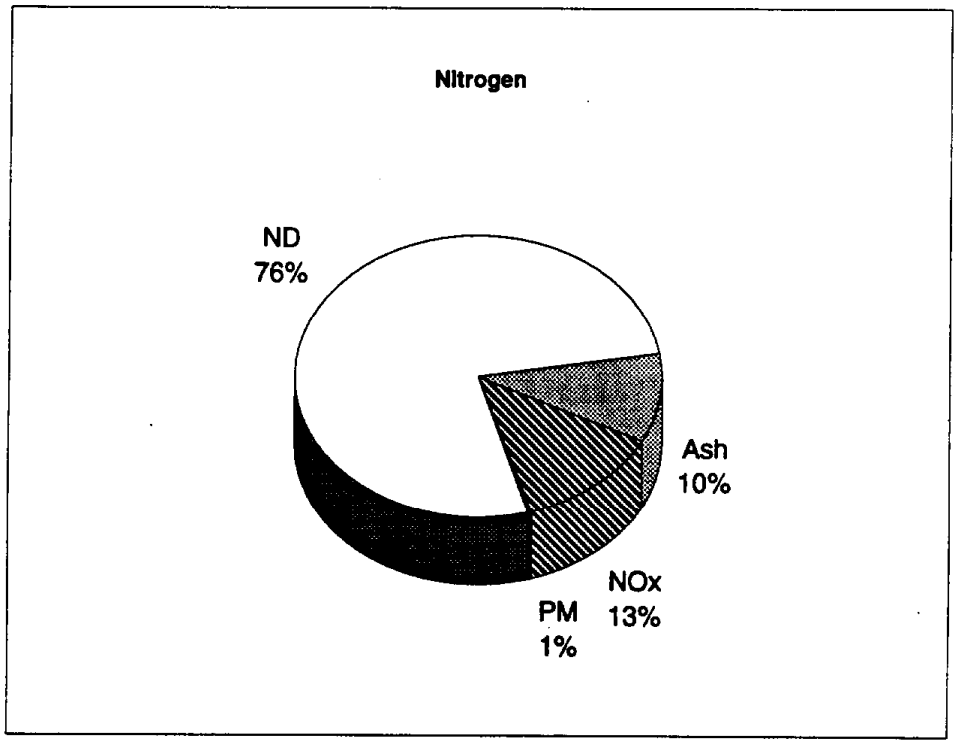

Figure 3.1.6.20. Sulfur balance.
Date of Test: 2-Sep-92
Fuel Rice Straw
Type 1

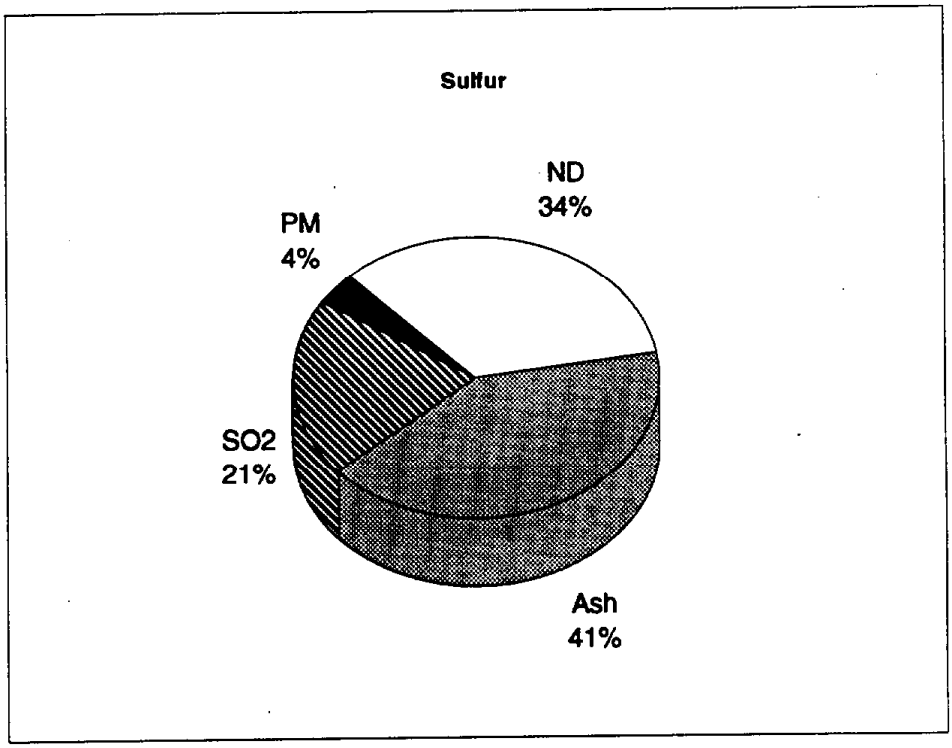

Figure 3.1.6.21. Sulfur balance.
Date of Test: 2-Sep-92
Fuel Rice Straw
Type 2

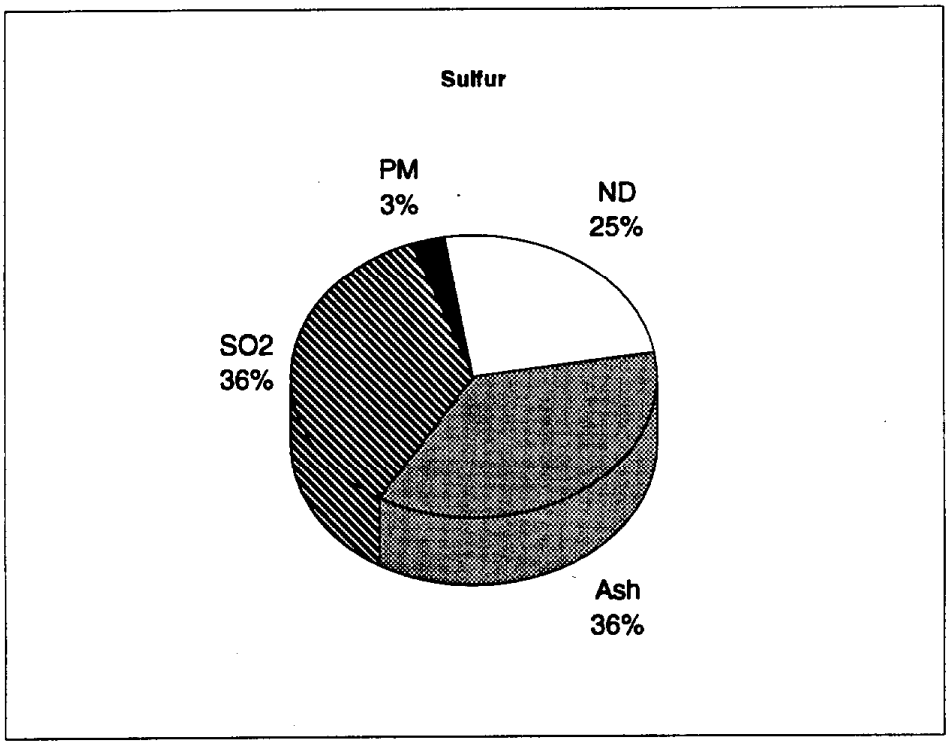

Table 3.1.7.1

Fuel and Ash Analyses

Run Date	21-Oct-92	21-Oct-92
Fuel Type	Rice Straw	Rice Straw
Sample Type	Fuel	Ash
Ultimate Analysis		
(% dry weight)		
C	36.54	14.29
H	4.96	0.80
N	0.79	0.46
Elemental Analysis		
(% by weight dry basis)		
N	0.83	0.57
P	0.10	0.38
K	2.73	8.84
Ca	0.24	0.84
Mg	0.22	0.63
Na	0.08	0.31
Cl	0.63	1.62
(mg/kg dry weight)		
S	1,090	2,300
B	6	16
Zn	22	65
Mn	687	2,160
Fe	326	1,280
Cu	8	13
Si		
Total (% dry weight)	46.55	28.86
Proximate Analysis		
(% dry weight)		
Ash	23.18	81.60
Volatiles	65.19	12.71
Fixed Carbon	11.62	5.69
Higher Heating Value		
(MJ/kg dry weight)	14.6377	7.1513

Table 3.1.7.2. Operating conditions and concentrations, 21 October 92.

Fuel:	Rice Straw	Date of Test:	21-Oct-92
		Configuration:	CEWF

Fuel Loading Rate (g/sq.m w.b.):	626
Total Fuel Consumption (kg w.b.)	62.2
Total Ash Recovered (kg w.b.)	17.2
Ash Fraction (w.b.)	0.28

	Traverse 1	Traverse 2
Mean Values		
Air Temperature (°C)	24.13	24.55
Air Relative Humidity (%)	55.34	52.42
Inlet Air Temperature (°C)	26.72	26.92
Stack Temperature (°C)	33.31	36.74
Impinger Outlet Temperature (°C)	17.08	17.68
Fire Spreading Rate (m/min)	0.48	0.61
Stack Gas Velocity (m/s)	3.21	3.08
Gas and PM Concentrations (less background)		
CO (ppmv)	45.01	62.81
NO (ppmv)	0.90	1.62
NOx (ppmv)	1.41	2.35
SO2 (ppmv)	0.10	0.21
THC (ppmv as CH4)	15.32	16.63
HC (ppmv as CH4 by GC)	6.58	8.62
CH4 (ppmv)	3.29	4.56
NMHC (ppmv as CH4)	12.03	12.07
NMHC (ppmv as CH4 by GC)	3.29	4.06
CO2 (ppmv by GC)	609	1,040
Total S (ppmv as SO2)	0.20	0.33
PM (mg/cu.m)	10.52	9.50
PM10 (mg/cu.m)	10.36	9.36
PM2.5 (mg/cu.m)	10.05	9.03

Table 3.1.7.3. Mass balance, 21 October 92.

Fuel: Rice Straw

Date of Test: 21-Oct-92

Configuration: CEWF

Mass Balance

	Traverse 1	Traverse 2
Total Conveyor Travel (m)	23.11	29.26
Fuel Moisture Content (% w.b.)	9.4	8.2
Fuel Loading Rate (g/sq.m d.b.)	567	574
Total Fuel Consumption (g w.b.)	17,626	22,311
Total Fuel Consumption (g d.b.)	15,973	20,490
Residual Ash (g w.b.)	4,858	6,149
Fuel Vaporized (g w.b.)	12,769	16,162
Fuel Consumption Rate (g/s w.b.)	6.12	7.75
Fuel Consumption Rate (g/s d.b.)	5.55	7.11
Ash Generation Rate (g/s w.b.)	1.69	2.13
Fuel Vaporization Rate (g/s w.b.)	4.43	5.61
Stack Gas Density (kg/cu.m)	1.1533	1.1405
Stack Gas Flow Rate (cu.m/s)	4.76	4.57
Stack Gas Mass Flow Rate (kg/s)	5.49	5.22
Inlet Air Mass Flow Rate (kg/s)	5.49	5.21
Overall Air-Fuel Ratio (w.b.)	897.05	672.78
Overall Air-Fuel Ratio (d.b.)	989.90	732.56

Table 3.1.7.4. Emission factors, rice straw, 21 October 92 (integrated basis).

Fuel:	Rice Straw	Date of Test:	21-Oct-92
		Configuration:	CEWF

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Average
CO	4.270	4.439	4.354
NO	0.091	0.123	0.107
NOx (as NO2)	0.221	0.273	0.247
SO2	0.022	0.033	0.027
THC (as CH4)	0.833	0.670	0.752
HC (as CH4 by GC)	0.360	0.349	0.354
CH4 (by GC)	0.180	0.184	0.182
NMHC (as CH4)	0.653	0.485	0.569
NMHC (as CH4 by GC)	0.180	0.164	0.172
CO2 (by GC)	91.583	115.715	103.649
Total S (as SO2)	0.042	0.053	0.048
SO2/Total S	0.51	0.63	0.57
PM	0.856	0.573	0.715
PM10	0.843	0.565	0.704
PM2.5	0.817	0.545	0.681
MMAD (μm)	0.175	0.156	0.166
σ	5.132	4.595	

Table 3.1.7.5. Emission factors, rice straw, 21 October 92 (average basis).

Fuel:	Rice Straw	Date of Test:	21-Oct-92
		Configuration:	CEWF

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Average
CO	4.305	4.448	4.376
NO	0.092	0.123	0.107
NOx (as NO2)	0.222	0.273	0.248
SO2	0.022	0.033	0.027
THC (as CH4)	0.837	0.673	0.755
HC (as CH4 by GC)	0.360	0.349	0.354
CH4 (by GC)	0.180	0.184	0.182
NMHC (as CH4)	0.658	0.488	0.573
NMHC (as CH4 by GC)	0.180	0.164	0.172
CO2 (by GC)	91.583	115.715	103.649
Total S (as SO2)	0.043	0.053	0.048
SO2/Total S	0.51	0.63	0.57
PM	0.856	0.573	0.715
PM10	0.843	0.565	0.704
PM2.5	0.817	0.545	0.681
MMAD (μm)	0.175	0.156	0.166
σ	5.132	4.595	

Table 3.1.7.6. Carbon balance.

Date of Test: Fuel	21-Oct-92 Rice Straw Traverse 1	21-Oct-92 Rice Straw Traverse 2
Carbon Balance		
Dry Fuel Consumption Rate (g/s)	5.55	7.11
Ash Generation Rate (g/s)	1.69	2.13
Ash Fraction (% dry basis)	30.45	29.96
Fuel Carbon Concentration (%)	36.54	36.54
Residual Ash Carbon Concentration (%)	14.29	14.29
Carbon released to stack (g/s)	1.79	2.29
Maximum CO2 emission factor (%)	118.02	118.28
Stack Gas Density (kg/cubic meter)	1.15	1.14
Average CO2 concentration (ppmv)	609	1,040
Average CO concentration (ppmv)	45.01	62.81
Average THC concentration (ppmv as CH4)	15.32	16.63
PM Concentration (mg/cubic meter)	10.52	9.50
PM Carbon Concentration (%)	50.43	50.43
PM Carbon (mg/cubic meter)	5.30	4.79
Stack Gas Temperature (°C)	33.31	36.74
Impinger Temperature (°C)	17.08	17.68
PM molar concentration (ppm)	10.53	9.53
Estimated Average Stack Gas Velocity (m/s)	3.70	2.90
Emission Factors (% Average Basis):		
CO2	91.583	115.715
CO	4.305	4.448
THC (as CH4)	0.837	0.673
PM	0.856	0.573
Emission Factors (% Integrated Basis):		
CO2	91.583	115.715
CO	4.270	4.439
THC (as CH4)	0.833	0.670
PM	0.856	0.573
Closure (% Average Basis)	87	106
Closure (% Integrated Basis)	85	105

Table 3.1.7.7. Nitrogen balance

Date of Test:	21-Oct-92	21-Oct-92
Fuel	Rice Straw Traverse 1	Rice Straw Traverse 2
Nitrogen Balance		
Fuel Nitrogen Concentration (% dry weight)	0.83	0.83
Ash Nitrogen Concentration (% weight)	0.57	0.57
Emission Factors (% Average Basis):		
NOx (as NO2)	0.222	0.273
PM	0.856	0.573
Emission Factors (% Integrated Basis):		
NOx (as NO2)	0.221	0.273
NO3- Concentration of PM (% weight)	0.241	0.241
NH4+ Concentration of PM (% weight)	7.182	7.182
Nitrogen Concentration of PM (%)	5.641	5.641
Fuel Nitrogen (mg/s)	46.07	59.01
Ash Nitrogen (mg/s)	9.63	12.14
Nitrogen as NOx (mg/s Average Basis)	3.75	5.91
Nitrogen as NOx (mg/s Integrated Basis)	3.73	5.91
Nitrogen as PM (mg/s Average Basis)	2.68	2.30
Nitrogen as NOx+PM (mg/s Average Basis)	6.43	8.21
Nitrogen as NOx+PM (mg/s Integrated Basis)	6.41	8.21
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.140	0.139
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.139	0.139
Ash Nitrogen/Fuel Nitrogen	0.209	0.206
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.349	0.345
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.348	0.345

Table 3.1.7.8. Sulfur balance.

Date of Test:	21-Oct-92	21-Oct-92
Fuel	Rice Straw Traverse 1	Rice Straw Traverse 2
Sulfur Balance		
Fuel Sulfur Concentration (mg/kg dry weight)	1,090	1,090
Ash Sulfur Concentration (mg/kg weight)	2,300	2,300
Emission Factors (% Average Basis)		
SO2	0.022	0.033
PM	0.856	0.573
Emission Factors (% Integrated Basis)		
SO2	0.022	0.033
Sulfur Concentration of PM (% weight)	0.904	0.904
Fuel Sulfur (mg/s)	6.05	7.75
Ash Sulfur (mg/s)	3.89	4.90
Sulfur as SO2 (mg/s Average Basis)	0.61	1.17
Sulfur as SO2 (mg/s Integrated Basis)	0.61	1.17
Sulfur as PM (mg/s Average Basis)	0.43	0.37
Sulfur as SO2+PM (mg/s Average Basis)	1.04	1.54
Sulfur as SO2+PM (mg/s Integrated Basis)	1.04	1.54
SO2+PM Sulfur/Fuel Sulfur (Average Basis)	0.172	0.199
SO2+PM Sulfur/Fuel Sulfur (Integrated Basis)	0.172	0.199
Ash Sulfur/Fuel Sulfur	0.643	0.632
Closure (% Average Basis)	81	83
Closure (% Integrated Basis)	81	83

Table 3.1.7.9. Water balance.

Estimated Stack Humidity

Fuel	Rice Straw
Configuration	CEWF
Date of Test	21-Oct-92

	Traverse 1	Traverse 2
Ambient Air Temperature °C)	24	25
Ambient Air Relative Humidity (%)	55	52
Air Temperature (K)	297	298
Saturation Pressure (Pa)	3,009	3,085
Vapor Pressure (Pa)	1,665	1,617
Air Dew Point Temperature (°C)	14.7	14.2
Ambient Volume Fraction Water Vapor	0.0164	0.0160
Ambient Mass Fraction Water Vapor	0.0102	0.0099
Fuel Burning Rate (g/s wet basis)	6.12	7.75
Fuel Moisture Content (%)	9.4	8.2
Ash Fraction (wet basis)	0.28	0.28
Fuel Hydrogen Content (%)	4.96	4.96
Ash Hydrogen Content (%)	0.80	0.80
Moisture Evaporated (g/s)	0.58	0.64
Water of Combustion (g/s)	2.35	3.02
Total Fuel Water Added (g/s)	2.93	3.66
Inlet Air Mass Flowrate (g/s)	5,490	5,210
Inlet Air Water Vapor Flowrate (g/s)	56	52
Total Stack Water Vapor Flowrate (g/s)	59	55
Stack Gas Mass Flowrate (g/s)	5,494	5,216
Mass Fraction Water Vapor in Stack	0.0107	0.0106
Volume Fraction Water Vapor in Stack	0.0173	0.0171
Stack Vapor Pressure (Pa)	1,751	1,730
Stack Temperature (°C)	33	37
Stack Temperature (K)	306	310
Stack Saturation Pressure (Pa)	5,123	6,193
Stack Relative Humidity (%)	34	28
Stack Dew Point Temperature (°C)	15.4	15.2
Impinger Outlet Temperature (°C)	17.1	17.7
Volume Stack Gas Sampled for PM (L)	694	663
Estimated Impinger/Desiccant Weight Gain (g)	9.1	8.5

Totals:

	Estimated	Measured
Total Impinger/Desiccant Weight Gain (g)	17.6	18.7
Estimated/Measured Weight Gain	0.94	

Table 3.1.7.10. Power balance.

Date of Test: Fuel	21-Oct-92 Rice Straw Traverse 1	21-Oct-92 Rice Straw Traverse 2
Power Balance		
Fuel Heating Value (MJ/kg dry weight)	14.6377	14.6377
Ash Heating Value (MJ/kg dry weight)	7.1513	7.1513
Average Energy Release Rate (kW)	69.2	88.8
Products of Incomplete Combustion (kW)		
CO	2.4	3.2
THC (as CH4)	2.6	2.7
PM	0.8	0.7
Heat Release Rate (kW)	63.4	82.3
Fireline Intensity (kW/m)	52.0	67.5
Stack Gas Flow (kg/s)	5.49	5.22
Stack Gas Temperature (°C)	33.31	36.74
Inlet Temperature (°C)	26.72	26.92
Sensible Power at Top of Stack (kW)	36.4	51.6
Tunnel Dissipation (kW)	27.0	30.7

Table 3.1.7.11. Mass concentrations (%) from DRI filter samples

Date	21-Oct-92		21-Oct-92		
Fuel	Rice Straw CEWF		Rice Straw CEWF		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT041		ABTT042		
Quartz Filter ID	ABTQ041		ABTQ042		
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)	0.36	0.02	0.36	0.02	
Quartz sample volume (m^3)	0.36	0.02	0.36	0.02	
Teflon mass concentration (µg/m^3)	7,447	375	8,078	406	
	Concentration (%)	±Uncertainty	Concentration (%)	±Uncertainty	PM2.5/PM10
Cl-	23.1639	1.9128	20.7367	1.7118	1.12
NO3-	0.2562	0.0320	0.2414	0.0297	1.06
SO4=	3.2660	0.2416	3.0297	0.2240	1.08
NH4+	8.1384	0.6071	7.1823	0.5378	1.13
Na+	0.1287	0.0157	0.1281	0.0151	1.00
K+	7.5109	0.5659	6.7419	0.5078	1.11
C(org)	47.6671	4.5937	45.1189	4.3461	1.06
C(oht)	38.6414	5.8730	36.8595	5.6006	1.05
C(e)	5.3637	0.5098	5.3061	0.5048	1.01
C(eht)	1.9321	1.1801	1.7503	1.0673	1.10
C	53.0308		50.4250		1.05
Al	0.0583	0.0785	0.0198	0.0745	2.94
Si	0.1821	0.0407	0.7795	0.0663	0.23
P	0.0000	0.1866	0.0000	0.1753	
S	0.9254	0.1069	0.9043	0.1019	1.02
Cl	17.2483	1.2246	16.1922	1.1491	1.07
K	6.4244	0.4562	5.9834	0.4247	1.07
Ca	0.0242	0.0925	0.0987	0.0298	0.25
Ti	0.0007	0.0259	0.0018	0.0231	0.39
V	0.0004	0.0112	0.0010	0.0100	0.40
Cr	0.0010	0.0025	0.0020	0.0016	0.50
Mn	0.0073	0.0013	0.0311	0.0025	0.23
Fe	0.0117	0.0044	0.0734	0.0066	0.16
Co	0.0000	0.0011	0.0000	0.0015	
Ni	0.0000	0.0011	0.0002	0.0010	0.00
Cu	0.0008	0.0012	0.0011	0.0007	0.73
Zn	0.0026	0.0009	0.0032	0.0008	0.81
Ga	0.0000	0.0021	0.0000	0.0019	
As	0.0017	0.0025	0.0021	0.0015	0.81
Se	0.0009	0.0014	0.0009	0.0013	1.00
Br	0.1130	0.0081	0.1115	0.0080	1.01
Rb	0.0043	0.0016	0.0043	0.0015	1.00
Sr	0.0001	0.0013	0.0003	0.0011	0.33
Y	0.0001	0.0017	0.0004	0.0015	0.25
Zr	0.0005	0.0019	0.0002	0.0016	2.50
Mo	0.0000	0.0032	0.0015	0.0028	0.00
Pd	0.0000	0.0115	0.0000	0.0105	
Ag	0.0015	0.0133	0.0037	0.0121	0.41
Cd	0.0000	0.0141	0.0043	0.0129	0.00
In	0.0010	0.0157	0.0000	0.0141	
Sn	0.0017	0.0198	0.0006	0.0179	2.83
Sb	0.0000	0.0227	0.0044	0.0202	0.00
Ba	0.0067	0.0775	0.0085	0.0695	0.79
La	0.0000	0.1036	0.0000	0.0926	
Au	0.0000	0.0035	0.0001	0.0031	0.00
Hg	0.0000	0.0029	0.0017	0.0026	0.00
Tl	0.0000	0.0028	0.0000	0.0025	
Pb	0.0000	0.0037	0.0000	0.0032	
U	0.0000	0.0034	0.0003	0.0031	0.00
Sum of measured species	86.5728	4.8499	82.2130	4.5828	1.05

Table 3.1.7.12. Element ratios from DRI filter samples.

Date	21-Oct-92	21-Oct-92	
Fuel	Rice Straw	Rice Straw	
Configuration	CEWF	CEWF	
Size Fraction	PM2.5	PM10	PM2.5/PM10
Teflon Filter ID	ABTT041	ABTT042	
Quartz Filter ID	ABTQ041	ABTQ042	
Cl-/Cl	1.34	1.28	1.05
K+/K	1.17	1.13	1.04
Sulfate S/Total S	1.18	1.12	1.05
C(org)/C	0.90	0.89	1.00
Cl/K	2.68	2.71	0.99
Cl-/K+	3.08	3.08	1.00
Cl-/Na+	179.98	161.88	1.11
S/K	0.14	0.15	0.95
S/Na+	7.19	7.06	1.02
Al/Si	0.32	0.03	12.60

Table 3.1.7.13. Emission factors (mg/kg) from DRI filter samples.

Date		21-Oct-92		21-Oct-92	
Fuel		Rice Straw CEWF		Rice Straw CEWF	
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT041		ABTT042		
Quartz Filter ID	ABTQ041		ABTQ042		
Start Time	15:56				
Stop Time	16:32				
Start Time					
End Time					
Elapsed Time (minutes)	36				Traverse 2
PM (mg/m^3 by total filter)					9.500
PM10 (by total filter/impactor)					9.360
PM2.5 (by total filter/impactor)					9.030
PM emission factor (%)					0.573
PM10 emission factor (%)					0.565
PM2.5 emission factor (%)					0.545
		±Uncertainty		±Uncertainty	
Teflon sample volume (m^3)	0.36	0.02	0.36	0.02	
Quartz sample volume (m^3)	0.36	0.02	0.36	0.02	
Teflon mass concentration (mg/m^3)	7.447	0.375	8.078	0.406	
Teflon mass/Total mass	0.825		0.863		
	Emission (mg/kg)	±Uncertainty	Emission (mg/kg)	±Uncertainty	PM2.5/PM10
Cl-	1458.2323	104.2476	1425.1074	96.7167	1.02
NO3-	16.1285	1.7440	16.5900	1.6781	0.97
SO4=	205.6038	13.1672	208.2129	12.6560	0.99
NH4+	512.3351	33.0870	493.5958	30.3857	1.04
Na+	8.1020	0.8557	8.8035	0.8532	0.92
K+	472.8322	30.8416	463.3298	28.6907	1.02
C(org)	3000.7773	250.3567	3100.7479	245.5547	0.97
C(oht)	2432.5843	320.0785	2533.1295	316.4339	0.96
C(e)	337.6599	27.7841	364.6560	28.5212	0.93
C(eht)	121.6311	64.3155	120.2875	60.3024	1.01
C	3338.4372	0.0000	3465.4039	0.0000	0.96
Al	3.6701	4.2783	1.3607	4.2093	2.70
Si	11.4637	2.2182	53.5703	3.7460	0.21
P	0.0000	10.1697	0.0000	9.9045	
S	58.2565	5.8261	62.1470	5.7574	0.94
Cl	1085.8287	66.7407	1112.7915	64.9242	0.98
K	404.4340	24.8629	411.2027	23.9956	0.98
Ca	1.5235	5.0413	6.7831	1.6837	0.22
Ti	0.0441	1.4116	0.1237	1.3052	0.36
V	0.0252	0.6104	0.0687	0.5650	0.37
Cr	0.0630	0.1363	0.1374	0.0904	0.46
Mn	0.4596	0.0709	2.1373	0.1413	0.22
Fe	0.7365	0.2398	5.0443	0.3729	0.15
Co	0.0000	0.0600	0.0000	0.0848	
Ni	0.0000	0.0600	0.0137	0.0565	0.00
Cu	0.0504	0.0654	0.0756	0.0396	0.67
Zn	0.1637	0.0491	0.2199	0.0452	0.74
Ga	0.0000	0.1145	0.0000	0.1074	
As	0.1070	0.1363	0.1443	0.0848	0.74
Se	0.0567	0.0763	0.0619	0.0735	0.92
Br	7.1137	0.4415	7.6627	0.4520	0.93
Rb	0.2707	0.0872	0.2955	0.0848	0.92
Sr	0.0063	0.0709	0.0206	0.0622	0.31
Y	0.0063	0.0927	0.0275	0.0848	0.23
Zr	0.0315	0.1036	0.0137	0.0904	2.29
Mo	0.0000	0.1744	0.1031	0.1582	0.00
Pd	0.0000	0.6268	0.0000	0.5933	
Ag	0.0944	0.7249	0.2543	0.6837	0.37
Cd	0.0000	0.7685	0.2955	0.7289	0.00
In	0.0630	0.8557	0.0000	0.7967	
Sn	0.1070	1.0791	0.0412	1.0114	2.60
Sb	0.0000	1.2372	0.3024	1.1413	0.00
Ba	0.4218	4.2238	0.5842	3.9268	0.72
La	0.0000	5.6462	0.0000	5.2319	
Au	0.0000	0.1908	0.0069	0.1752	0.00
Hg	0.0000	0.1581	0.1168	0.1469	0.00
Tl	0.0000	0.1526	0.0000	0.1413	
Pb	0.0000	0.2017	0.0000	0.1808	
U	0.0000	0.1853	0.0206	0.1752	0.00
Sum of measured species	5,450	264	5,650	250	0.96

Table 3.1.7.14. Element concentrations (ng/m^3) from CNL filter samples.

Fuel:	Rice
Date:	21-Oct-92
Time:	14:39
Filter ID:	AG-46

Element	Concentration ng/m^3	±Uncertainty
H	351,530	29,100
Na		
Mg	57,640	10,400
Al		
Si	31,120	2,800
P		
S		
Cl	998,880	51,000
K	294,600	15,500
Ca		
Ti		
V		
Cr	640	300
Mn	1,230	300
Fe	4,470	400
Ni		
Cu		
Zn		
As		
Pb		
Se		
Br	4,670	400
Rb	610	400
Sr		
Zr		

Table 3.1.7.15. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Rice
Date:	21-Oct-92
Time:	14:39
Filter ID:	AG-46
Fuel rate (g/s)	5.55
Stack gas flow rate (m^3/s)	4.76
Stack Temperature (°C)	33.31
Ambient Temperature (°C)	24.13

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	292.5	24.2
Na		
Mg	48.0	8.7
Al		
Si	25.9	2.3
P		
S		
Cl	831.0	42.4
K	245.1	12.9
Ca		
Ti		
V		
Cr	0.5	0.2
Mn	1.0	0.2
Fe	3.7	0.3
Ni		
Cu		
Zn		
As		
Pb		
Se		
Br	3.9	0.3
Rb	0.5	0.3
Sr		
Zr		

Table 3.1.7.16. Element concentrations (ng/m^3) from CNL filter samples.

Fuel:	Rice
Date:	21-Oct-92
Time:	15:58
Filter ID:	AG-47

Element	Concentration	±Uncertainty
	ng/m^3	
H	332,060	24,900
Na	153,800	38,700
Mg		
Al		
Si	86,430	5,300
P		
S		
Cl	2,170,380	109,400
K	694,420	35,100
Ca		
Ti		
V		
Cr		
Mn	2,150	300
Fe	6,140	400
Ni		
Cu	410	100
Zn		
As	140	100
Pb		
Se		
Br	9,890	600
Rb		
Sr		
Zr		

Table 3.1.7.17. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Rice
Date:	21-Oct-92
Time:	15:58
Filter ID:	AG-47
Fuel rate (g/s)	7.11
Stack gas flow rate (m^3/s)	4.57
Stack Temperature (°C)	36.74
Ambient Temperature (°C)	24.55

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	205.0	15.4
Na	95.0	23.9
Mg		
Al		
Si	53.4	3.3
P		
S		
Cl	1,340.2	67.6
K	428.8	21.7
Ca		
Ti		
V		
Cr		
Mn	1.3	0.2
Fe	3.8	0.2
Ni		
Cu	0.3	0.1
Zn		
As	0.1	0.1
Pb		
Se		
Br	6.1	0.4
Rb		
Sr		
Zr		

Table 3.1.7.18. Relative element concentrations by stage from DRUM impactor.

Stage 1: 10 - 15 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	5,319.79	302.73	3.6728	1
S				
Cl	687.10	105.82	0.4744	1
K	1,448.44	105.41	1.0000	1
Ca	562.15	64.77	0.3881	1
Ti	52.34	20.59	0.0361	1
V				
Cr				
Mn	125.54	18.00	0.0867	1
Fe	1,297.12	78.95	0.8955	1
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.7.19. Relative element concentrations by stage from DRUM impactor.

Stage 2: 5 - 10 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	2,854.50	176.73	2.9231	0.5366
S	41.39	23.86	0.0424	
Cl	274.99	46.36	0.2816	0.4002
K	976.54	73.77	1.0000	0.6742
Ca				
Ti	50.50	22.50	0.0517	0.9648
V				
Cr				
Mn	66.18	13.91	0.0678	0.5272
Fe	770.54	50.86	0.7890	0.5940
Ni	20.97	5.73	0.0215	
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.7.20. Relative element concentrations by stage from DRUM impactor.

Stage 3: 2.5 - 5 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	5,030.99	271.91	3.3629	0.9457
S				
Cl	858.95	75.41	0.5742	1.2501
K	1,496.00	111.41	1.0000	1.0328
Ca	922.25	97.77	0.6165	1.6406
Ti				
V	35.29	12.68	0.0236	
Cr				
Mn	237.00	24.27	0.1584	1.8879
Fe	530.10	39.27	0.3543	0.4087
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.7.21. Relative element concentrations by stage from DRUM impactor.

Stage 4: 1.15 - 2.5 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg	232.38	58.64	1.1149	
Al				
Si	275.25	46.91	1.3206	0.0517
S	156.46	42.14	0.7507	
Cl	285.97	41.45	1.3720	0.4162
K	208.43	32.45	1.0000	0.1439
Ca	56.15	27.41	0.2694	0.0999
Ti				
V				
Cr	98.17	18.95	0.4710	
Mn				
Fe	104.56	19.91	0.5017	0.0806
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.7.22. Relative element concentrations by stage from DRUM impactor.

Stage 5: 0.56 - 1.15 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	700.04	90.82	1.6807	
Na				
Mg				
Al	375.41	54.00	0.9013	
Si	138.38	32.32	0.3322	0.0260
S	98.05	26.73	0.2354	
Cl	566.44	54.27	1.3600	0.8244
K	416.51	42.41	1.0000	0.2876
Ca				
Ti				
V				
Cr	43.70	12.41	0.1049	
Mn	72.01	16.77	0.1729	0.5736
Fe				
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.7.23. Relative element concentrations by stage from DRUM impactor.

Stage 6: 0.34 - 0.56 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	9,938.97	924.14	0.8726	
Na				
Mg				
Al				
Si	139.53	40.09	0.0122	0.0262
S				
Cl	23,404.75	1,216.50	2.0547	34.0633
K	11,390.59	616.36	1.0000	7.8640
Ca				
Ti				
V	77.60	23.18	0.0068	
Cr				
Mn	71.58	16.91	0.0063	0.5702
Fe	148.85	24.41	0.0131	0.1148
Ni				
Cu				
Zn	38.99	10.23	0.0034	
As				
Se				
Br	151.98	23.86	0.0133	
Rb	51.57	24.00	0.0045	
Sr				
Pb				

Table 3.1.7.24. Relative element concentrations by stage from DRUM impactor.

Stage 7: 0.24 - 0.34 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	1,720.73	186.27	0.4460	
Na				
Mg				
Al				
Si	82.81	25.23	0.0215	0.0156
S				
Cl	3,727.30	219.55	0.9660	5.4247
K	3,858.56	225.14	1.0000	2.6639
Ca				
Ti				
V				
Cr				
Mn				
Fe				
Ni	22.53	6.68	0.0058	
Cu	25.96	7.50	0.0067	
Zn	22.72	7.36	0.0059	
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.7.25. Relative element concentrations by stage from DRUM impactor.

Stage 8: < 0.24 μm

	21-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	12,473.70	833.32	0.4900	
Na				
Mg				
Al	278.81	87.14	0.0110	
Si				
S				
Cl	37,372.92	1,924.09	1.4682	54.3926
K	25,454.09	1,332.41	1.0000	17.5734
Ca				
Ti				
V	162.70	61.09	0.0064	
Cr				
Mn	49.00	16.91	0.0019	0.3903
Fe				
Ni	28.13	11.86	0.0011	
Cu	72.31	16.36	0.0028	
Zn				
As				
Se	42.83	14.05	0.0017	
Br	354.19	50.18	0.0139	
Rb				
Sr				
Pb				

Table 3.1.7.26
VOC Concentrations (ppbv)

Date	21-Oct-92	21-Oct-92
Fuel	Rice Straw	Rice Straw
Traverse	Traverse 1	Traverse 2
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		117
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	103.1	152.5
Dimethylbutane		
Hexane		
Phenol	124.1	83.8
Dimethylfuran		123.9
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	81.6	159.1
Benzonitrile		
Benzaldehyde	33.5	40.6
Methylphenol (hydroxy toluene)		
Styrene	65.7	85.8
Xylene	15	26.9
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		
Naphthalene	13.2	9.2
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 3.1.7.27
VOC Emission Factors (mg/kg)

Date	21-Oct-92	21-Oct-92
Fuel	Rice Straw	Rice Straw
Traverse	Traverse 1	Traverse 2
Fuel Consumption Rate (g/s d.b)	5.55	7.11
Stack Gas Mass Flow Rate (kg/s)	5.49	5.22
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		208
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	275	301
Dimethylbutane		
Hexane		
Phenol	399	200
Dimethylfuran		301
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	257	371
Benzonitrile		
Benzaldehyde	121	109
Methylphenol (hydroxy toluene)		
Styrene	234	226
Xylene	54	72
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		
Naphthalene	58	30
Unknown		
Alpha-pinene		
Camphene		
Δ3-Carene		
Limonene		

Table 3.1.7.28. PAH emission factors, rice straw, 21 October 1992 (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	250	249	35	14,166	6,900	1	14,453	7,185	10,819
2-Methyl-naphthalene	269	343	46	26,684	15,015	1	27,001	15,406	21,204
Acenaphthylene	12	11	1	411	262	0	425	274	350
Acenaphthene	0	0	0	1,220	921	0	1,220	921	1,070
Fluorene	-1	1	5	1,215	736	0	1,219	742	980
Phenanthrene	98	102	59	2,359	1,827	2	2,517	1,989	2,253
Anthracene	25	26	6	337	384	0	368	416	392
Fluoranthene	146	75	100	368	273	0	614	449	531
Pyrene	159	89	71	134	173	0	363	332	348
Benz[a]-anthracene	215	125	1	0	4	0	216	130	173
Chrysene	222	119	13	17	6	0	252	138	195
Benzo[b]-fluoranthene	171	64	20	9	8	0	200	92	146
Benzo[k]-fluoranthene	177	77	0	12	10	0	189	87	138
Benzo[a]pyrene	63	38	0	0	4	0	63	42	52
Benzo[e]pyrene	128	70	0	0	7	0	128	77	103
Perylene	13	5	0	0	0	0	13	5	9
Benzo[ghi]-perylene	24	12	0	0	0	0	24	12	18
Indeno[1,2,3-cd]-pyrene	24	11	0	0	0	0	24	11	18
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	1,995	1,418	356	46,930	26,530	5	49,287	28,309	38,798

Figure 3.1.7.1. Ambient air conditions, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

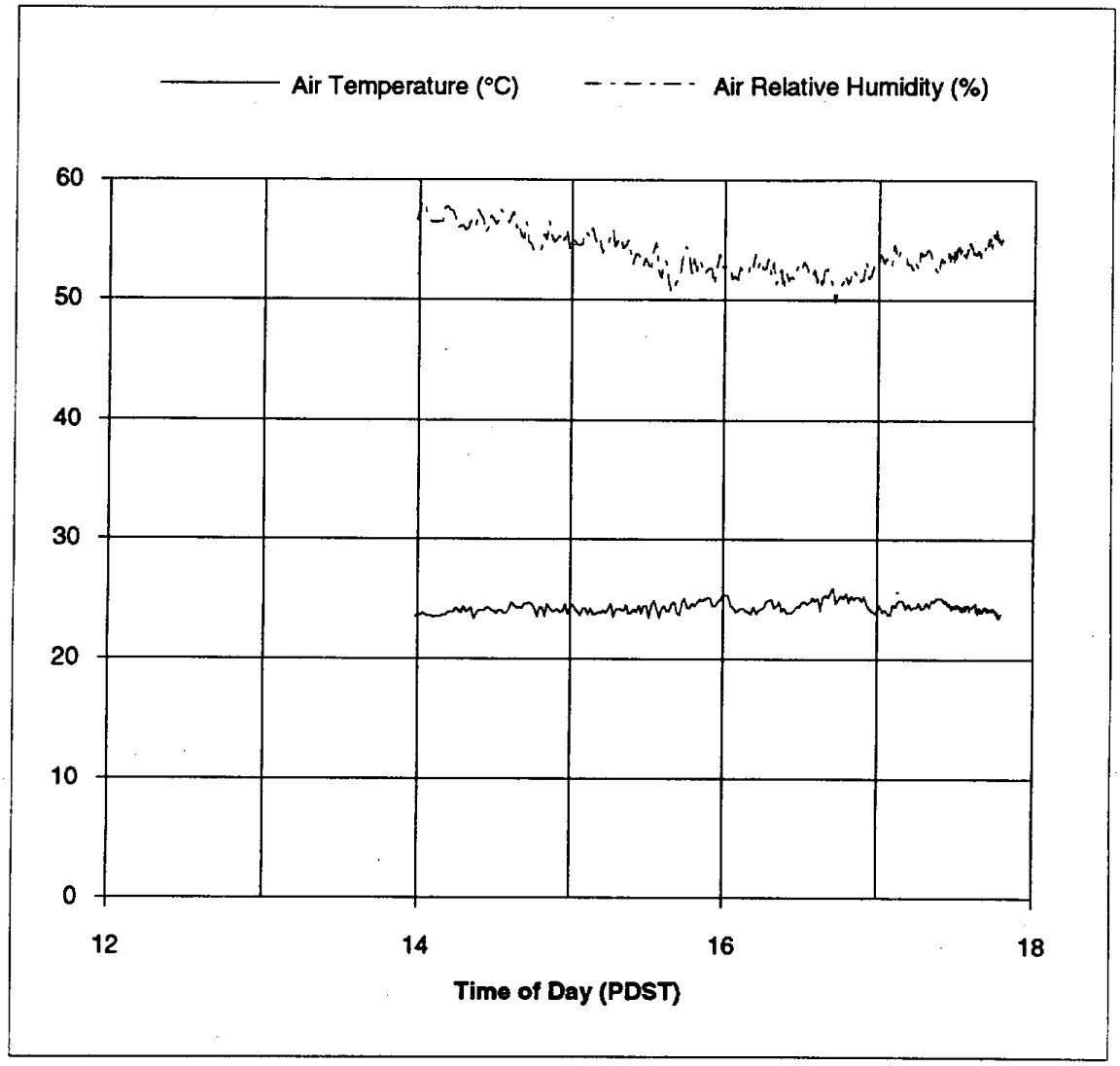

Figure 3.1.7.2. Air temperature and relative humidity from CIMIS station.

Fuel: Rice Straw Date of Test: 21-Oct-92

Configuration: CEWF

Hourly Average CIMIS Data for Davis, California

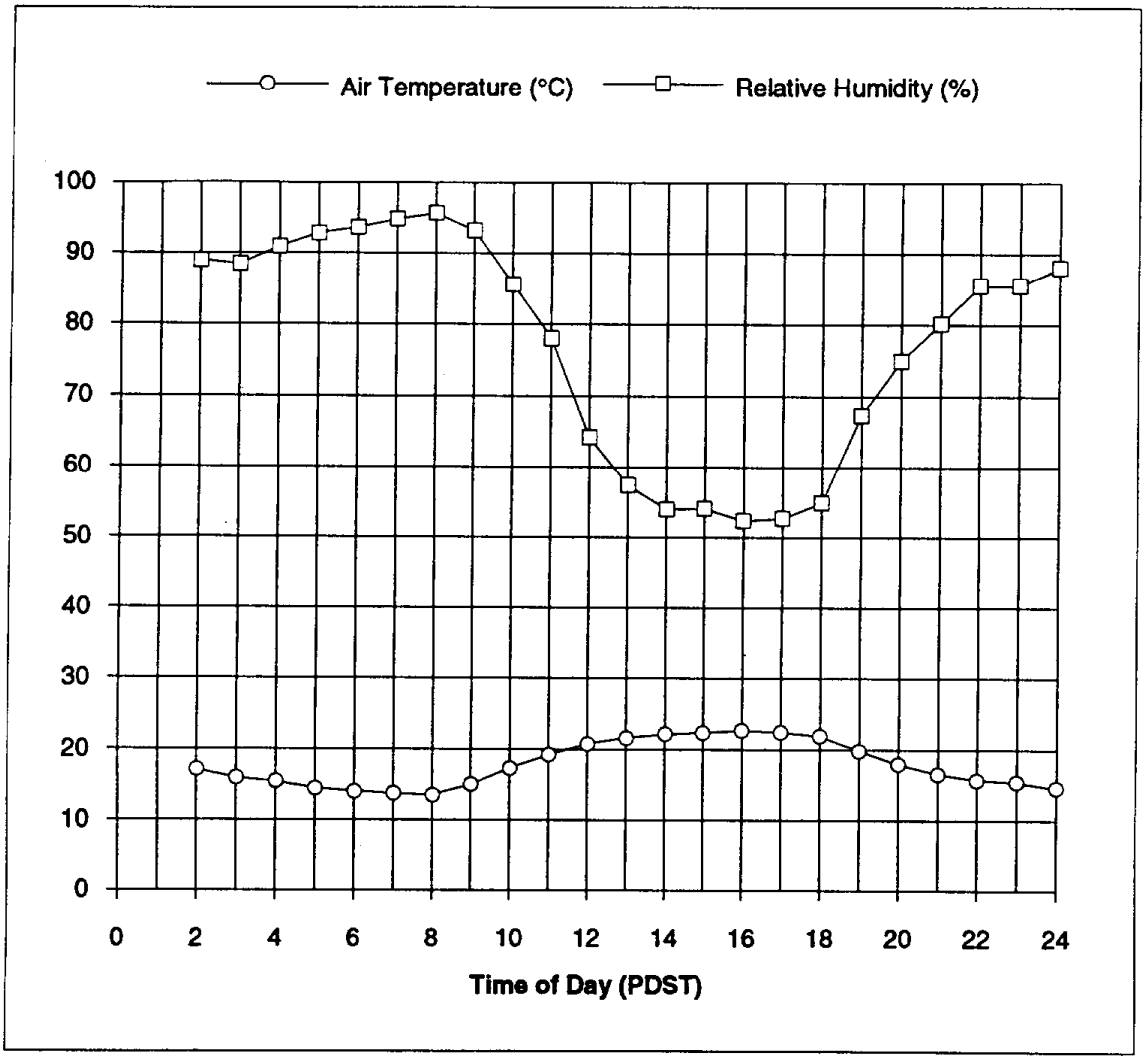

Figure 3.1.7.3. Wind speed from CIMIS station.

Fuel: Rice Straw Date of Test: 21-Oct-92

Configuration: CEWF

Hourly Average CIMIS Data for Davis, California

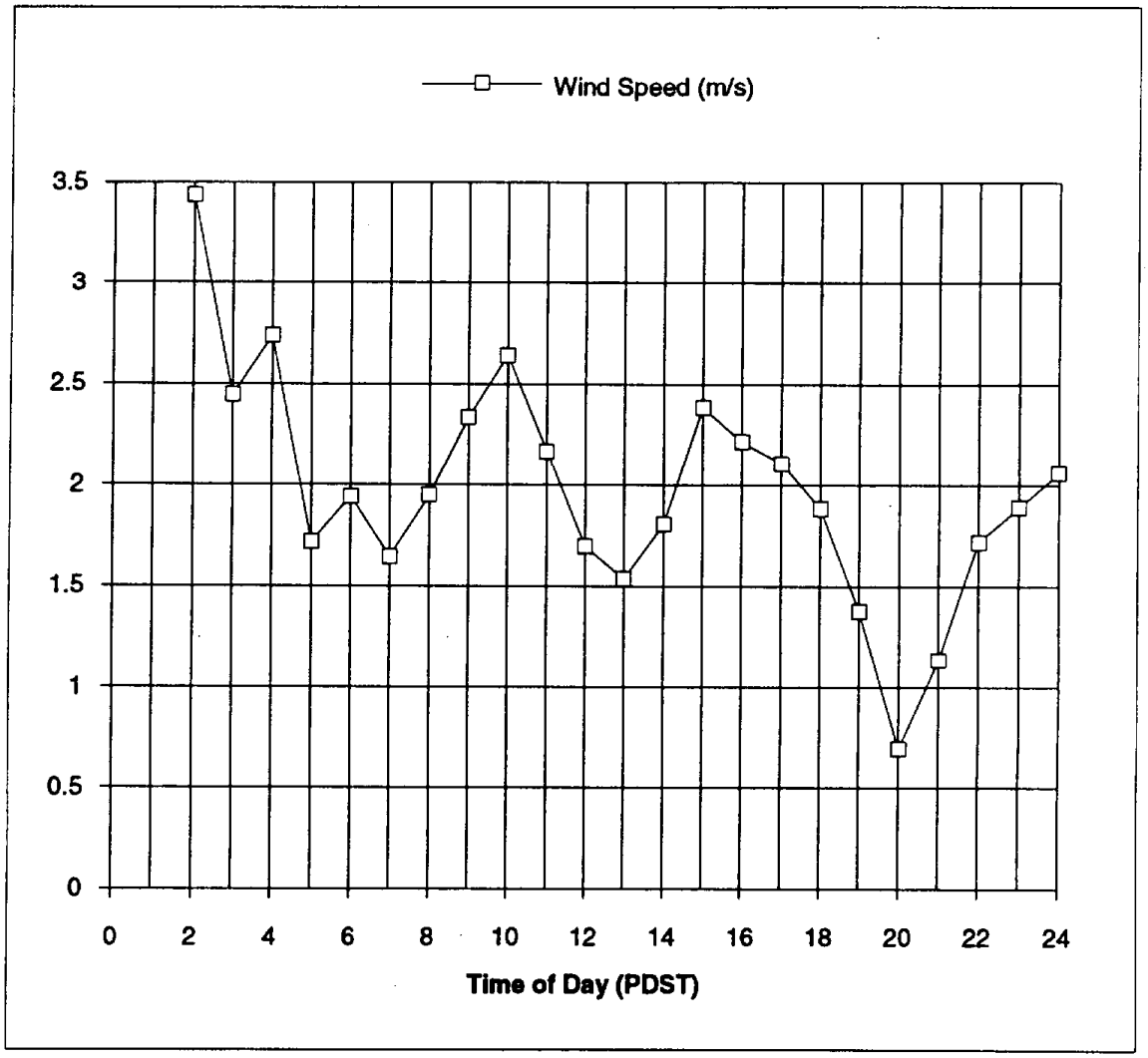

Figure 3.1.7.4. Wind direction and solar radiation from CIMIS station.

Fuel: Rice Straw Date of Test: 21-Oct-92

Configuration: CEWF

Hourly Average CIMIS Data for Davis, California

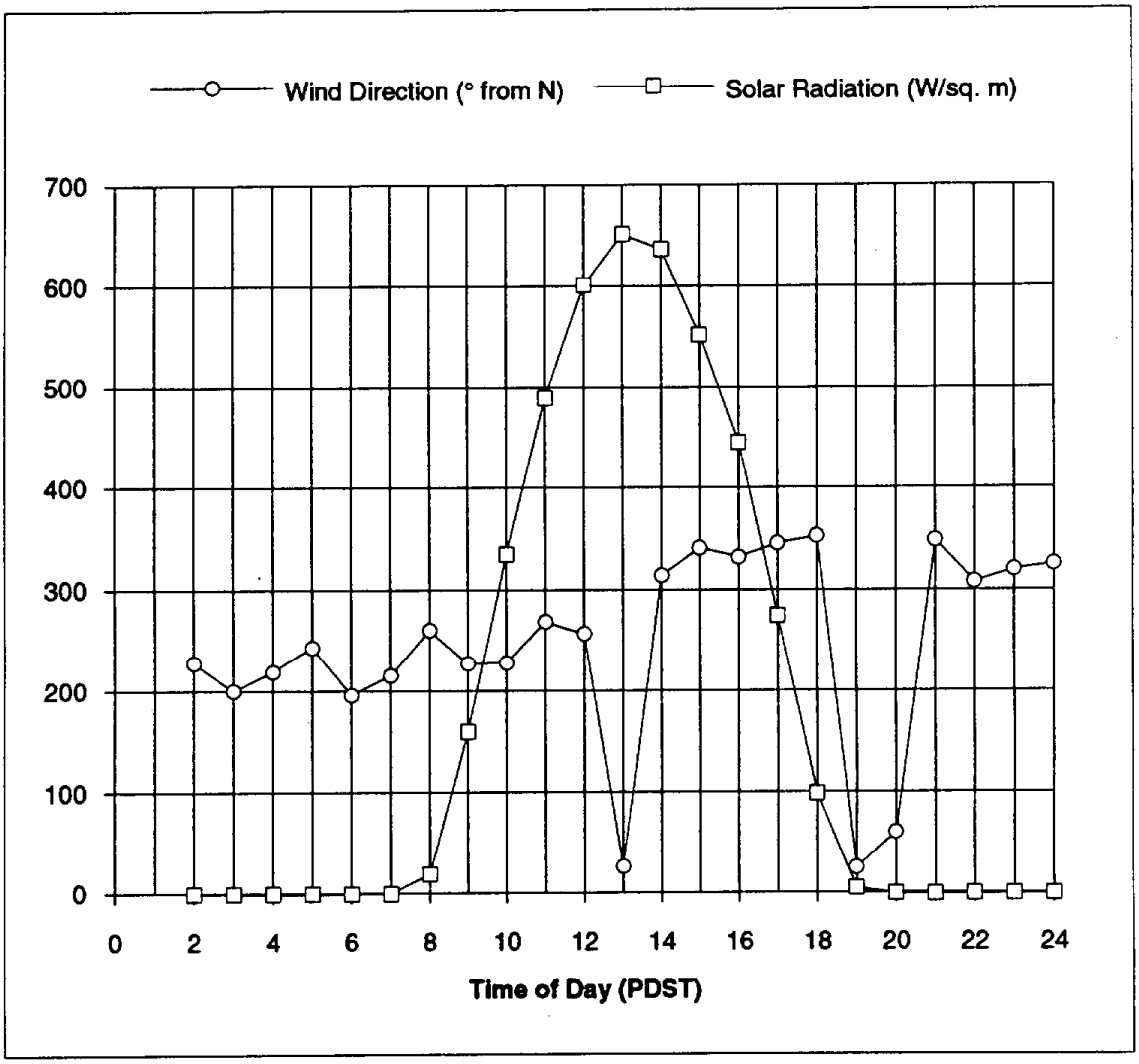

Figure 3.1.7.5. Inlet air, stack gas, and impinger temperatures, 21 October 92.

Fuel Type: Rice Straw Test Date 21-Oct-92
Configuration: CEWF

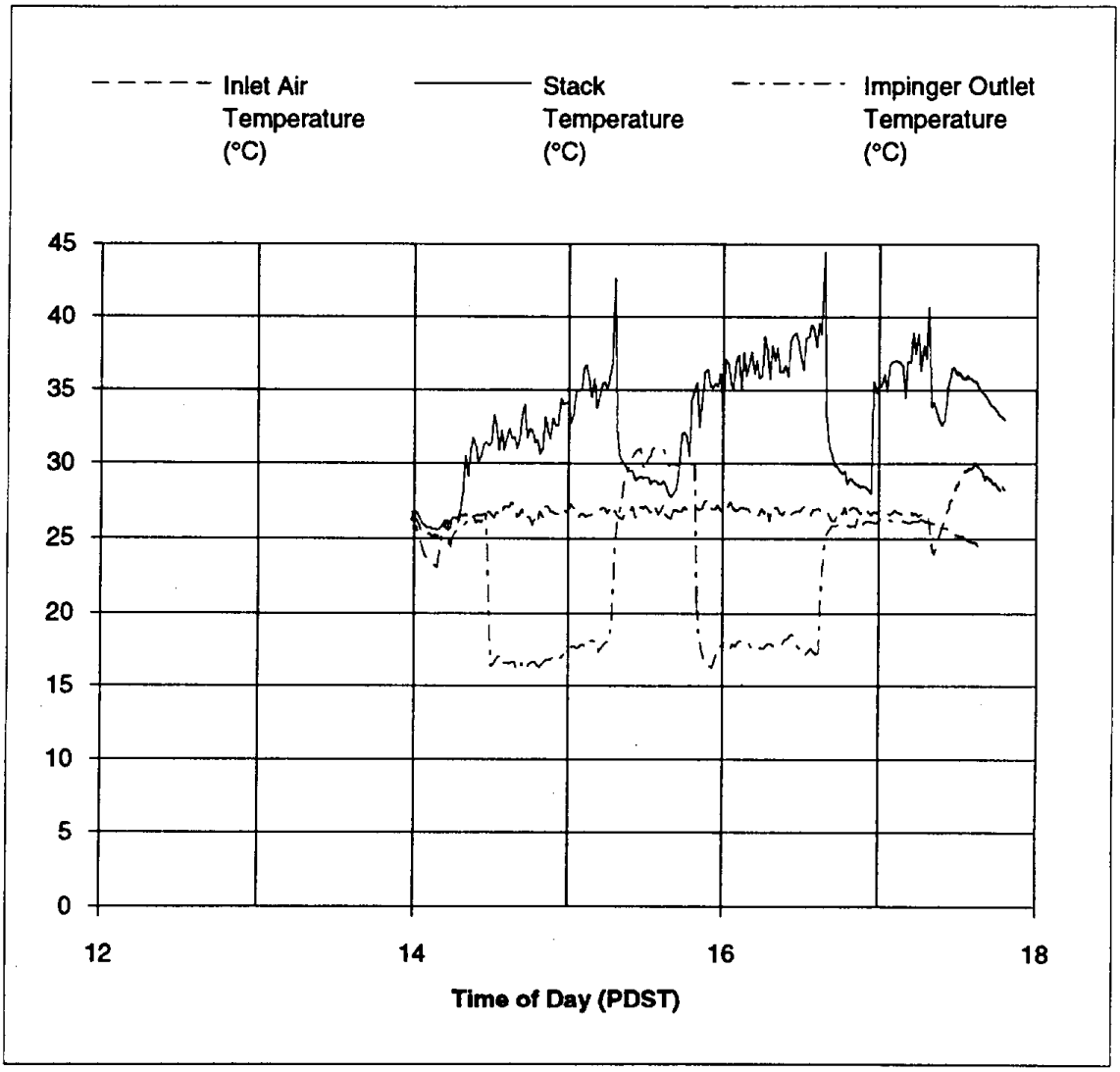

Figure 3.1.7.6. Conveyor speed and stack gas velocity, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

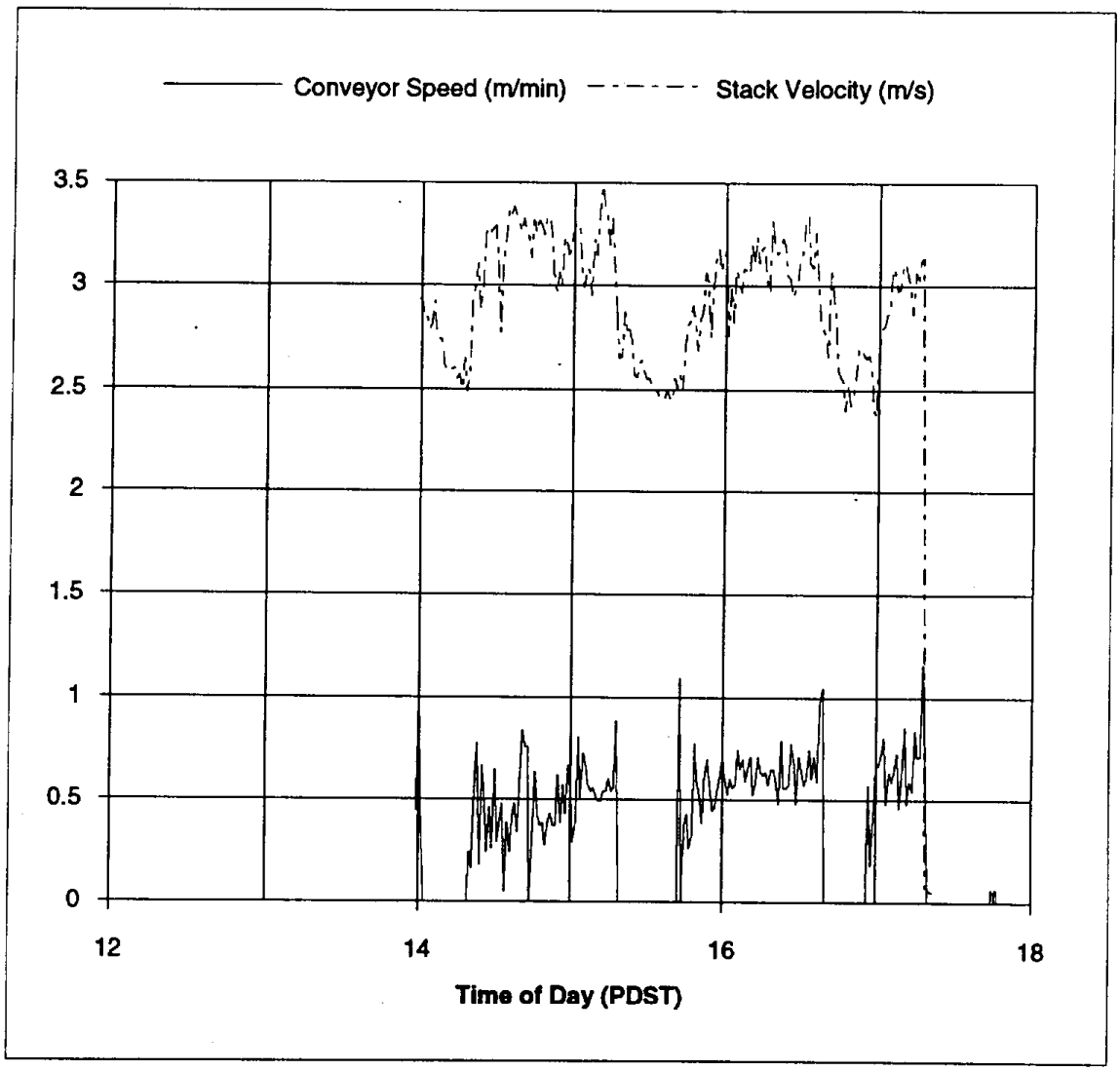

Figure 3.1.7.7. Conveyor speed with 10 min moving average, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

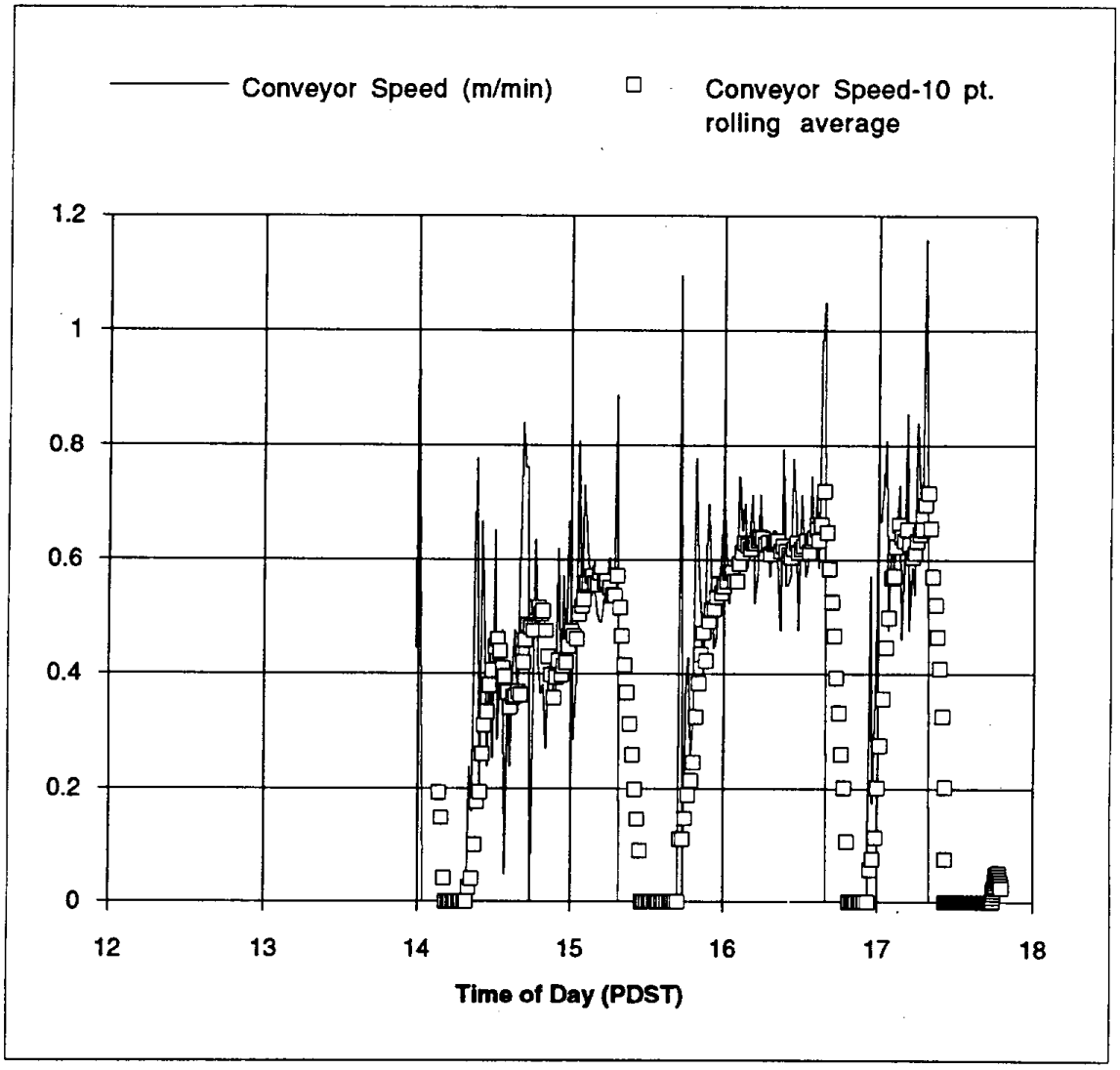

Figure 3.1.7.8. Conveyor travel, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

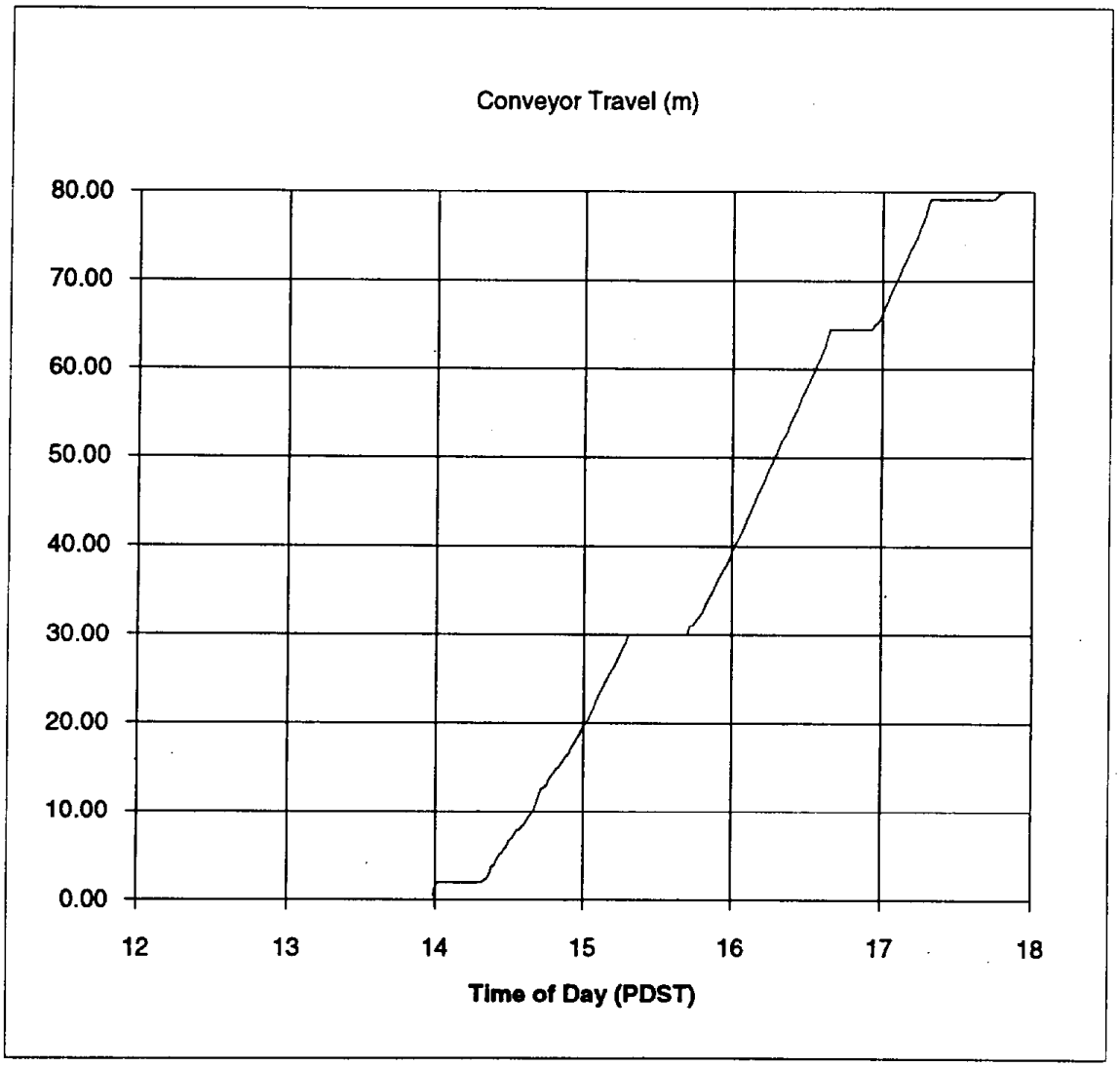

Figure 3.1.7.9. CO concentration in stack gas, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

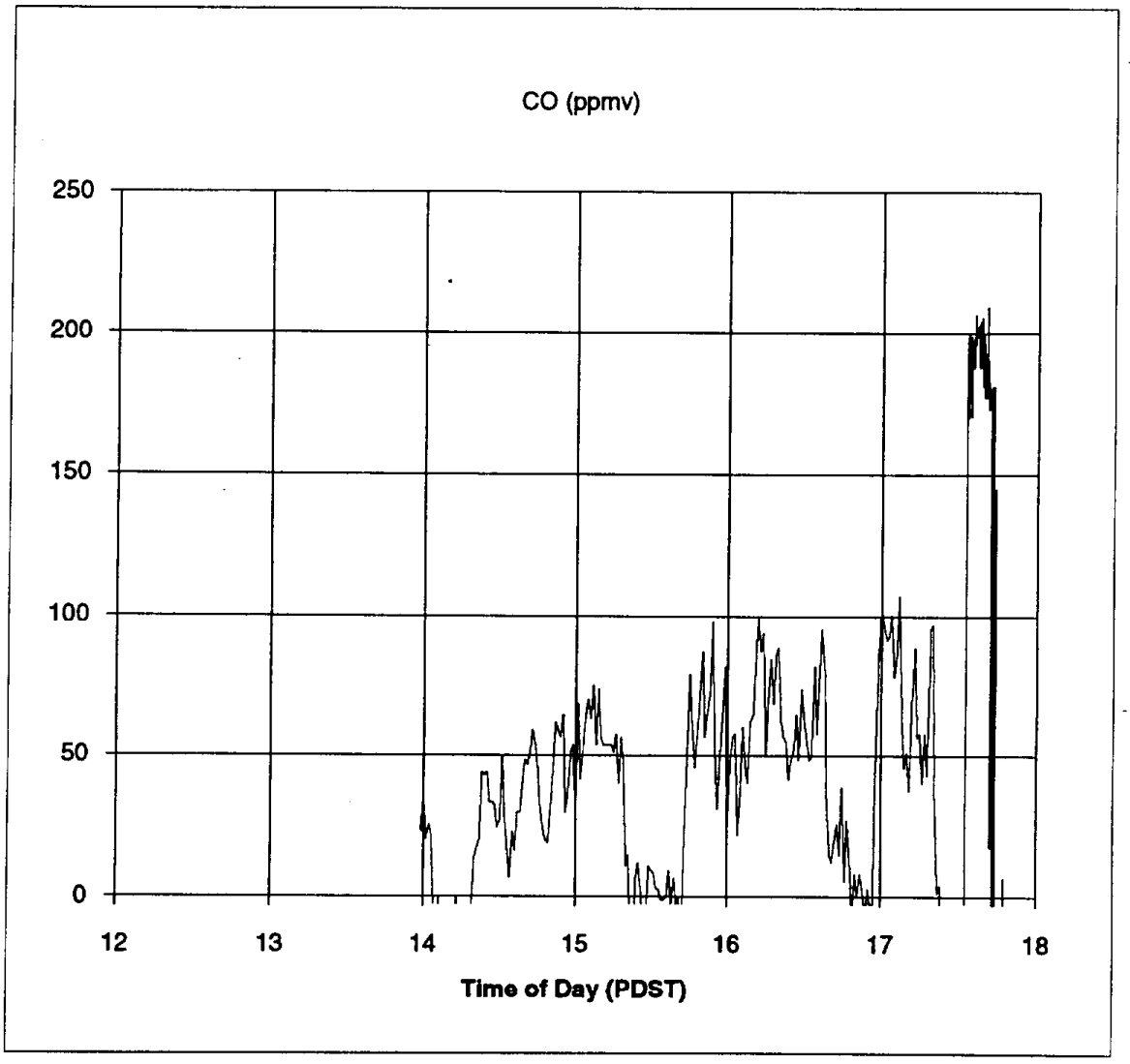

Figure 3.1.7.10. NO and NOx concentrations in stack gas, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

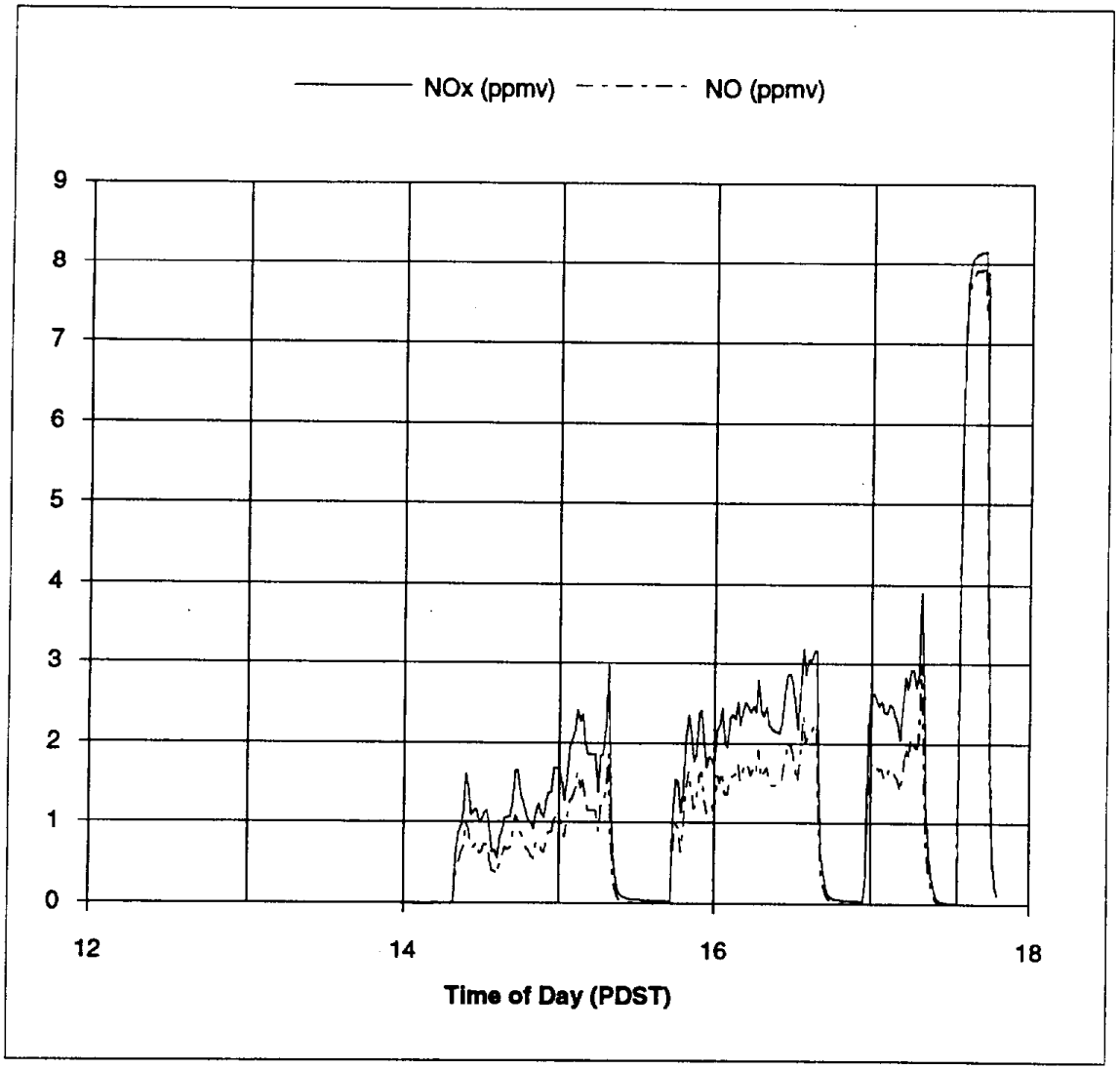

Figure 3.1.7.11. SO2 concentrations in stack gas, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

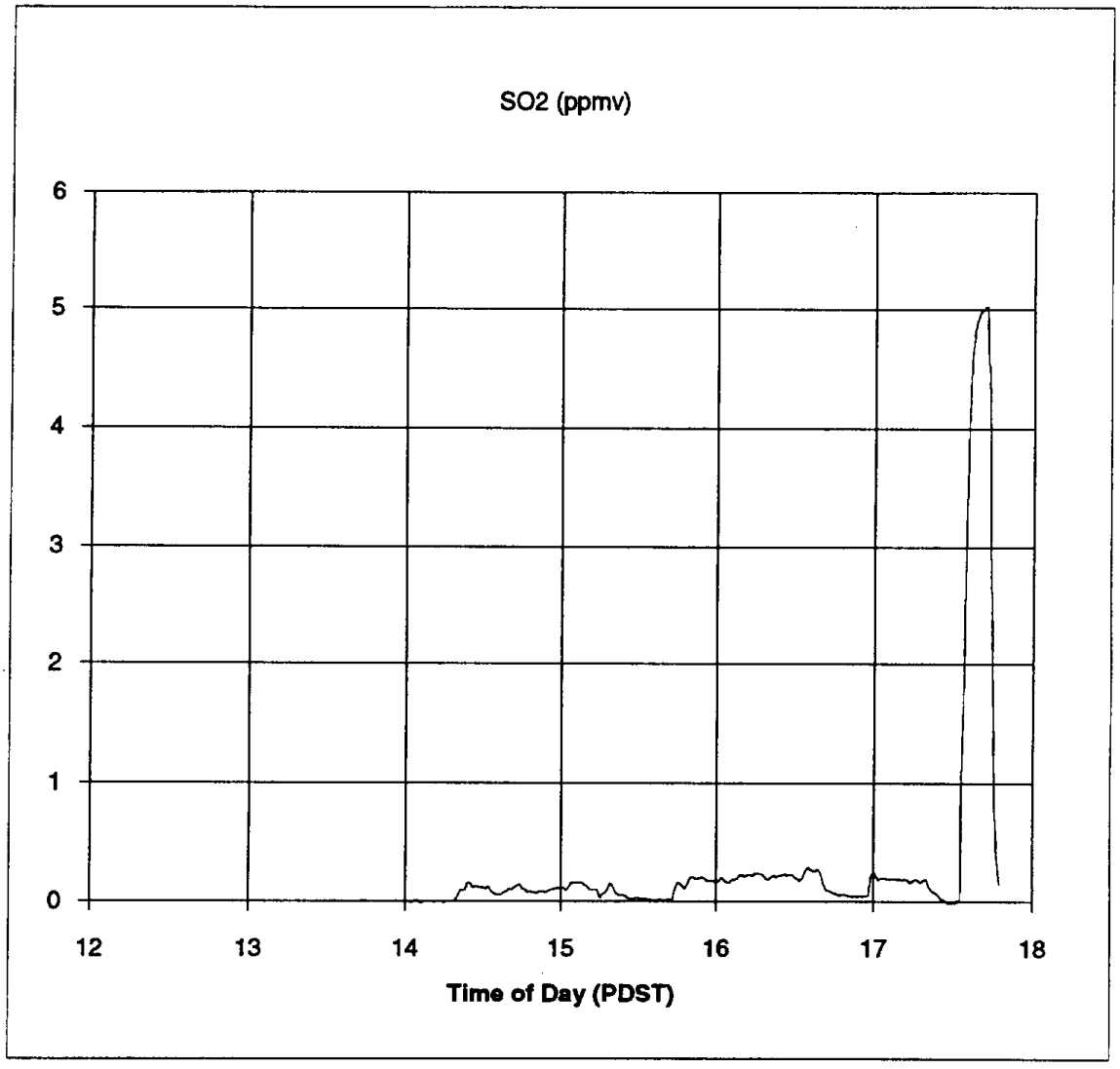

Figure 3.1.7.12. Total sulfur concentration in stack gas, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

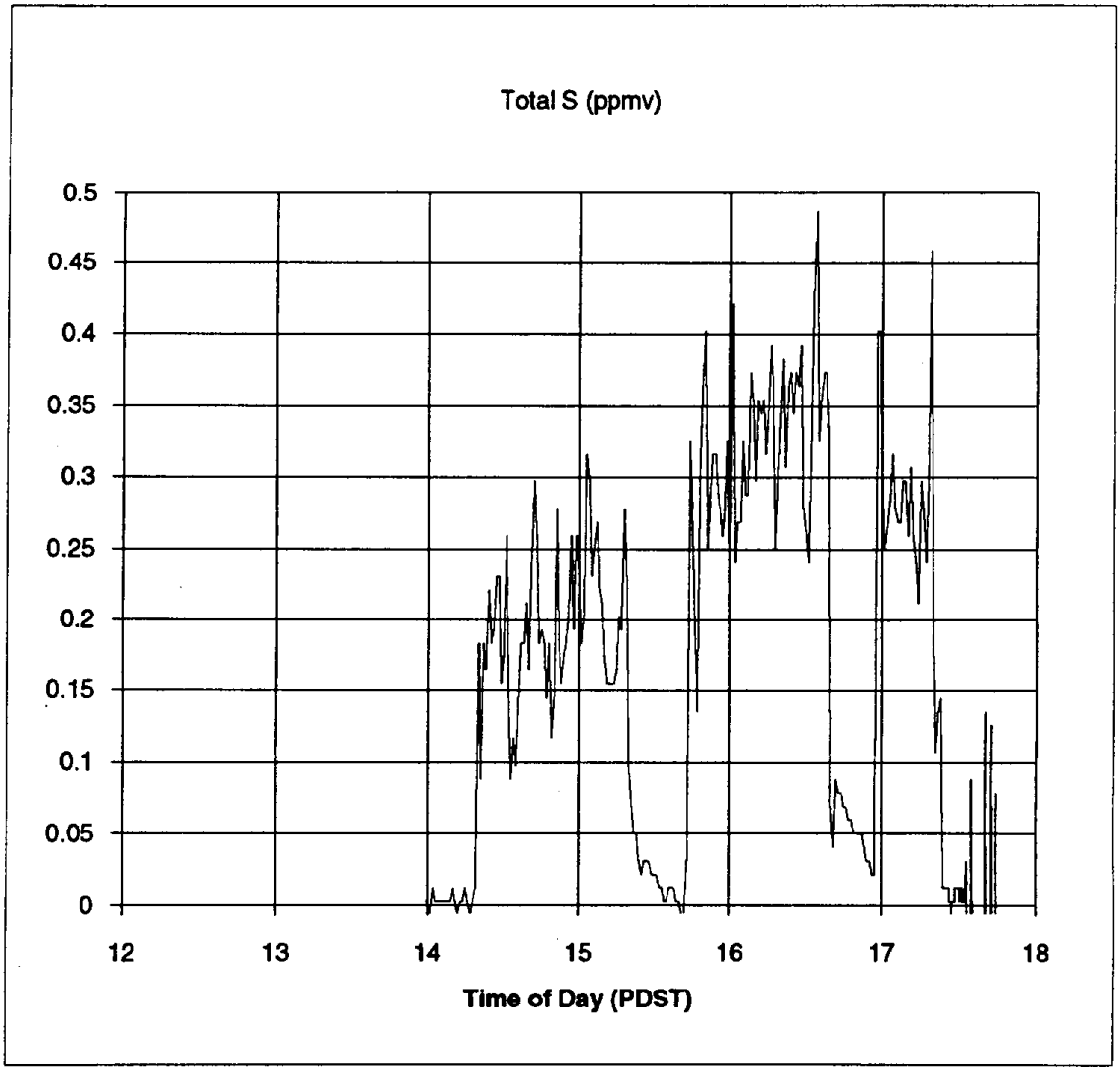

Figure 3.1.7.13. THC concentration in stack gas, 21 October 92.

Fuel Type:	Rice Straw	Test Date	21-Oct-92
Configuration:	CEWF		

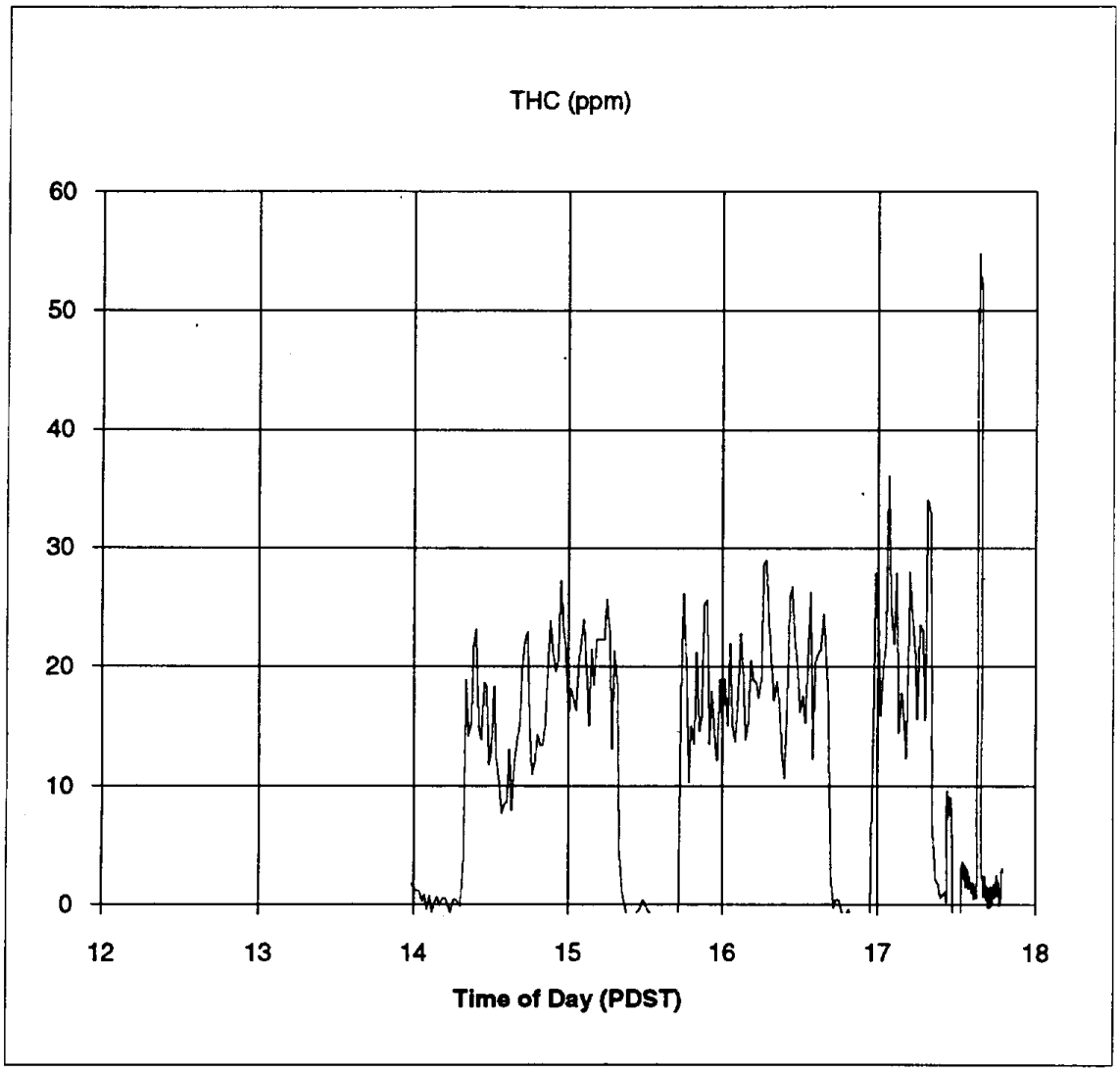

Figure 3.1.7.14. Particle size distribution, traverse 1, 21 October 92.

Fuel:	Rice Straw	Date of Test:	21-Oct-92
		Configuration:	CEWF

Particle Size Distribution
Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.82	0.15	10.26	1.000
2	7.74	0.17	10.11	0.985
3	4.13	0.18	9.94	0.969
4	2.18	0.39	9.76	0.951
5	1.26	0.57	9.37	0.913
6	0.74	1.07	8.8	0.858
7	0.39	1.08	7.73	0.753
filter	0.00	6.65	6.65	0.648

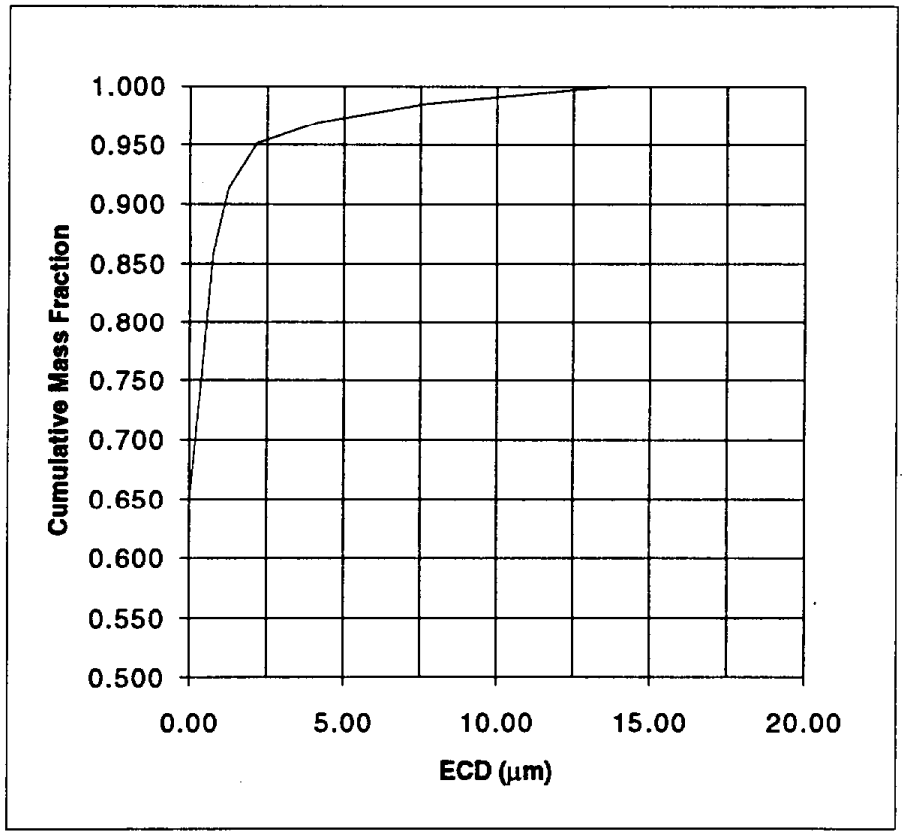

Figure 3.1.7.15. Particle size distribution, traverse 2, 21 October 92.

Fuel: Rice Straw

Date of Test: 21-Oct-92

Configuration: CEWF

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	14.01	0.14	9.00	1.000
2	7.85	0.14	8.86	0.984
3	4.19	0.20	8.72	0.969
4	2.21	0.24	8.52	0.947
5	1.27	0.33	8.28	0.920
6	0.75	0.80	7.95	0.883
7	0.39	1.03	7.15	0.794
filter	0.00	6.12	6.12	0.680

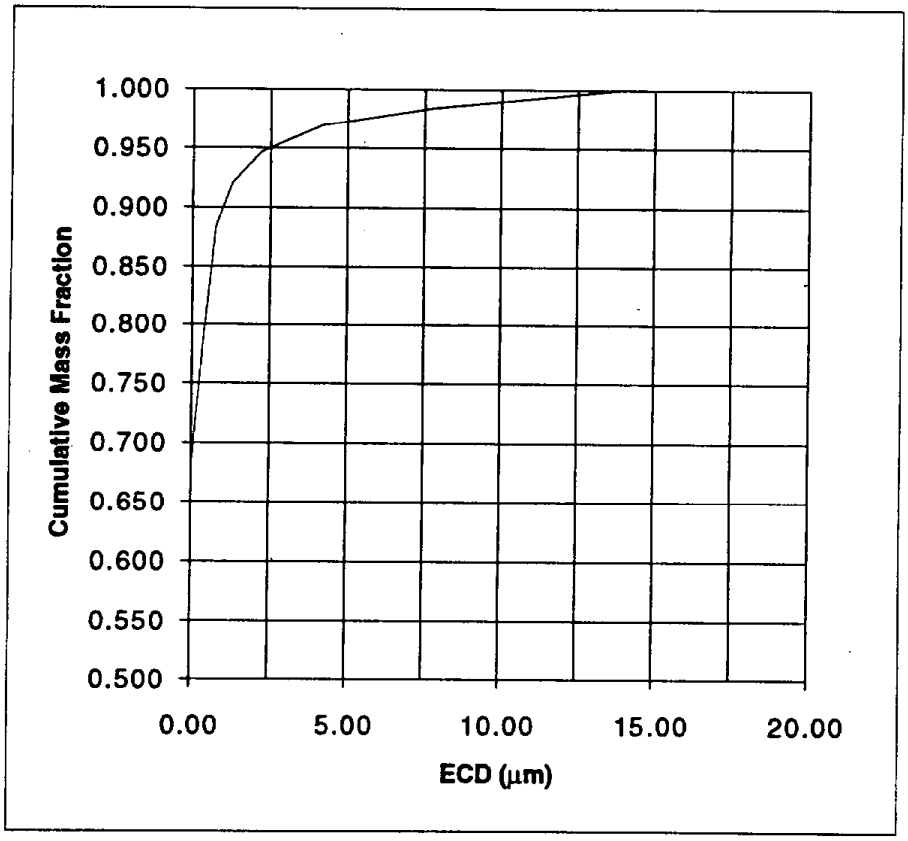

Figure 3.1.7.16. Nitrogen balance.
Date of Test: 21-Oct-92
Fuel Rice Straw

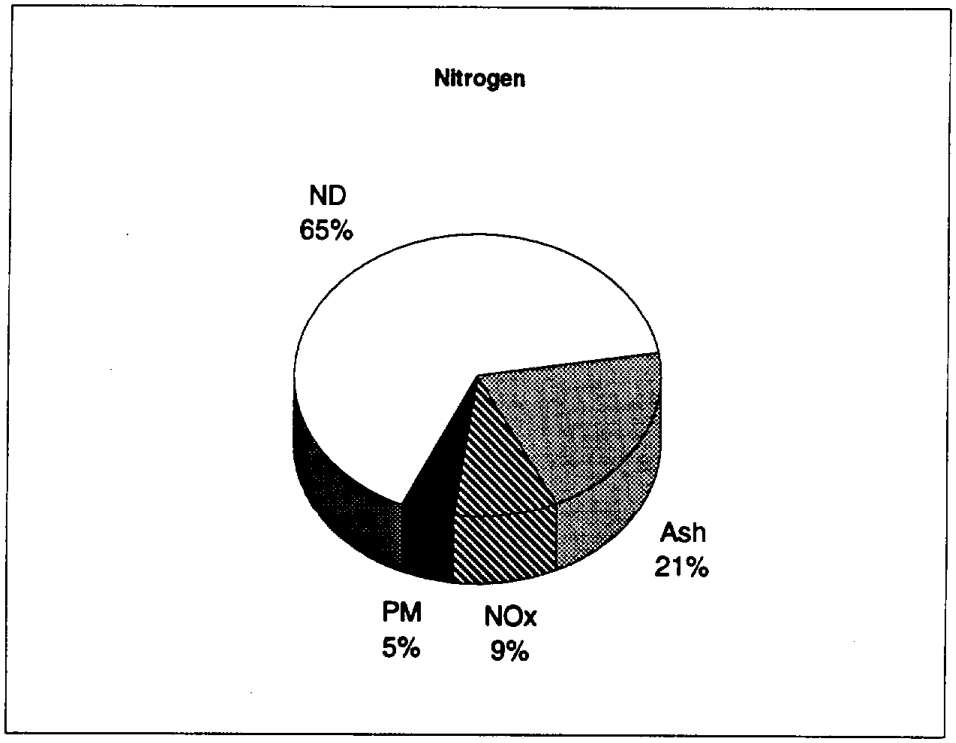

Figure 3.1.7.17. Sulfur balance.
Date of Test: 21-Oct-92
Fuel Rice Straw

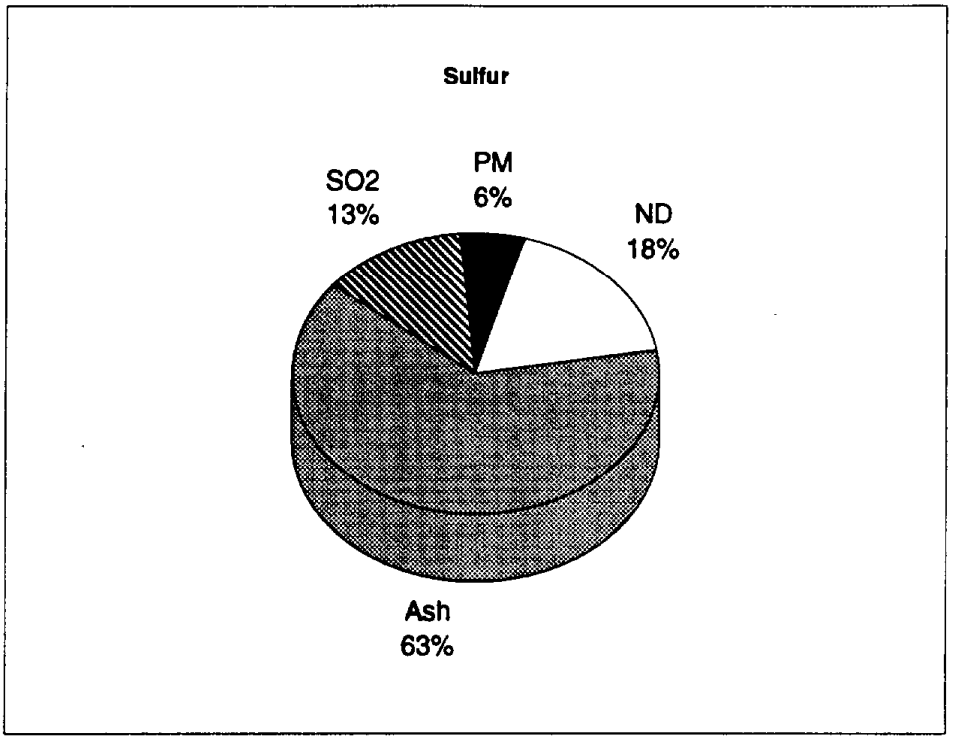

Figure 3.1.7.18. Relative abundance for major elements from DRUM impactor, Rice Straw, 21-Oct-92 , (CEWF).

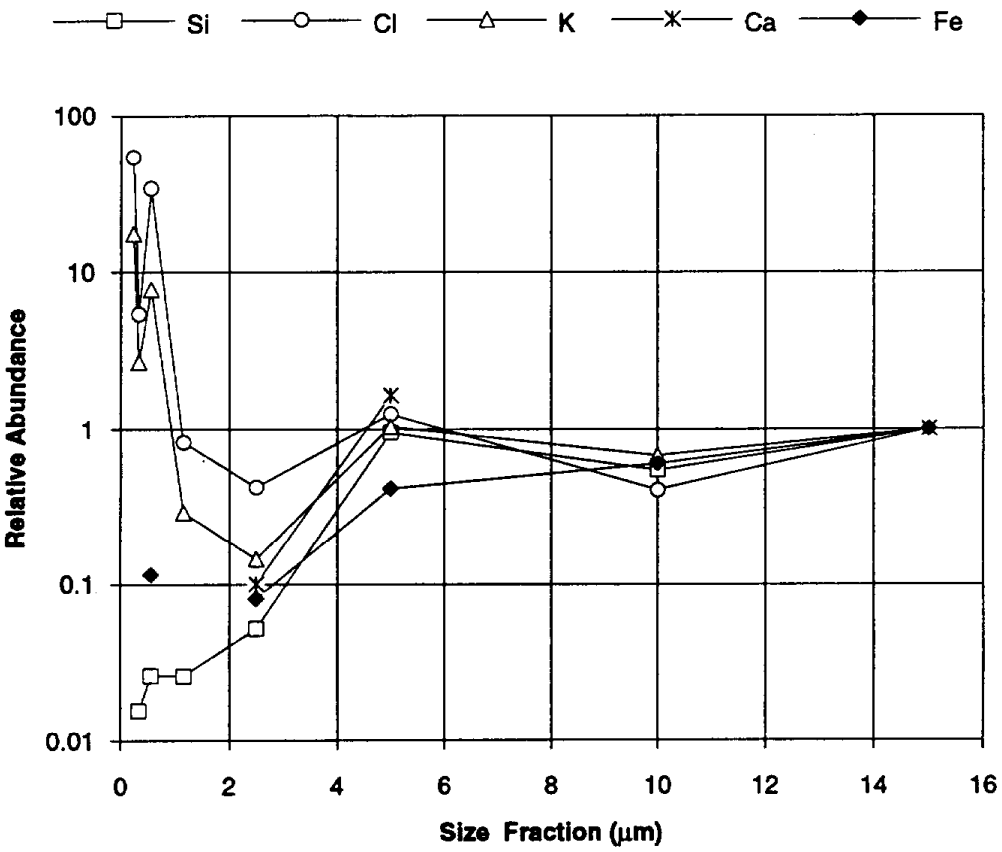

Figure 3.1.7.19. Mass fraction of PAH on primary filter samples, 21 October 1992, rice straw.

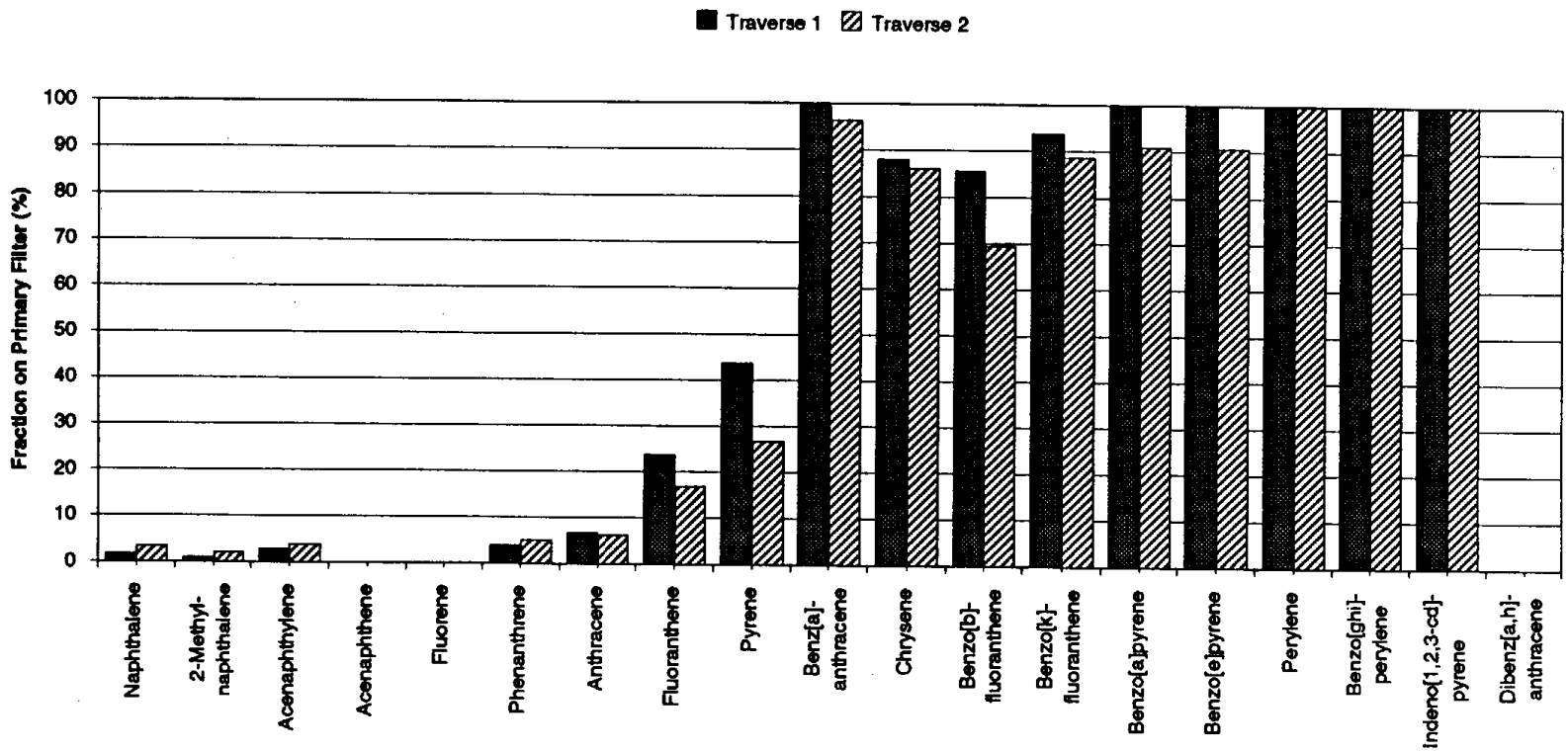

Table 3.1.8.1

Fuel and Ash Analyses

Run Date	23-Oct-92	23-Oct-92
Fuel Type	Rice Straw	Rice Straw
Sample Type	Fuel	Ash
Ultimate Analysis		
(% dry weight)		
C	36.86	12.28
H	4.99	0.61
N	0.72	0.39
Elemental Analysis		
(% by weight dry basis)		
N	0.77	0.44
P	0.08	0.32
K	2.75	9.52
Ca	0.23	0.80
Mg	0.19	0.62
Na	0.09	0.32
Cl	0.56	1.69
(mg/kg dry weight)		
S	993	1,550
B	6	14
Zn	23	68
Mn	562	1,930
Fe	230	747
Cu	11	10
Si		
Total (% dry weight)	46.70	27.04
Proximate Analysis		
(% dry weight)		
Ash	22.30	85.26
Volatiles	64.57	10.13
Fixed Carbon	13.13	4.61
Higher Heating Value		
(MJ/kg dry weight)	14.7934	4.4267

Table 3.1.8.2. Operating conditions and concentrations, 23 October 92.

Fuel:	Rice Straw	Date of Test:	23-Oct-92
		Configuration:	CRNF

Fuel Loading Rate (g/sq.m w.b.):	629
Total Fuel Consumption (kg w.b.)	64.9
Total Ash Recovered (kg w.b.)	16.6
Ash Fraction (w.b.)	0.26

	Traverse 1	Traverse 2
Mean Values		
Air Temperature (°C)	27.63	28.10
Air Relative Humidity (%)	34.57	31.85
Inlet Air Temperature (°C)	31.79	32.39
Stack Temperature (°C)	55.87	59.45
Impinger Outlet Temperature (°C)	22.74	20.42
Fire Spreading Rate (m/min)	0.97	1.13
Stack Gas Velocity (m/s)	2.41	2.31
Gas and PM Concentrations (less background)		
CO (ppmv)	125.52	115.93
NO (ppmv)	4.08	4.99
NOx (ppmv)	5.73	6.78
SO2 (ppmv)	0.74	1.06
THC (ppmv as CH4)	29.69	27.09
HC (ppmv as CH4 by GC)	8.59	9.12
CH4 (ppmv)	3.78	4.06
NMHC (ppmv as CH4)	25.91	23.03
NMHC (ppmv as CH4 by GC)	4.81	5.06
CO2 (ppmv by GC)	2,405	2,660
Total S (ppmv as SO2)	0.86	1.08
PM (mg/cu.m)	21.95	23.89
PM10 (mg/cu.m)	21.51	23.41
PM2.5 (mg/cu.m)	20.63	22.10

Table 3.1.8.3. Mass balance, rice straw, 23 October 92.

Fuel:	Rice Straw	Date of Test:	23-Oct-92
		Configuration:	CRNF

Mass Balance

	Traverse 1	Traverse 2
Total Conveyor Travel (m)	23.34	27.18
Fuel Moisture Content (% w.b.)	7.7	9.1
Fuel Loading Rate (g/sq.m d.b.)	580	572
Total Fuel Consumption (g w.b.)	17,888	20,833
Total Fuel Consumption (g d.b.)	16,505	18,936
Residual Ash (g w.b.)	4,590	5,346
Fuel Vaporized (g w.b.)	13,298	15,487
Fuel Consumption Rate (g/s w.b.)	12.42	14.47
Fuel Consumption Rate (g/s d.b.)	11.46	13.15
Ash Generation Rate (g/s w.b.)	3.19	3.71
Fuel Vaporization Rate (g/s w.b.)	9.23	10.76
Stack Gas Density (kg/cu.m)	1.0742	1.0626
Stack Gas Flow Rate (cu.m/s)	3.58	3.44
Stack Gas Mass Flow Rate (kg/s)	3.84	3.65
Inlet Air Mass Flow Rate (kg/s)	3.84	3.64
Overall Air-Fuel Ratio (w.b.)	308.74	251.63
Overall Air-Fuel Ratio (d.b.)	334.61	276.84

Table 3.1.8.4. Emission factors, rice straw 23 October 92 (integrated basis).

Fuel: Rice Straw | Date of Test: 23-Oct-92 | Configuration: CRNF

Emission Factors (% of fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Average
CO	4.033	3.123	3.578
NO	0.141	0.144	0.142
NOx (as NO2)	0.305	0.299	0.302
SO2	0.055	0.065	0.060
THC (as CH4)	0.481	0.369	0.425
HC (as CH4 by GC)	0.159	0.140	0.149
CH4 (by GC)	0.070	0.062	0.066
NMHC (as CH4)	0.411	0.307	0.359
NMHC (as CH4 by GC)	0.089	0.078	0.083
CO2 (by GC)	122.393	112.067	117.230
Total S (as SO2)	0.064	0.066	0.065
SO2/Total S	0.87	0.99	0.93
PM	0.616	0.551	0.584
PM10	0.604	0.540	0.572
PM2.5	0.579	0.510	0.545
MMAD (μm)	0.176	0.181	0.179
σ	5.191	5.406	

Table 3.1.8.5. Emission factors, rice straw 23 October 92 (average basis).

Fuel:	Rice Straw	Date of Test:	23-Oct-92
		Configuration:	CRNF

Emission Factors (% of fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Average
CO	4.065	3.108	3.586
NO	0.142	0.143	0.142
NOx (as NO2)	0.305	0.298	0.302
SO2	0.055	0.065	0.060
THC (as CH4)	0.549	0.415	0.482
HC (as CH4 by GC)	0.159	0.140	0.149
CH4 (by GC)	0.070	0.062	0.066
NMHC (as CH4)	0.479	0.353	0.416
NMHC (as CH4 by GC)	0.089	0.078	0.083
CO2 (by GC)	122.393	112.067	117.230
Total S (as SO2)	0.063	0.066	0.065
SO2/Total S	0.86	0.98	0.92
PM	0.616	0.551	0.584
PM10	0.604	0.540	0.572
PM2.5	0.579	0.510	0.545
MMAD (μm)	0.176	0.181	0.179
σ	5.191	5.406	

Table 3.1.8.6. Carbon balance.

Date of Test:	23-Oct-92	23-Oct-92
Fuel	Rice Straw	Rice Straw
	Traverse 1	Traverse 2
Carbon Balance		
Dry Fuel Consumption Rate (g/s)	11.46	13.15
Ash Generation Rate (g/s)	3.19	3.71
Ash Fraction (% dry basis)	27.84	28.21
Fuel Carbon Concentration (%)	36.86	36.86
Residual Ash Carbon Concentration (%)	12.28	12.28
Carbon released to stack (g/s)	3.83	4.39
Maximum CO2 emission factor (%)	122.62	122.45
Stack Gas Density (kg/cubic meter)	1.07	1.06
Average CO2 concentration (ppmv)	2,405	2,660
Average CO concentration (ppmv)	125.52	115.93
Average THC concentration (ppmv as CH4)	29.69	27.09
PM Concentration (mg/cubic meter)	21.95	23.89
PM Carbon Concentration (%)	26.89	26.89
PM Carbon (mg/cubic meter)	5.90	6.42
Stack Gas Temperature (°C)	55.87	59.45
Impinger Temperature (°C)	22.74	20.42
PM molar concentration (ppm)	11.94	12.90
Estimated Average Stack Gas Velocity (m/s)	2.26	2.39
Emission Factors (% Average Basis):		
CO2	122.393	112.067
CO	4.065	3.108
THC (as CH4)	0.549	0.415
PM	0.616	0.551
Emission Factors (% Integrated Basis):		
CO2	122.393	112.067
CO	4.033	3.123
THC (as CH4)	0.481	0.369
PM	0.616	0.551
Closure (% Average Basis)	107	97
Closure (% Integrated Basis)	106	96

Table 3.1.8.7. Nitrogen balance

Date of Test:	23-Oct-92	23-Oct-92
Fuel	Rice Straw Traverse 1	Rice Straw Traverse 2
Nitrogen Balance		
Fuel Nitrogen Concentration (% dry weight)	0.77	0.77
Ash Nitrogen Concentration (% weight)	0.44	0.44
Emission Factors (% Average Basis):		
NOx (as NO2)	0.305	0.298
PM	0.616	0.551
Emission Factors (% Integrated Basis):		
NOx (as NO2)	0.305	0.299
NO3- Concentration of PM (% weight)	0.160	0.160
NH4+ Concentration of PM (% weight)	7.414	7.414
Nitrogen Concentration of PM (%)	5.802	5.802
Fuel Nitrogen (mg/s)	88.24	101.26
Ash Nitrogen (mg/s)	14.04	16.32
Nitrogen as NOx (mg/s Average Basis)	10.64	11.93
Nitrogen as NOx (mg/s Integrated Basis)	10.64	11.97
Nitrogen as PM (mg/s Average Basis)	4.10	4.20
Nitrogen as NOx+PM (mg/s Average Basis)	14.73	16.13
Nitrogen as NOx+PM (mg/s Integrated Basis)	14.73	16.17
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.167	0.159
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.167	0.160
Ash Nitrogen/Fuel Nitrogen	0.159	0.161
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.326	0.321
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.326	0.321

Table 3.1.8.8. Sulfur balance.

Date of Test:	23-Oct-92	23-Oct-92
Fuel	Rice Straw Traverse 1	Rice Straw Traverse 2
Sulfur Balance		
Fuel Sulfur Concentration (mg/kg dry weight)	993	993
Ash Sulfur Concentration (mg/kg weight)	1,550	1,550
Emission Factors (% Average Basis)		
SO2	0.055	0.065
PM	0.616	0.551
Emission Factors (% Integrated Basis)		
SO2	0.055	0.065
Sulfur Concentration of PM (% weight)	0.817	0.817
Fuel Sulfur (mg/s)	11.38	13.06
Ash Sulfur (mg/s)	4.94	5.75
Sulfur as SO2 (mg/s Average Basis)	3.15	4.27
Sulfur as SO2 (mg/s Integrated Basis)	3.15	4.27
Sulfur as PM (mg/s Average Basis)	0.58	0.59
Sulfur as SO2+PM (mg/s Average Basis)	3.73	4.87
Sulfur as SO2+PM (mg/s Integrated Basis)	3.73	4.87
SO2+PM Sulfur/Fuel Sulfur (Average Basis)	0.328	0.373
SO2+PM Sulfur/Fuel Sulfur (Integrated Basis)	0.328	0.373
Ash Sulfur/Fuel Sulfur	0.434	0.440
Closure (% Average Basis)	76	81
Closure (% Integrated Basis)	76	81

Table 3.1.8.9. Water balance.

Estimated Stack Humidity

Fuel	Rice Straw
Configuration	CRNF
Date of Test	23-Oct-92

	Traverse 1	Traverse 2
Ambient Air Temperature °C)	28	28
Ambient Air Relative Humidity (%)	35	32
Air Temperature (K)	301	301
Saturation Pressure (Pa)	3,701	3,804
Vapor Pressure (Pa)	1,280	1,212
Air Dew Point Temperature (°C)	10.6	9.8
Ambient Volume Fraction Water Vapor	0.0126	0.0120
Ambient Mass Fraction Water Vapor	0.0078	0.0074
Fuel Burning Rate (g/s wet basis)	12.42	14.47
Fuel Moisture Content (%)	7.7	9.1
Ash Fraction (wet basis)	0.26	0.26
Fuel Hydrogen Content (%)	4.99	4.99
Ash Hydrogen Content (%)	0.61	0.61
Moisture Evaporated (g/s)	0.96	1.32
Water of Combustion (g/s)	4.97	5.70
Total Fuel Water Added (g/s)	5.93	7.02
Inlet Air Mass Flowrate (g/s)	3,840	3,640
Inlet Air Water Vapor Flowrate (g/s)	30	27
Total Stack Water Vapor Flowrate (g/s)	36	34
Stack Gas Mass Flowrate (g/s)	3,849	3,651
Mass Fraction Water Vapor in Stack	0.0094	0.0093
Volume Fraction Water Vapor in Stack	0.0151	0.0150
Stack Vapor Pressure (Pa)	1,528	1,522
Stack Temperature (°C)	56	59
Stack Temperature (K)	329	333
Stack Saturation Pressure (Pa)	16,428	19,442
Stack Relative Humidity (%)	9	8
Stack Dew Point Temperature (°C)	13.3	13.3
Impinger Outlet Temperature (°C)	22.7	20.4
Volume Stack Gas Sampled for PM (L)	257	253
Estimated Impinger/Desiccant Weight Gain (g)	2.9	2.8

Totals:

	Estimated	Measured
Total Impinger/Desiccant Weight Gain (g)	5.7	6.9
Estimated/Measured Weight Gain	0.83	

Table 3.1.8.10. Power balance.

Date of Test:	23-Oct-92	23-Oct-92
Fuel	Rice Straw Traverse 1	Rice Straw Traverse 2
Power Balance		
Fuel Heating Value (MJ/kg dry weight)	14.7934	14.7934
Ash Heating Value (MJ/kg dry weight)	4.4267	4.4267
Average Energy Release Rate (kW)	155.4	178.1
Products of Incomplete Combustion (kW)		
CO	4.7	4.1
THC (as CH4)	3.5	3.0
PM	0.6	0.6
Heat Release Rate (kW)	146.6	170.3
Fireline Intensity (kW/m)	120.2	139.7
Stack Gas Flow (kg/s)	3.84	3.65
Stack Gas Temperature (°C)	55.87	59.45
Inlet Temperature (°C)	31.79	32.39
Sensible Power at Top of Stack (kW)	93.0	99.4
Tunnel Dissipation (kW)	53.6	70.9

Table 3.1.8.11. Mass concentrations (%) from DRI filter samples

Date		23-Oct-92		23-Oct-92	
Fuel		Rice Straw CRNF		Rice Straw CRNF	
Size Fraction		PM2.5		PM10	
Teflon Filter ID		ABTT043		ABTT044	
Quartz Filter ID		ABTQ043		ABTQ044	
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)		0.24	0.01	0.24	0.01
Quartz sample volume (m^3)		0.24	0.01	0.24	0.01
Teflon mass concentration (µg/m^3)		18,233	914	19,238	964
	Concentration (%)	±Uncertainty	Concentration (%)	±Uncertainty	PM2.5/PM10
Cl-	38.0901	3.1394	34.9973	2.8843	1.09
NO3-	0.1673	0.0200	0.1598	0.0190	1.05
SO4=	3.4331	0.2529	3.2312	0.2380	1.06
NH4+	8.3213	0.6320	7.4139	0.5679	1.12
Na+	0.3192	0.0281	0.3002	0.0264	1.06
K+	21.8542	1.6434	20.0559	1.5080	1.09
C(org)	22.6110	2.1850	19.3579	1.8742	1.17
C(oht)	19.1836	2.9254	16.6856	2.5491	1.15
C(e)	8.0119	0.7570	7.5352	0.7129	1.06
C(eht)	1.0329	0.6311	0.7581	0.4631	1.36
C	30.6229		26.8931		1.14
Al	0.0000	0.1233	0.0000	0.1097	
Si	0.0959	0.1624	0.8392	0.0771	0.11
P	0.0000	0.3072	0.0000	0.2713	
S	0.9064	0.1535	0.8169	0.1360	1.11
Cl	28.6228	2.0276	25.2706	1.7900	1.13
K	17.2113	1.2188	15.3427	1.0863	1.12
Ca	0.0589	0.2459	0.2083	0.2199	0.28
Ti	0.0036	0.0173	0.0305	0.0101	0.12
V	0.0027	0.0075	0.0023	0.0071	1.17
Cr	0.0027	0.0011	0.0029	0.0010	0.93
Mn	0.0175	0.0015	0.0598	0.0044	0.29
Fe	0.0124	0.0028	0.0702	0.0056	0.18
Co	0.0012	0.0005	0.0008	0.0013	1.50
Ni	0.0004	0.0007	0.0011	0.0005	0.36
Cu	0.0030	0.0006	0.0024	0.0005	1.25
Zn	0.0067	0.0007	0.0069	0.0007	0.97
Ga	0.0000	0.0014	0.0000	0.0013	
As	0.0027	0.0011	0.0024	0.0010	1.13
Se	0.0013	0.0006	0.0014	0.0006	0.93
Br	0.2176	0.0155	0.1941	0.0138	1.12
Rb	0.0142	0.0028	0.0127	0.0025	1.12
Sr	0.0010	0.0005	0.0016	0.0005	0.63
Y	0.0008	0.0016	0.0007	0.0015	1.14
Zr	0.0094	0.0010	0.0008	0.0011	11.75
Mo	0.0000	0.0021	0.0000	0.0019	
Pd	0.0000	0.0089	0.0000	0.0083	
Ag	0.0000	0.0098	0.0013	0.0093	0.00
Cd	0.0000	0.0106	0.0000	0.0098	
In	0.0000	0.0116	0.0005	0.0108	0.00
Sn	0.0021	0.0143	0.0000	0.0132	
Sb	0.0000	0.0159	0.0000	0.0146	
Ba	0.0047	0.0510	0.0000	0.0474	
La	0.0047	0.0674	0.0006	0.0629	7.83
Au	0.0000	0.0023	0.0000	0.0022	
Hg	0.0000	0.0020	0.0001	0.0018	0.00
Tl	0.0001	0.0019	0.0004	0.0017	0.25
Pb	0.0000	0.0025	0.0000	0.0023	
U	0.0015	0.0043	0.0009	0.0039	1.67
Sum of measured species	86.6361	3.4020	77.6394	2.9824	1.12

Table 3.1.8.12. Element ratios from DRI filter samples.

Date	23-Oct-92	23-Oct-92	
Fuel	Rice Straw	Rice Straw	
Configuration	CRNF	CRNF	
Size Fraction	PM2.5	PM10	PM2.5/PM10
Teflon Filter ID	ABTT043	ABTT044	
Quartz Filter ID	ABTQ043	ABTQ044	
Cl-/Cl	1.33	1.38	0.96
K+/K	1.27	1.31	0.97
Sulfate S/Total S	1.26	1.32	0.96
C(org)/C	0.74	0.72	1.03
Cl/K	1.66	1.65	1.01
Cl-/K+	1.74	1.74	1.00
Cl-/Na+	119.33	116.58	1.02
S/K	0.05	0.05	0.99
S/Na+	2.84	2.72	1.04
Al/Si	0.00	0.00	

Table 3.1.8.13. Emission factors (mg/kg) from DRI filter samples.

Date		23-Oct-92		23-Oct-92	
Fuel		Rice Straw CRNF		Rice Straw CRNF	
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT043		ABTT044		
Quartz Filter ID	ABTQ043		ABTQ044		
Start Time	15:59				
Stop Time	16:23				
Start Time					
End Time					
Elapsed Time (minutes)	24				Traverse 2
PM (mg/m^3 by total filter)					23.890
PM10 (by total filter/impactor)					23.410
PM2.5 (by total filter/impactor)					22.100
PM emission factor (%)					0.551
PM10 emission factor (%)					0.540
PM2.5 emission factor (%)					0.510
		±Uncertainty		±Uncertainty	
Teflon sample volume (m^3)	0.24	0.01	0.24	0.01	
Quartz sample volume (m^3)	0.24	0.01	0.24	0.01	
Teflon mass concentration (mg/m^3)	18.233	0.914	19.238	0.964	
Teflon mass/Total mass	0.825		0.822		
	Emission (mg/kg)	±Uncertainty	Emission (mg/kg)	±Uncertainty	PM2.5/PM10
Cl-	2242.2467	160.1094	2434.1432	155.7522	0.92
NO3-	9.8484	1.0200	11.1145	1.0260	0.89
SO4=	202.0960	12.8979	224.7374	12.8520	0.90
NH4+	489.8493	32.2320	515.6539	30.6666	0.95
Na+	18.7903	1.4331	20.8796	1.4256	0.90
K+	1286.4894	83.8134	1394.9343	81.4320	0.92
C(org)	1331.0398	111.4350	1346.3868	101.2068	0.99
C(oht)	1129.2794	149.1954	1160.5221	137.6514	0.97
C(e)	471.6358	38.6070	524.0906	38.4966	0.90
C(eht)	60.8036	32.1861	52.7276	25.0074	1.15
C	1802.6757	0.0000	1870.4774	0.0000	0.96
Al	0.0000	6.2883	0.0000	5.9238	
Si	5.6453	8.2824	58.3683	4.1634	0.10
P	0.0000	15.6672	0.0000	14.6502	
S	53.3570	7.8285	56.8173	7.3440	0.94
Cl	1684.9360	103.4076	1757.6287	96.6600	0.96
K	1013.1761	62.1588	1067.1203	58.6602	0.95
Ca	3.4673	12.5409	14.4877	11.8746	0.24
Ti	0.2119	0.8823	2.1213	0.5454	0.10
V	0.1589	0.3825	0.1600	0.3834	0.99
Cr	0.1589	0.0561	0.2017	0.0540	0.79
Mn	1.0302	0.0765	4.1592	0.2376	0.25
Fe	0.7299	0.1428	4.8826	0.3024	0.15
Co	0.0706	0.0255	0.0556	0.0702	1.27
Ni	0.0235	0.0357	0.0765	0.0270	0.31
Cu	0.1766	0.0306	0.1669	0.0270	1.06
Zn	0.3944	0.0357	0.4799	0.0378	0.82
Ga	0.0000	0.0714	0.0000	0.0702	
As	0.1589	0.0561	0.1669	0.0540	0.95
Se	0.0765	0.0306	0.0974	0.0324	0.79
Br	12.8094	0.7905	13.5001	0.7452	0.95
Rb	0.8359	0.1428	0.8833	0.1350	0.95
Sr	0.0589	0.0255	0.1113	0.0270	0.53
Y	0.0471	0.0816	0.0487	0.0810	0.97
Zr	0.5533	0.0510	0.0556	0.0594	9.94
Mo	0.0000	0.1071	0.0000	0.1026	
Pd	0.0000	0.4539	0.0000	0.4482	
Ag	0.0000	0.4998	0.0904	0.5022	0.00
Cd	0.0000	0.5406	0.0000	0.5292	
In	0.0000	0.5916	0.0348	0.5832	0.00
Sn	0.1236	0.7293	0.0000	0.7128	
Sb	0.0000	0.8109	0.0000	0.7884	
Ba	0.2767	2.6010	0.0000	2.5596	
La	0.2767	3.4374	0.0417	3.3966	6.63
Au	0.0000	0.1173	0.0000	0.1188	
Hg	0.0000	0.1020	0.0070	0.0972	0.00
Tl	0.0059	0.0969	0.0278	0.0918	0.21
Pb	0.0000	0.1275	0.0000	0.1242	
U	0.0883	0.2193	0.0626	0.2106	1.41
Sum of measured species	5,100	174	5,400	152	0.94

Table 3.1.8.14. Element concentrations (ng/m^3) from CNL filter samples.

Fuel:	Rice
Date:	23-Oct-92
Time:	15:20
Filter ID:	AG-48

Element	Concentration	±Uncertainty
	ng/m^3	
H	353,750	28,500
Na	108,660	61,600
Mg		
Al		
Si	237,710	13,800
P		
S		
Cl	7,168,980	360,000
K	3,537,430	177,800
Ca		
Ti	1,270	500
V	2,180	600
Cr	8,150	1,300
Mn	11,500	1,400
Fe	10,880	700
Ni		
Cu	460	100
Zn	360	100
As		
Pb		
Se		
Br	27,110	1,500
Rb		
Sr		
Zr		

Table 3.1.8.15. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Rice	
Date:	23-Oct-92	
Time:	15:20	
Filter ID:	AG-48	
Fuel rate (g/s)		11.46
Stack gas flow rate (m^3/s)		3.58
Stack Temperature (°C)		55.87
Ambient Temperature (°C)		27.63

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	101.0	8.1
Na	31.0	17.6
Mg		
Al		
Si	67.9	3.9
P		
S		
Cl	2,047.3	102.8
K	1,010.2	50.8
Ca		
Ti	0.4	0.1
V	0.6	0.2
Cr	2.3	0.4
Mn	3.3	0.4
Fe	3.1	0.2
Ni		
Cu	0.1	0.0
Zn	0.1	0.0
As		
Pb		
Se		
Br	7.7	0.4
Rb		
Sr		
Zr		

Table 3.1.8.16. Element concentrations (ng/m^3) from CNL filter samples.

Fuel:	Rice
Date:	23-Oct-92
Time:	
Filter ID:	AG-60

	Concentration	±Uncertainty
	ng/m^3	
H	705,120	46,500
Na	388,580	68,000
Mg		
Al		
Si	115,090	7,300
P		
S		
Cl	4,537,320	228,000
K	1,856,230	93,500
Ca		
Ti		
V	1,270	500
Cr	1,660	600
Mn	5,770	800
Fe	8,990	700
Ni	330	100
Cu	860	200
Zn	280	100
As	430	100
Pb		
Se	910	300
Br	20,970	1,200
Rb		
Sr		
Zr		

Table 3.1.8.17. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Rice	
Date:	23-Oct-92	
Time:		
Filter ID:	AG-60	
Fuel rate (g/s)		13.15
Stack gas flow rate (m^3/s)		3.44
Stack Temperature (°C)		59.45
Ambient Temperature (°C)		28.10

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	167.1	11.0
Na	92.1	16.1
Mg		
Al		
Si	27.3	1.7
P		
S		
Cl	1,075.1	54.0
K	439.8	22.2
Ca		
Ti		
V	0.3	0.1
Cr	0.4	0.1
Mn	1.4	0.2
Fe	2.1	0.2
Ni	0.1	0.0
Cu	0.2	0.0
Zn	0.1	0.0
As	0.1	0.0
Pb		
Se	0.2	0.1
Br	5.0	0.3
Rb		
Sr		
Zr		

Table 3.1.8.16. Relative element concentrations by stage from DRUM impactor.

Stage 1: 10 - 15 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al	82,345.66	5,949.43	22.0359	1
Si	21,701.40	2,283.29	5.8073	1
S				
Cl	1,975.47	158.57	0.5286	1
K	3,736.89	238.43	1.0000	1
Ca	2,834.10	208.57	0.7584	1
Ti	613.16	77.86	0.1641	1
V				
Cr	38.09	21.14	0.0102	1
Mn	131.16	27.57	0.0351	1
Fe	11,217.54	586.29	3.0018	1
Ni				
Cu	246.71	26.14	0.0660	1
Zn	339.83	58.57	0.0909	1
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.8.19. Relative element concentrations by stage from DRUM impactor.

Stage 2: 5 - 10 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	10,588.29	558.29	1.8748	0.4879
S				
Cl	3,611.36	217.57	0.6395	1.8281
K	5,647.56	361.71	1.0000	1.5113
Ca	3,077.33	309.29	0.5449	1.0858
Ti				
V				
Cr				
Mn	562.46	43.43	0.0996	4.2884
Fe	1,021.03	71.14	0.1808	0.0910
Ni	22.36	6.86	0.0040	
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.8.20. Relative element concentrations by stage from DRUM impactor.

Stage 3: 2.5 - 5 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	8,703.89	471.14	0.6353	0.4011
S				
Cl	11,452.04	619.00	0.8359	5.7971
K	13,699.90	767.57	1.0000	3.6661
Ca	5,931.89	460.00	0.4330	2.0930
Ti				
V				
Cr				
Mn	1,082.34	70.71	0.0790	8.2523
Fe	898.23	80.43	0.0656	0.0801
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.1.8.21. Relative element concentrations by stage from DRUM impactor.

Stage 4: 1.15 - 2.5 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	2,902.50	469.29	0.3272	
Na				
Mg				
Al				
Si	194.00	37.43	0.0219	0.0089
S				
Cl	10,482.99	564.43	1.1818	5.3066
K	8,870.57	486.14	1.0000	2.3738
Ca				
Ti				
V				
Cr	59.94	17.00	0.0068	1.5739
Mn				
Fe				
Ni				
Cu				
Zn				
As				
Se				
Br	54.00	13.00	0.0061	
Rb				
Sr				
Pb				

Table 3.1.8.22. Relative element concentrations by stage from DRUM impactor.

Stage 5: 0.56 - 1.15 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	11,019.60	1,320.29	0.2360	
Na				
Mg				
Al	85.34	62.14	0.0018	0.0010
Si				
S				
Cl	87,000.21	4,408.71	1.8636	44.0402
K	46,683.39	2,396.57	1.0000	12.4926
Ca				
Ti				
V				
Cr				
Mn				
Fe	164.60	34.29	0.0035	0.0147
Ni				
Cu	55.13	16.86	0.0012	0.2235
Zn				
As				
Se				
Br	800.63	110.00	0.0172	
Rb				
Sr				
Pb				

Table 3.1.8.23. Relative element concentrations by stage from DRUM impactor.

Stage 6: 0.34 - 0.56 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	13,829.39	1,356.29	0.3048	
Na				
Mg				
Al	355.10	103.57	0.0078	0.0043
Si				
S				
Cl	68,353.01	3,469.29	1.5067	34.6009
K	45,365.16	2,322.14	1.0000	12.1398
Ca				
Ti				
V				
Cr	143.01	33.29	0.0032	3.7551
Mn				
Fe	119.73	25.29	0.0026	0.0107
Ni				
Cu				
Zn	49.53	13.57	0.0011	0.1457
As				
Se				
Br	479.69	83.57	0.0106	
Rb				
Sr				
Pb	77.63	26.43	0.0017	

Table 3.1.8.24. Relative element concentrations by stage from DRUM impactor.

Stage 7: 0.24 - 0.34 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	21,696.69	2,088.14	0.2242	
Na				
Mg				
Al	979.34	148.00	0.0101	0.0119
Si				
S				
Cl	224,629.17	11,300.86	2.3211	113.7091
K	96,776.14	4,909.00	1.0000	25.8975
Ca				
Ti				
V				
Cr				
Mn				
Fe				
Ni	39.84	14.00	0.0004	
Cu	92.49	22.86	0.0010	0.3749
Zn				
As				
Se				
Br	1,666.40	146.00	0.0172	
Rb				
Sr				
Pb				

Table 3.1.8.25. Relative element concentrations by stage from DRUM impactor.

Stage 8: < 0.24 μm

	23-Oct-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	9,500.99	747.86	0.2400	
Na				
Mg				
Al	525.77	97.57	0.0133	0.0064
Si				
S				
Cl	51,064.20	2,618.00	1.2900	25.8491
K	39,583.51	2,043.14	1.0000	10.5926
Ca				
Ti				
V				
Cr				
Mn				
Fe				
Ni				
Cu	150.31	26.29	0.0038	0.6093
Zn	140.16	32.00	0.0035	0.4124
As				
Se				
Br	456.34	103.86	0.0115	
Rb				
Sr				
Pb				

Table 3.1.8.26
VOC Concentrations (ppbv)

Date	23-Oct-92	23-Oct-92
Fuel	Rice Straw	Rice Straw
Traverse	Traverse 1	Traverse 2
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	85.6	84.6
Dimethylbutane	57.3	40.5
Hexane		
Phenol	81.6	80.6
Dimethylfuran	104.7	111
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	110.8	98.8
Benzonitrile		
Benzaldehyde		
Methylphenol (hydroxy toluene)		
Styrene	76.7	71.3
Xylene	27.1	10.4
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		
Naphthalene	12.5	17.3
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)	119.6	87.7
No match r.t.(8.5)		

Table 3.1.8.27
VOC Emission Factors (mg/kg)

Date	23-Oct-92	23-Oct-92
Fuel	Rice Straw	Rice Straw
Traverse	Traverse 1	Traverse 2
Fuel Consumption Rate (g/s d.b)	11.46	13.15
Stack Gas Mass Flow Rate (kg/s)	3.84	3.65
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	77	63
Dimethylbutane	57	33
Hexane		
Phenol	89	73
Dimethylfuran	116	102
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	118	87
Benzonitrile		
Benzaldehyde		
Methylphenol (hydroxy toluene)		
Styrene	92	71
Xylene	33	11
Trimethylpentane		
Benzofuran		
Methoxymethylphenol (creosol)		
Naphthalene	19	21
Unknown		
Alpha-pinene		
Camphene		
Δ3-Carene		
Limonene		

Table 3.1.8.28. PAH emission factors, rice straw, 23 October 1992 (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	63	72	9	7,911	7,374	7	7,989	7,462	7,726
2-Methyl-naphthalene	6	46	-1	1,925	2,140	11	1,941	2,195	2,068
Acenaphthylene	2	2	0	2,565	2,700	1	2,568	2,703	2,636
Acenaphthene	0	0	0	180	197	0	180	197	189
Fluorene	-12	-2	-2	40	6	7	34	9	22
Phenanthrene	-93	-25	4	2,977	2,148	52	2,940	2,178	2,559
Anthracene	4	28	14	542	349	10	571	401	486
Fluoranthene	114	127	119	424	292	173	829	711	770
Pyrene	147	146	87	317	251	100	650	584	617
Benz[a]-anthracene	219	219	-3	120	100	12	347	327	337
Chrysene	254	309	13	93	98	22	383	443	413
Benzo[b]-fluoranthene	273	162	20	17	11	0	310	192	251
Benzo[k]-fluoranthene	319	65	23	17	14	0	360	103	231
Benzo[a]pyrene	152	231	0	23	13	0	175	244	209
Benzo[e]pyrene	155	340	0	16	11	0	171	352	261
Perylene	34	67	0	0	0	0	34	67	51
Benzo[ghi]-perylene	46	53	0	0	0	0	46	53	50
Indeno[1,2,3-cd]-pyrene	107	206	0	0	0	0	107	206	156
Dibenz[a,h]-anthracene	0	0	0	0	0	0	0	0	0
Total	1,791	2,045	284	17,168	15,703	394	19,636	18,426	19,031

Figure 3.1.8.1. Ambient air conditions, 23 October 92.

Fuel Type:	Rice Straw	Test Date	23-Oct-92
Configuration:	CRNF		

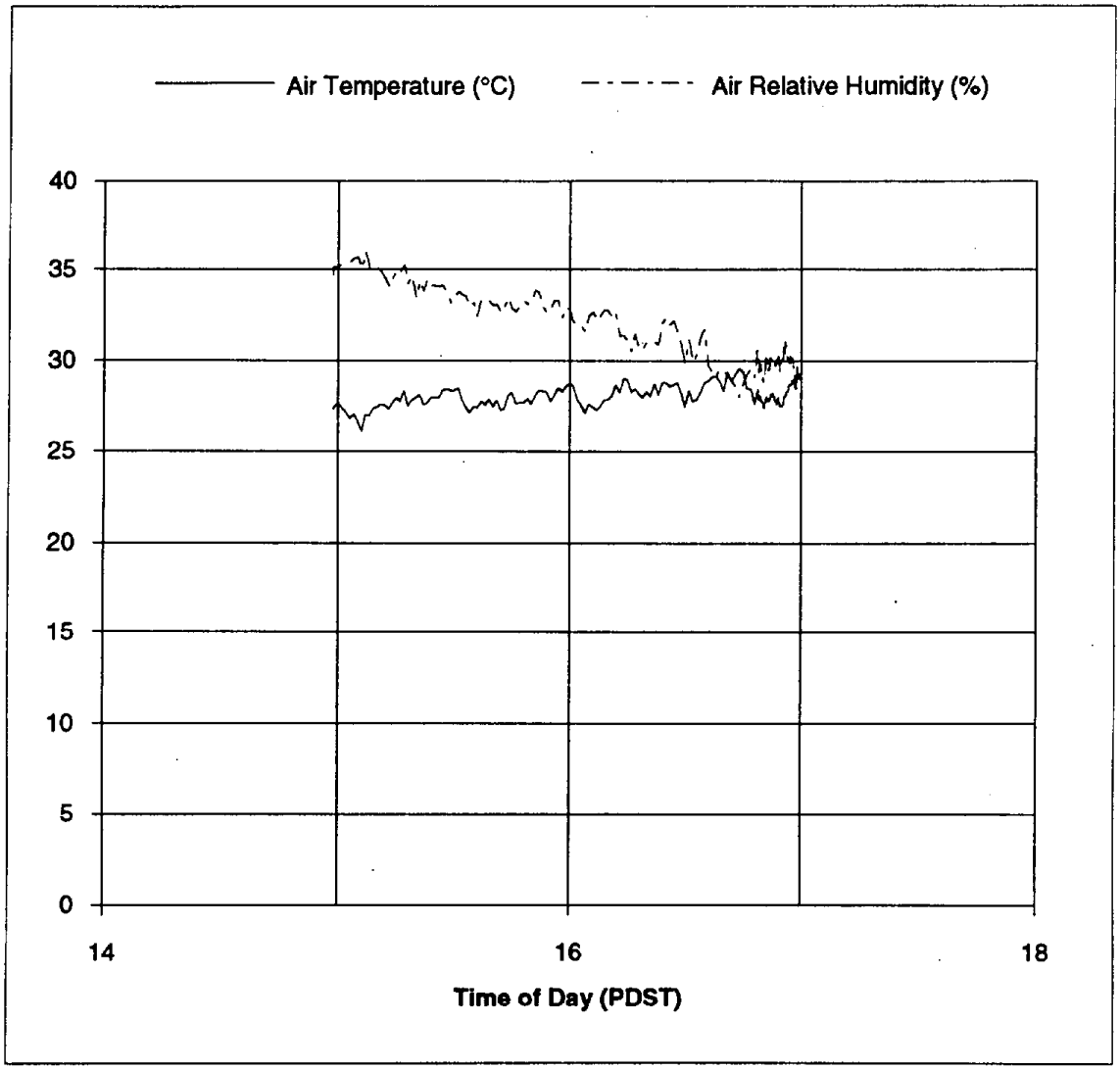

Figure 3.1.8.2. Air temperature and relative humidity from CIMIS station.

Fuel: Rice Straw Date of Test: 23-Oct-92

Configuration: CRNF

Hourly Average CIMIS Data for Davis, California

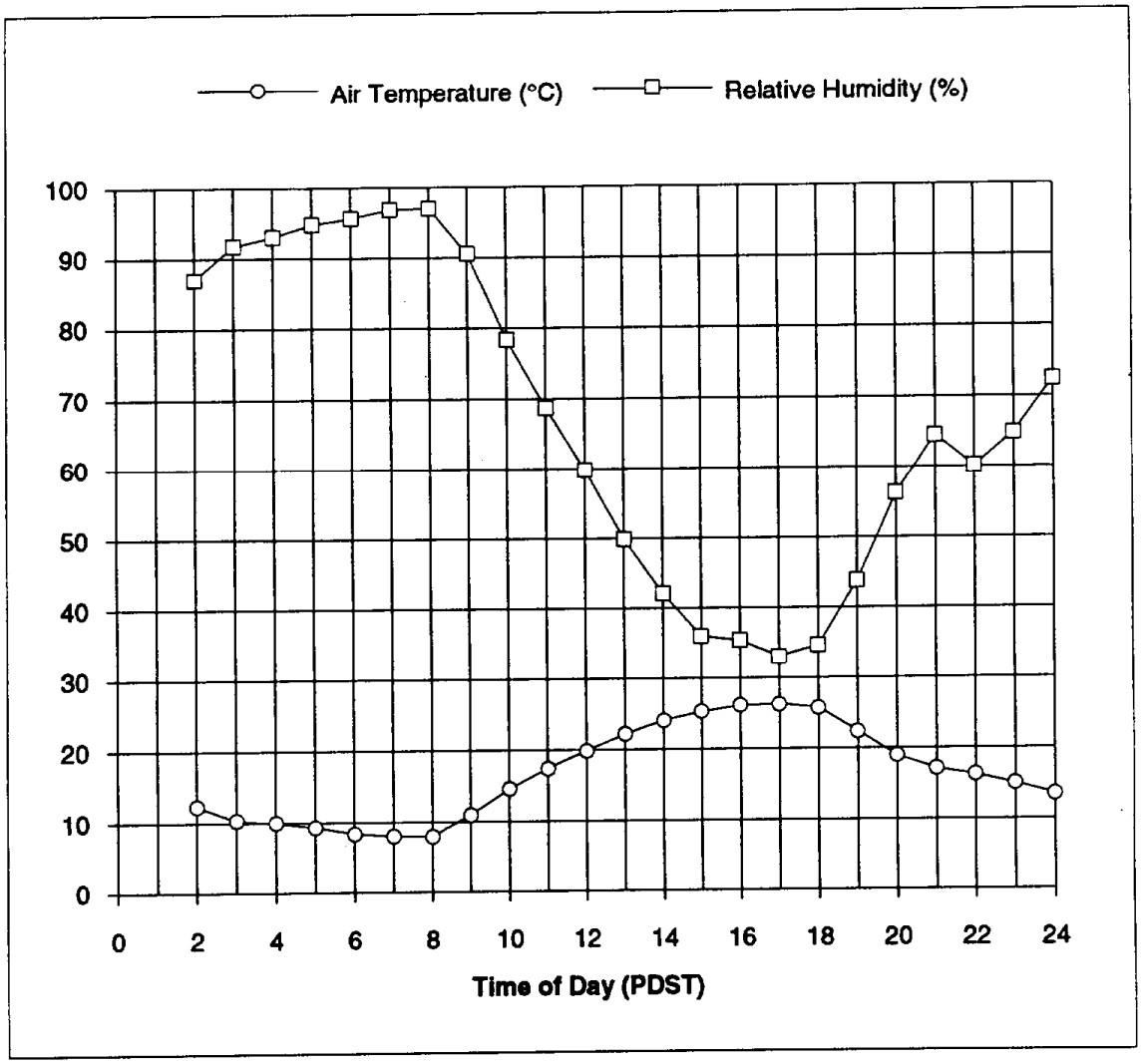

Figure 3.1.8.3. Wind speed from CIMIS station.

Fuel: Rice Straw Date of Test: 23-Oct-92

Configuration: CRNF

Hourly Average CIMIS Data for Davis, California

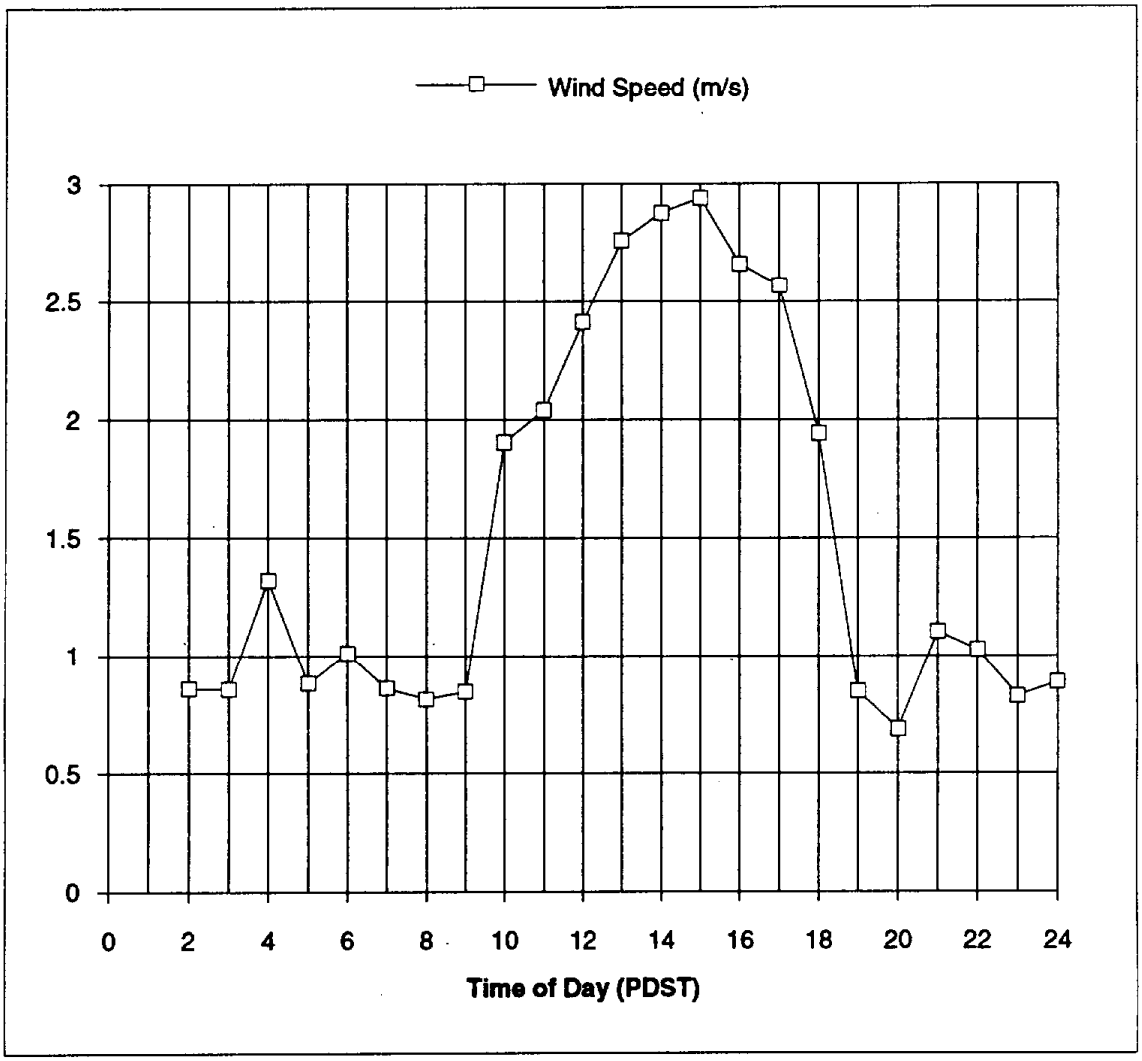

Figure 3.1.8.4. Wind direction and solar radiation from CIMIS station.

Fuel: Rice Straw Date of Test: 23-Oct-92

Configuration: CRNF

Hourly Average CIMIS Data for Davis, California

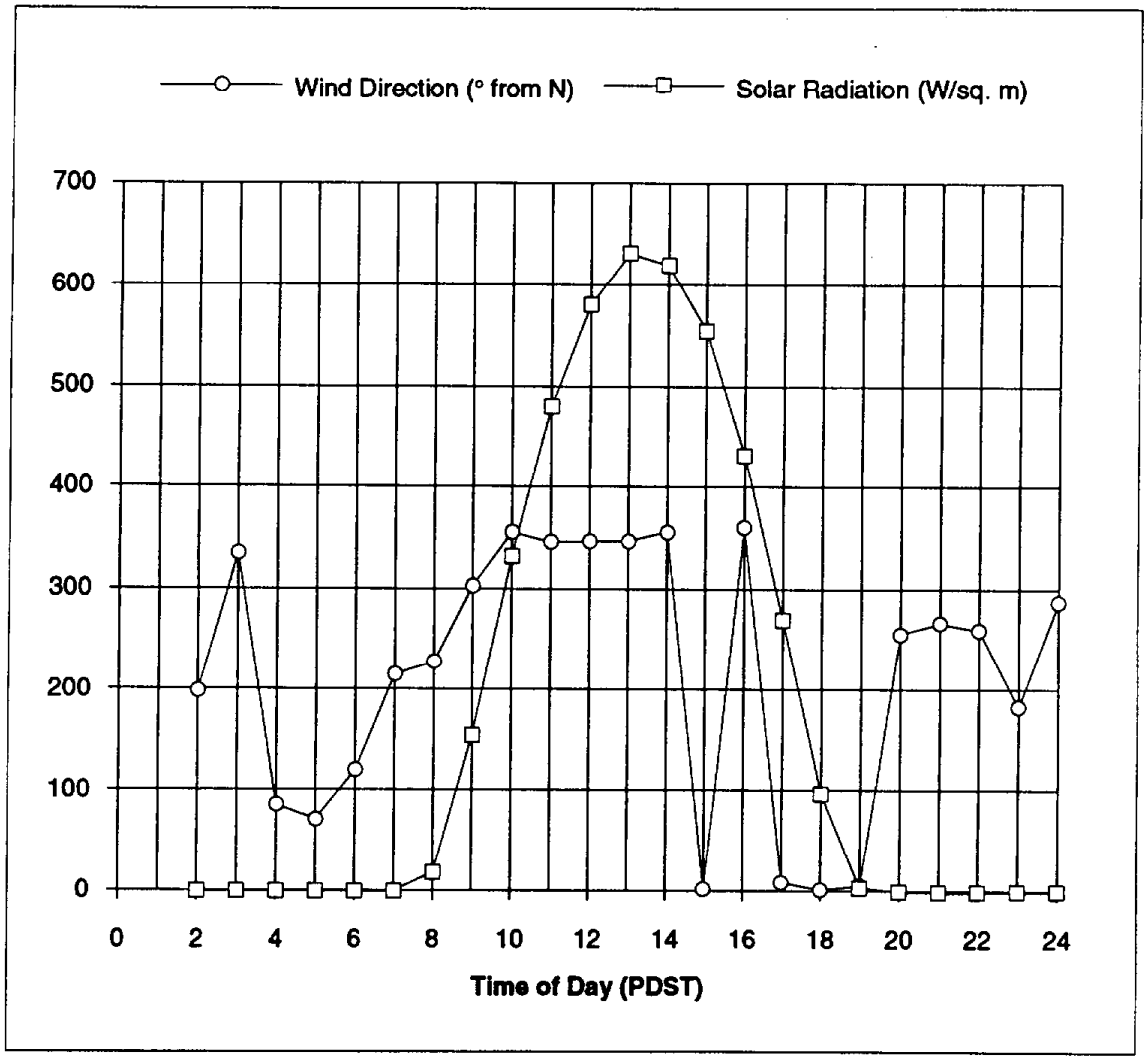

Figure 3.1.8.5. Inlet air, stack gas, and impinger temperatures, 21 October 92.

Fuel Type:	Rice Straw	Test Date	23-Oct-92
Configuration:	CRNF		

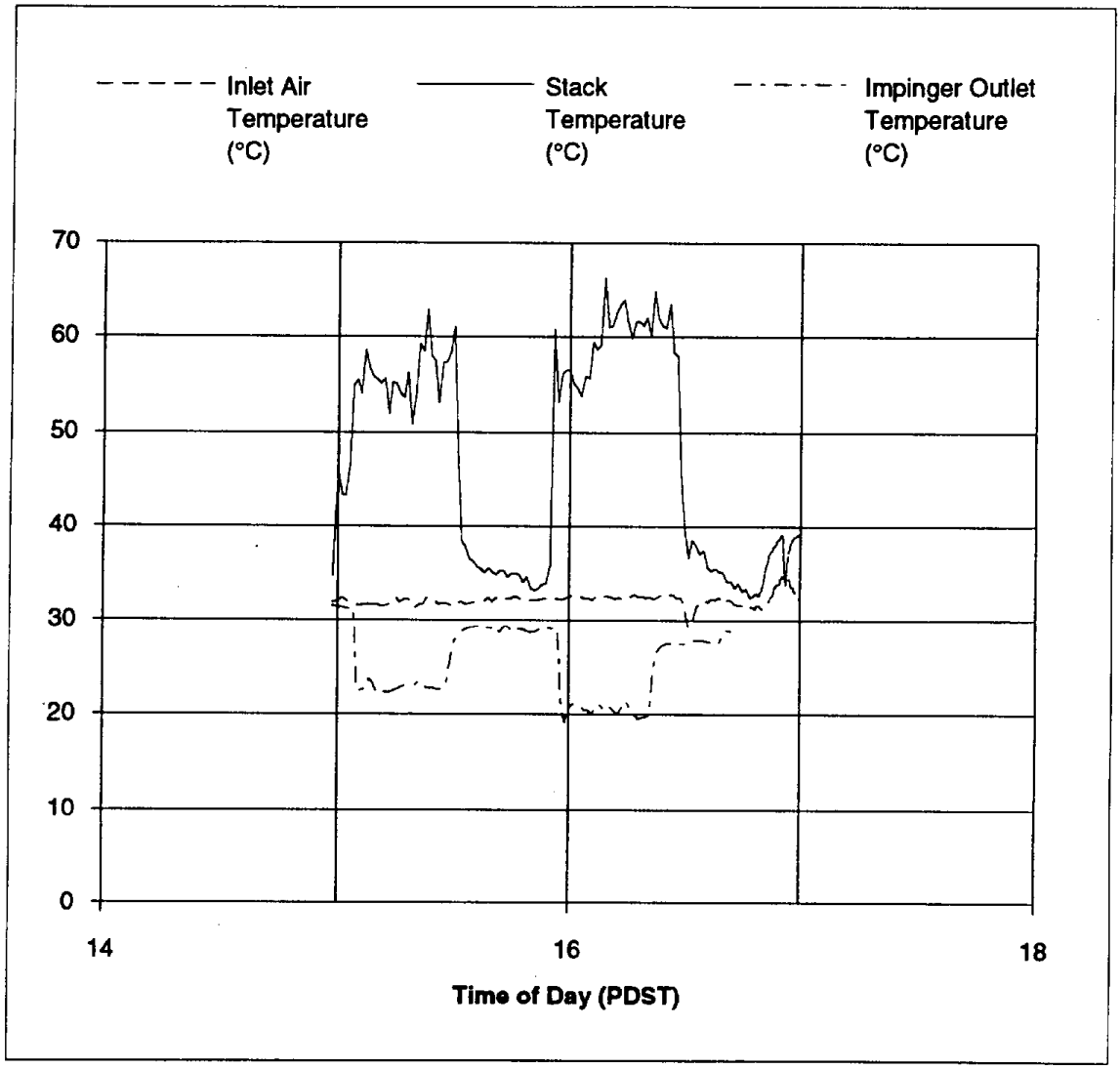

Figure 3.1.8.6. Conveyor speed and stack gas velocity, 23 October 92.

Fuel Type:	Rice Straw	Test Date	23-Oct-92
Configuration:	CRNF		

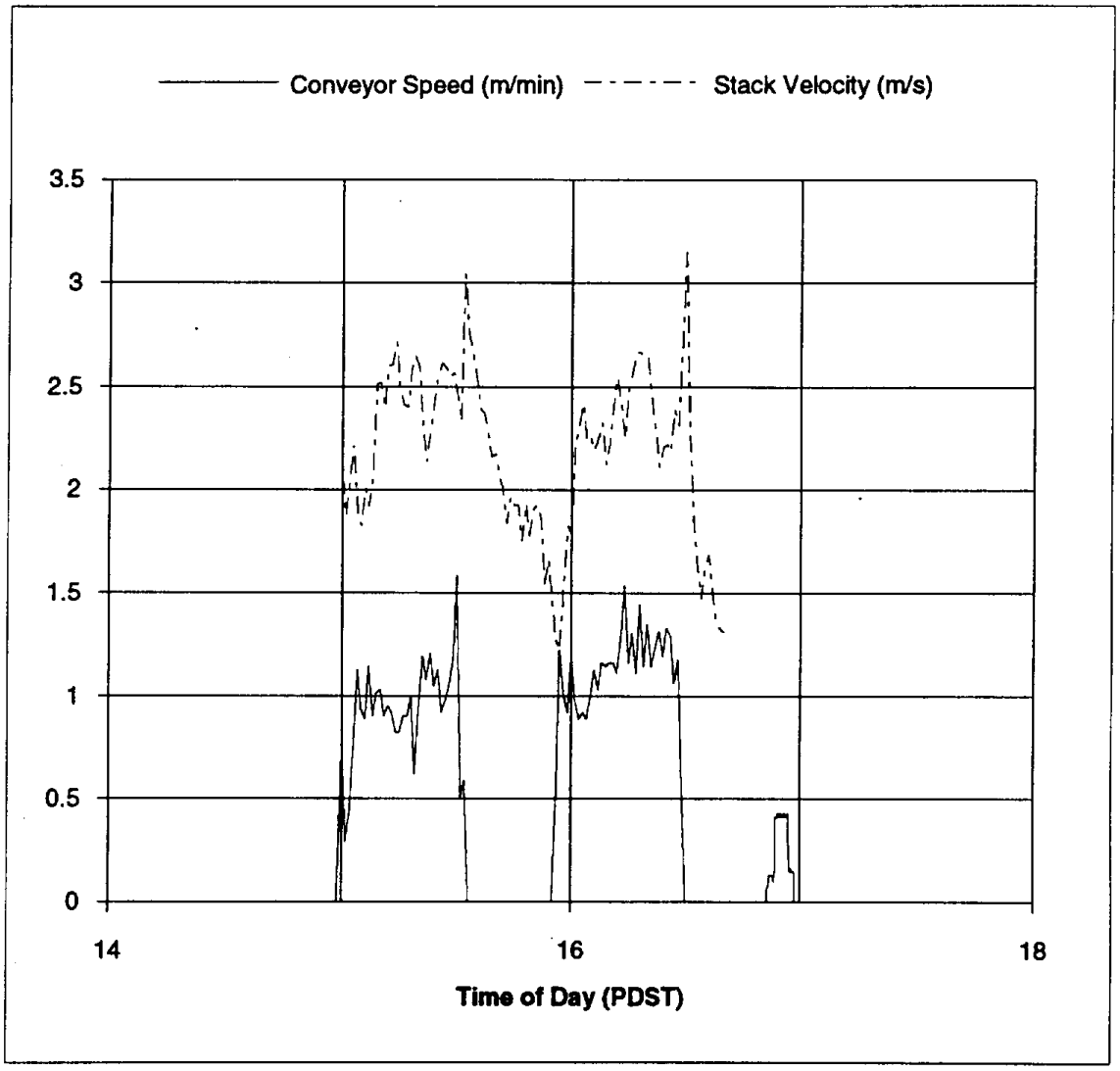

Figure 3.1.8.7. Conveyor speed with 10 min moving average, 23 October 92.

Fuel Type:	Rice Straw	Test Date	23-Oct-92
Configuration:	CRNF		

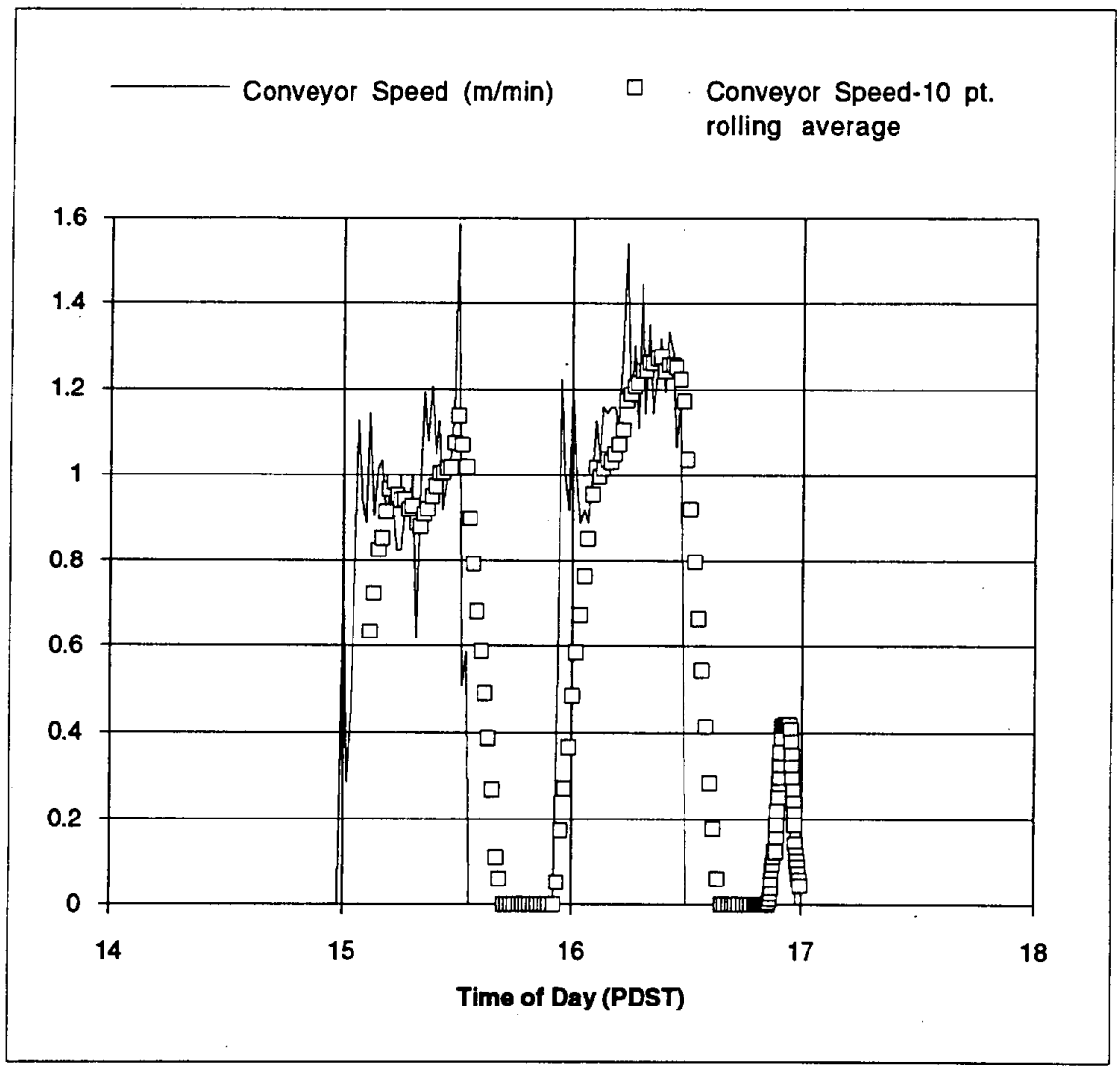

Figure 3.1.8.8. Conveyor travel, 23 October 92.

Fuel Type: Rice Straw
Configuration: CRNF

Test Date 23-Oct-92

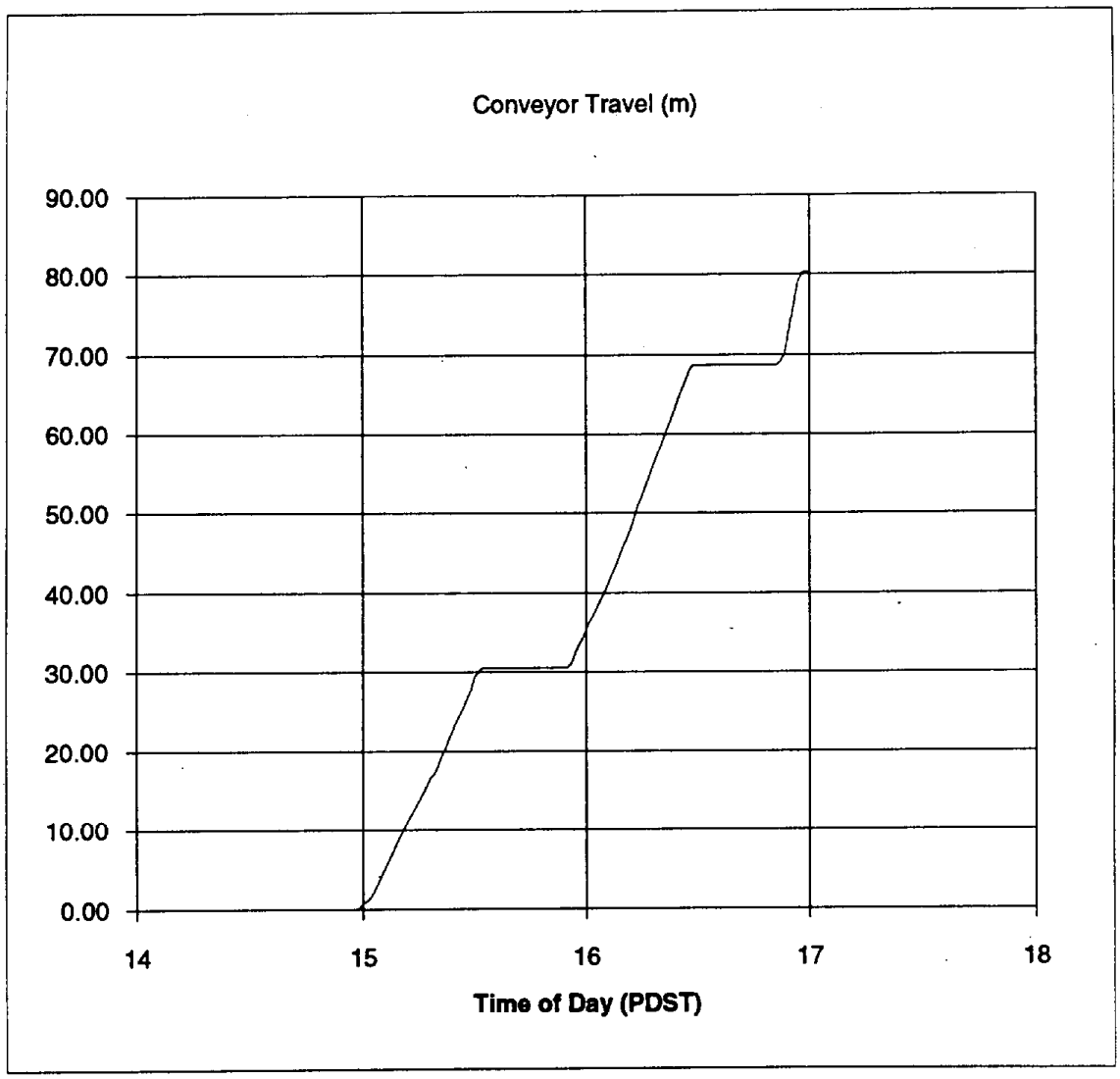

Figure 3.1.8.9. CO concentration in stack gas, 23 October 92.

Fuel Type: Rice Straw
Configuration: CRNF

Test Date 23-Oct-92

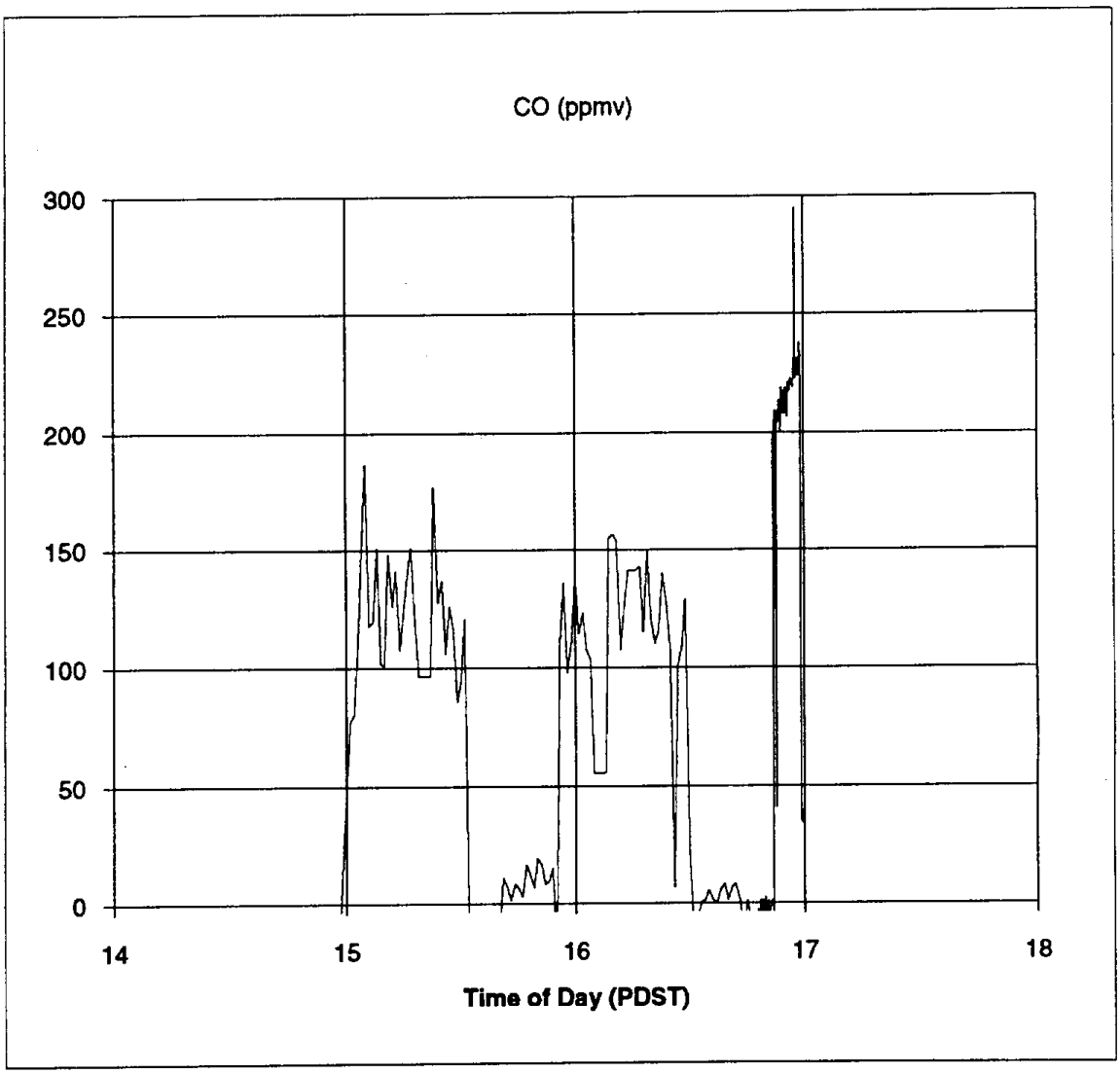

Figure 3.1.8.10. NO and NOx concentrations in stack gas, 23 October 92.

Fuel Type: Rice Straw
Configuration: CRNF
Test Date 23-Oct-92

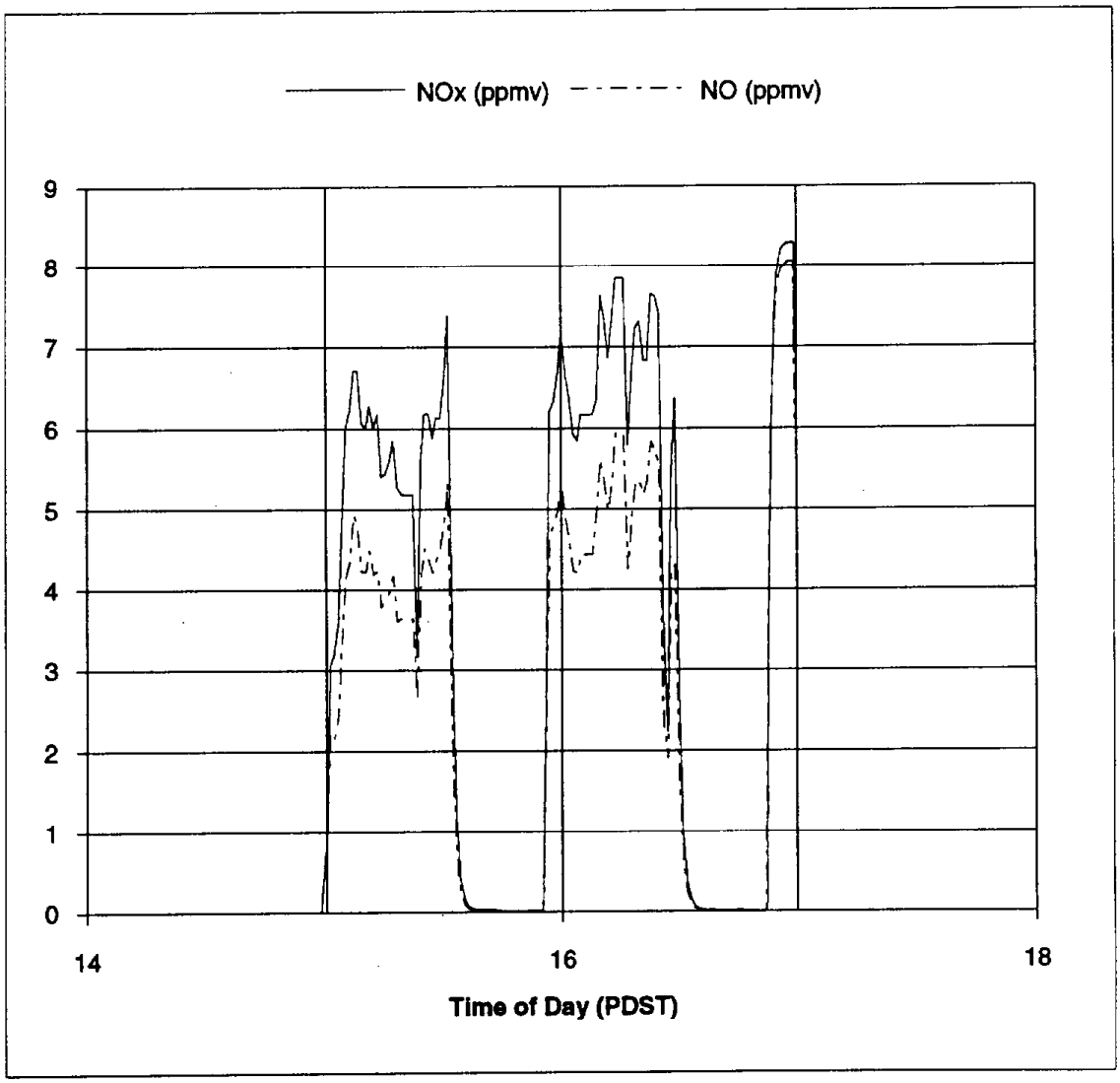

Figure 3.1.8.11. SO2 concentrations in stack gas, 23 October 92.

Fuel Type: Rice Straw Test Date 23-Oct-92
Configuration: CRNF

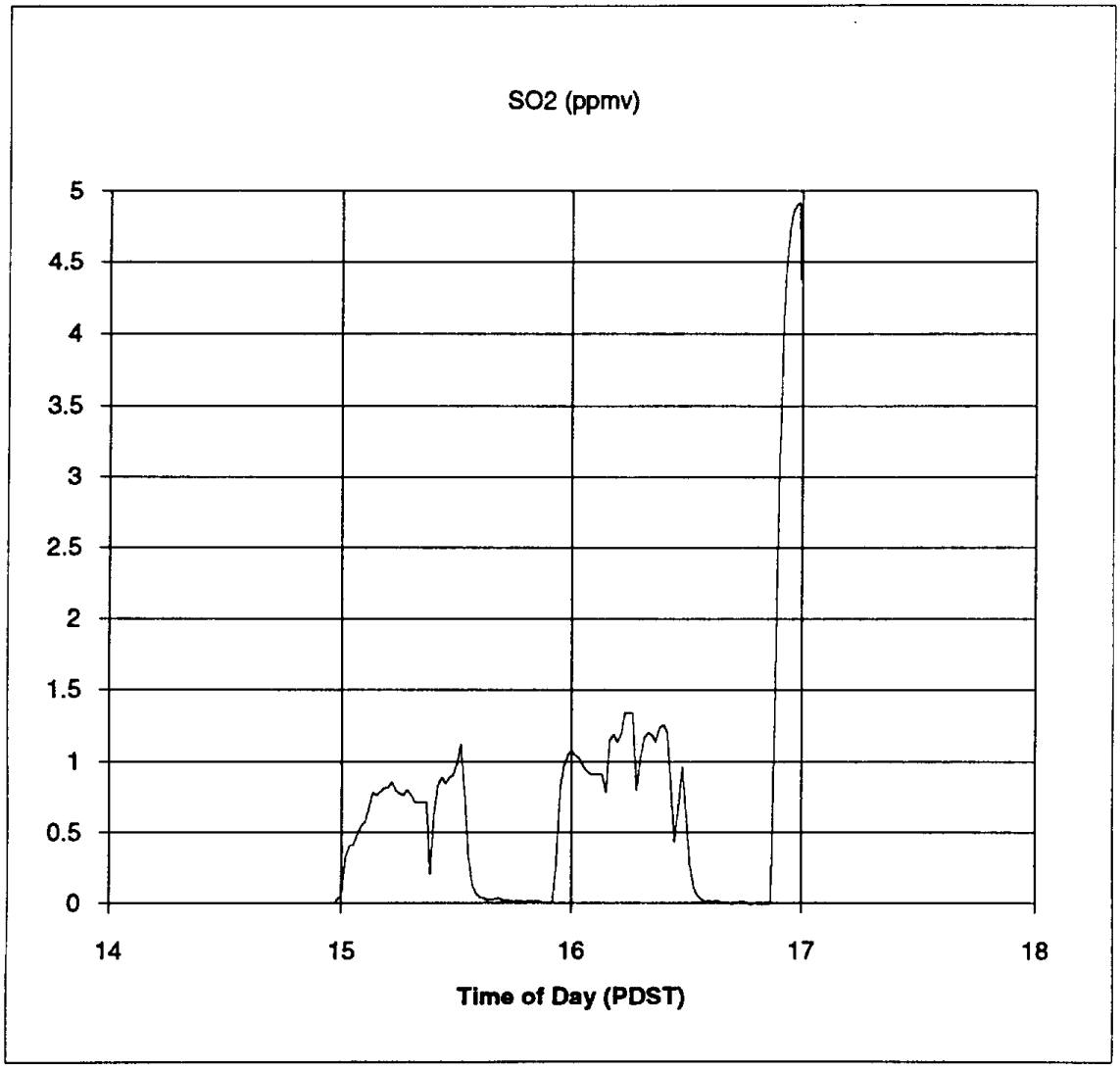

Figure 3.1.8.12. Total sulfur concentration in stack gas, 23 October 92.

Fuel Type:	Rice Straw	Test Date	23-Oct-92
Configuration:	CRNF		

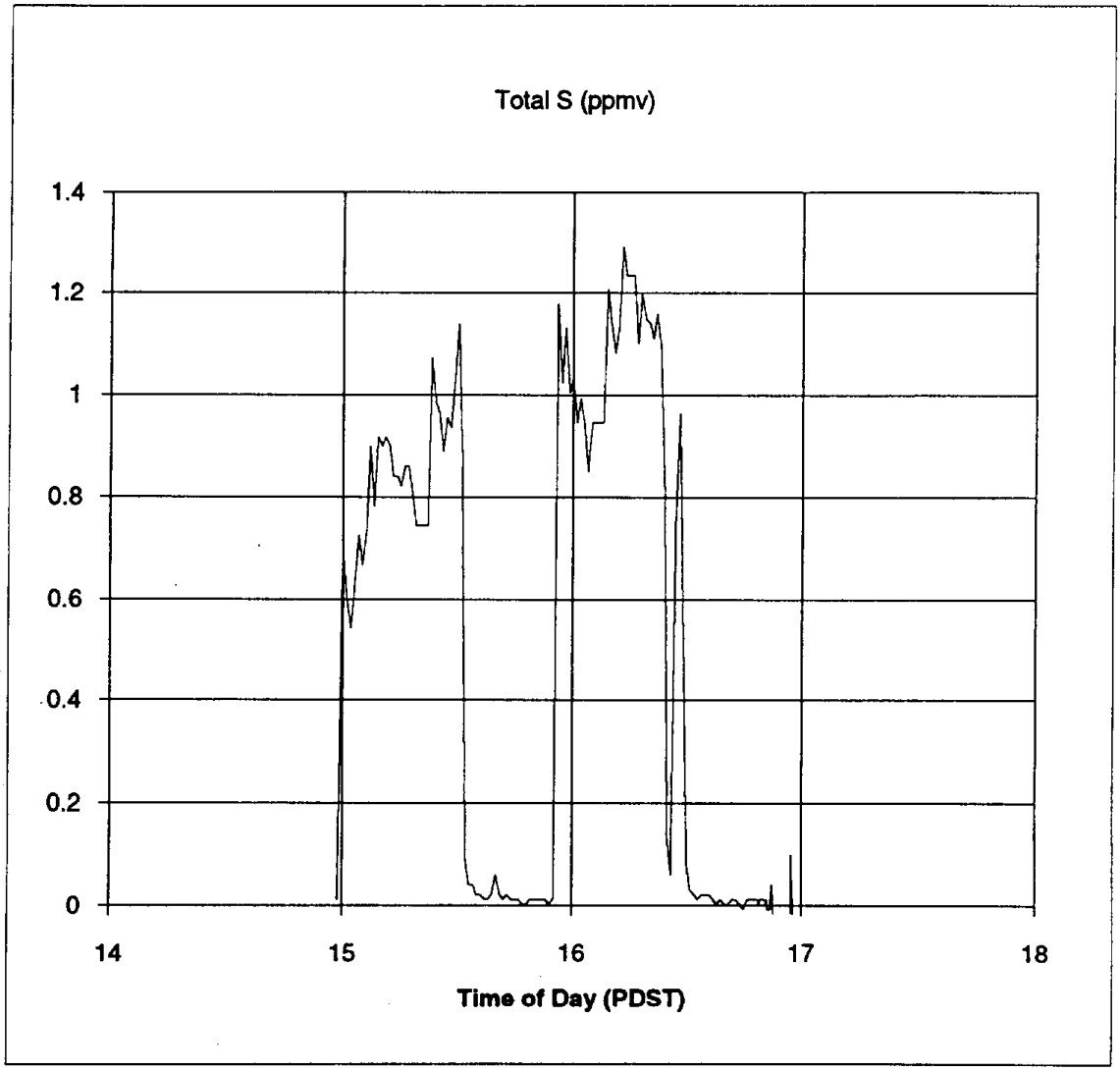

Figure 3.1.8.13. THC concentration in stack gas, 23 October 92.

Fuel Type:	Rice Straw	Test Date	23-Oct-92
Configuration:	CRNF		

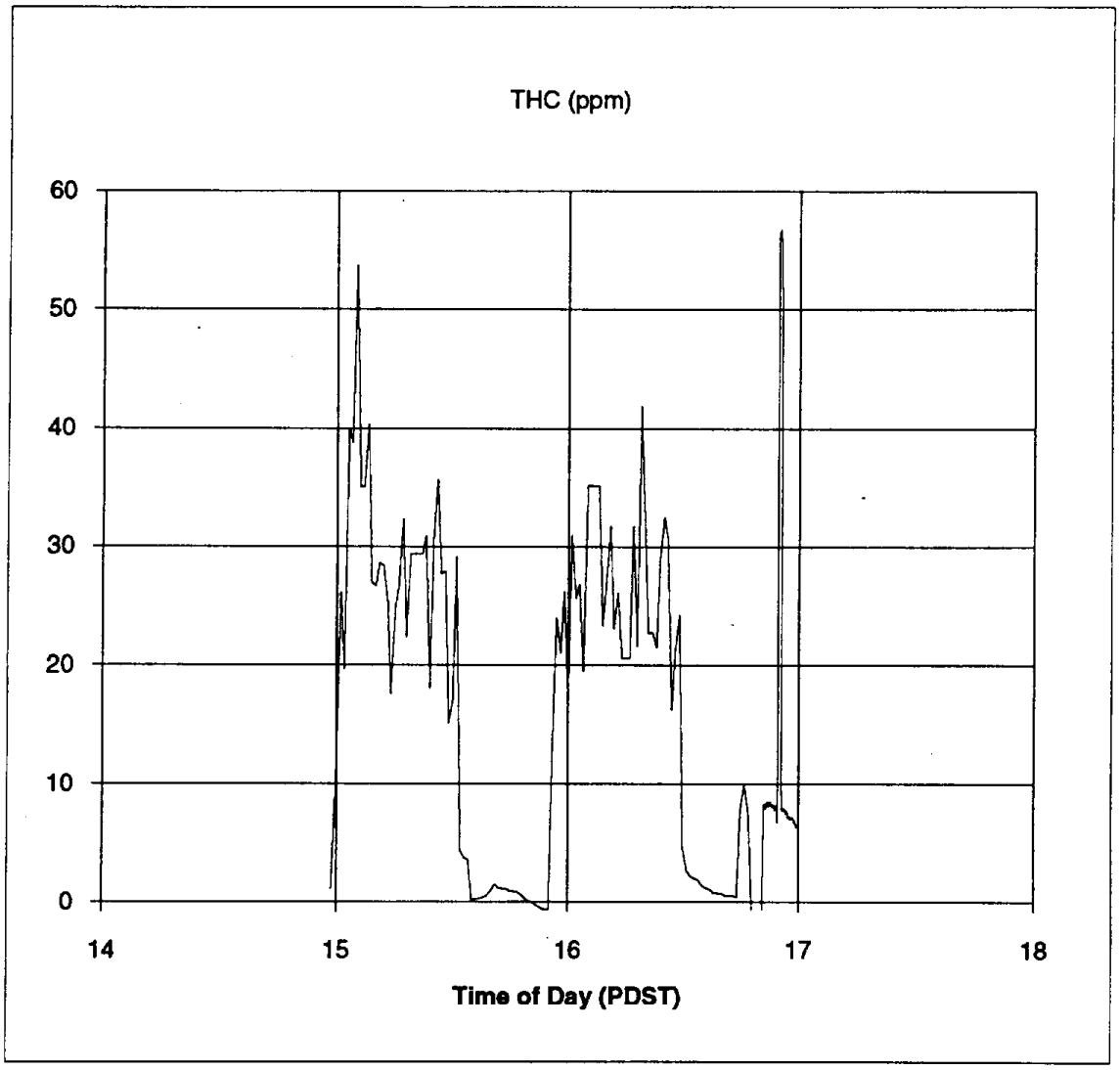

Figure 3.1.8.14. Particle size distribution, traverse 1, 23 October 92.

Fuel:	Rice Straw	Date of Test:	23-Oct-92
		Configuration:	CRNF

Particle Size Distribution
Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.88	0.22	9.49	1.000
2	7.78	0.21	9.27	0.977
3	4.15	0.2	9.06	0.955
4	2.19	0.26	8.86	0.934
5	1.26	0.46	8.6	0.906
6	0.74	1.04	8.14	0.858
7	0.39	1.16	7.1	0.748
filter	0.00	5.94	5.94	0.626

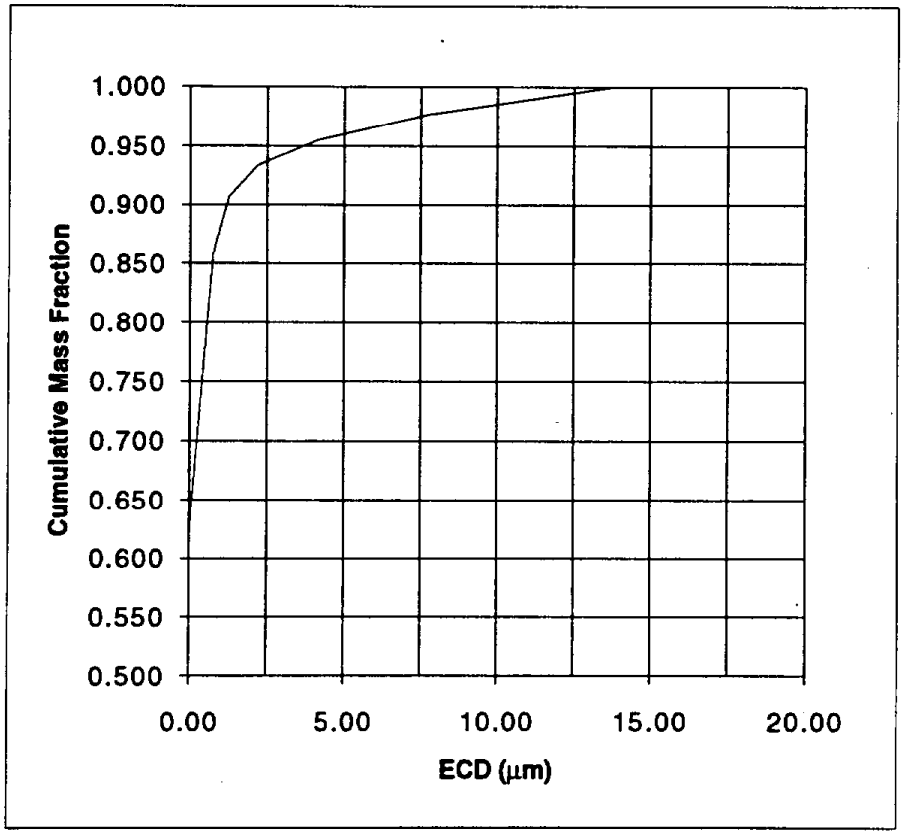

Figure 3.1.8.15. Particle size distribution, traverse 2, 23 October 92.

Fuel: Rice Straw

Date of Test: 23-Oct-92

Configuration: CRNF

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.92	0.28	10.73	1.000
2	7.80	0.30	10.45	0.974
3	4.16	0.27	10.15	0.946
4	2.20	0.32	9.88	0.921
5	1.27	0.51	9.56	0.891
6	0.74	1.07	9.05	0.843
7	0.39	1.35	7.98	0.744
filter	0.00	6.63	6.63	0.618

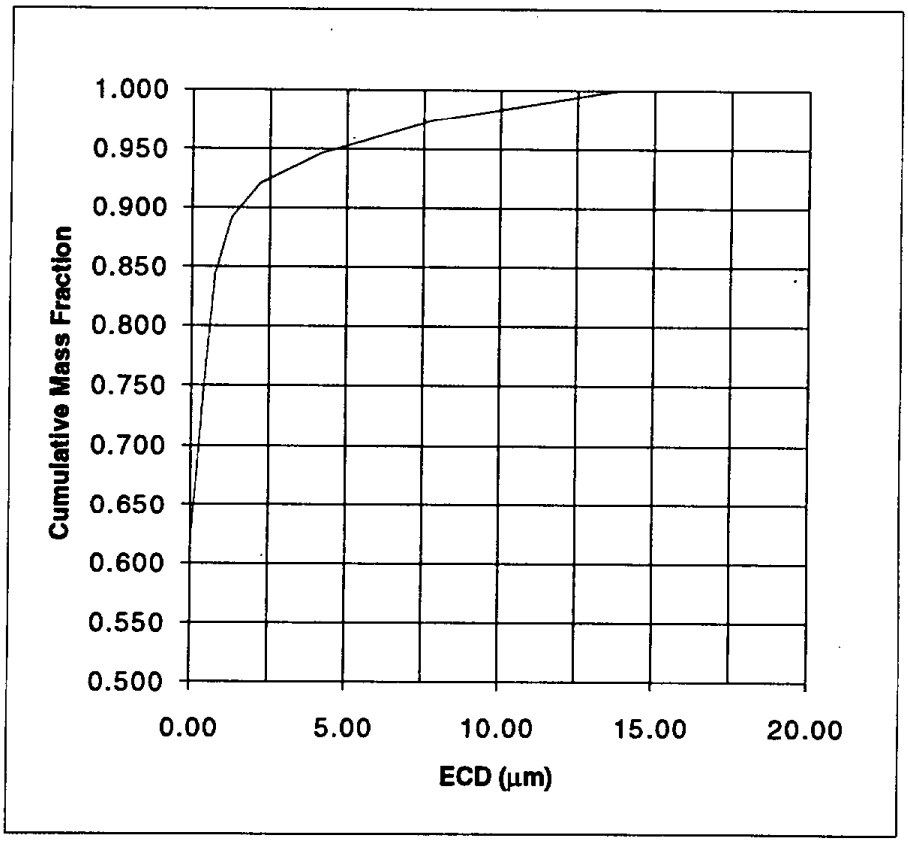

Figure 3.1.8.16. Nitrogen balance.
Date of Test: 23-Oct-92
Fuel Rice Straw

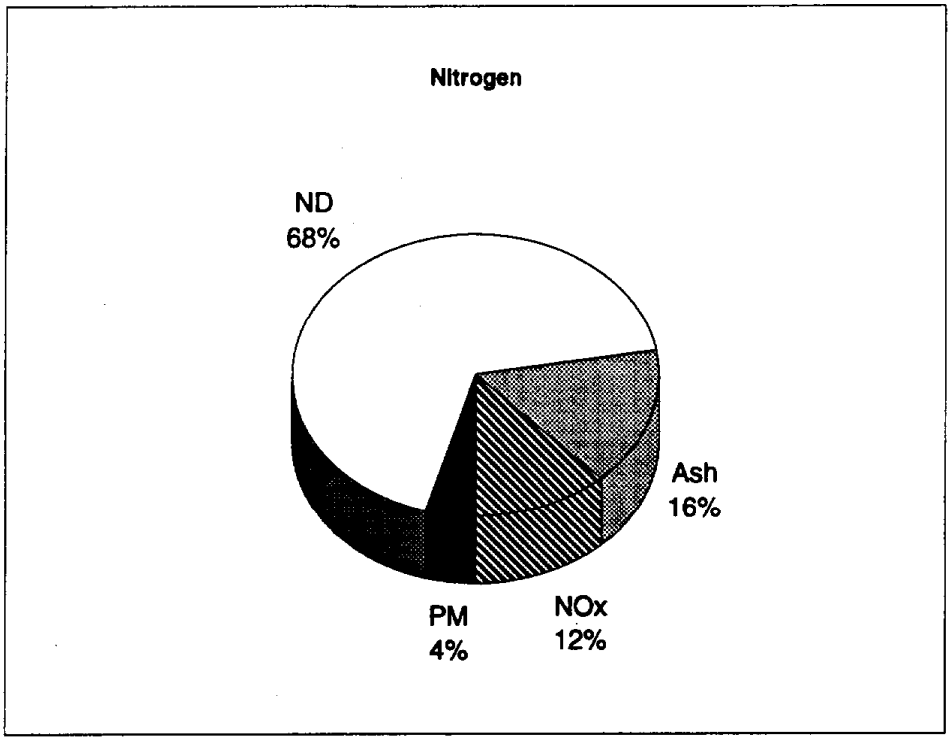

Figure 3.1.8.17. Sulfur balance.
Date of Test: 23-Oct-92
Fuel Rice Straw

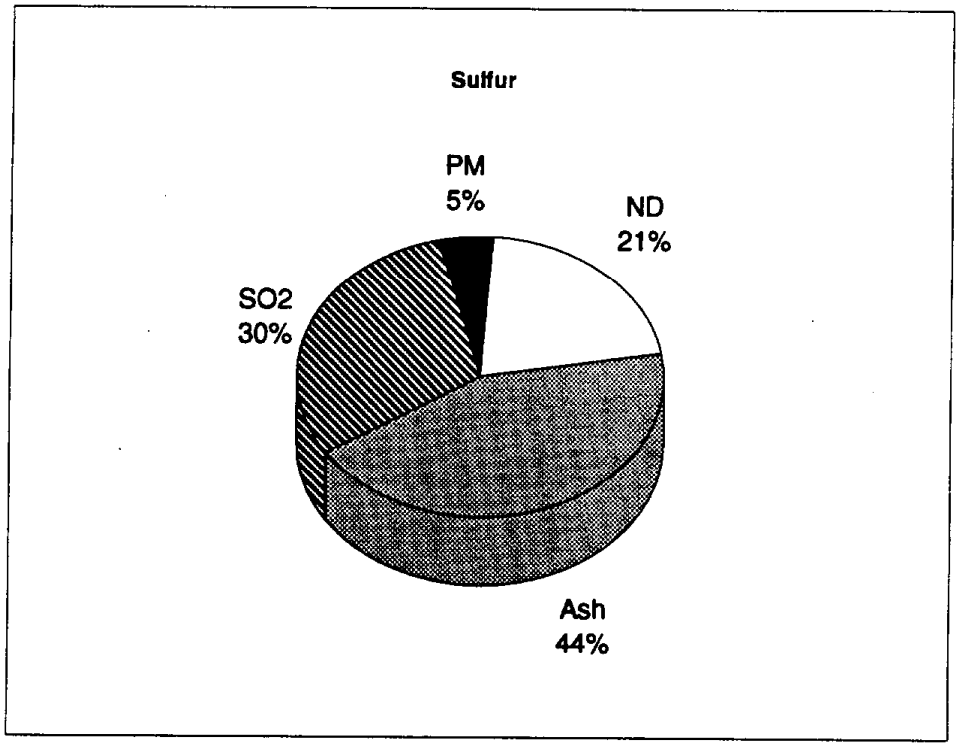

Figure 3.1.8.18. Relative abundance for major elements from DRUM impactor, Rice Straw, 23-Oct-92, (CRNF).

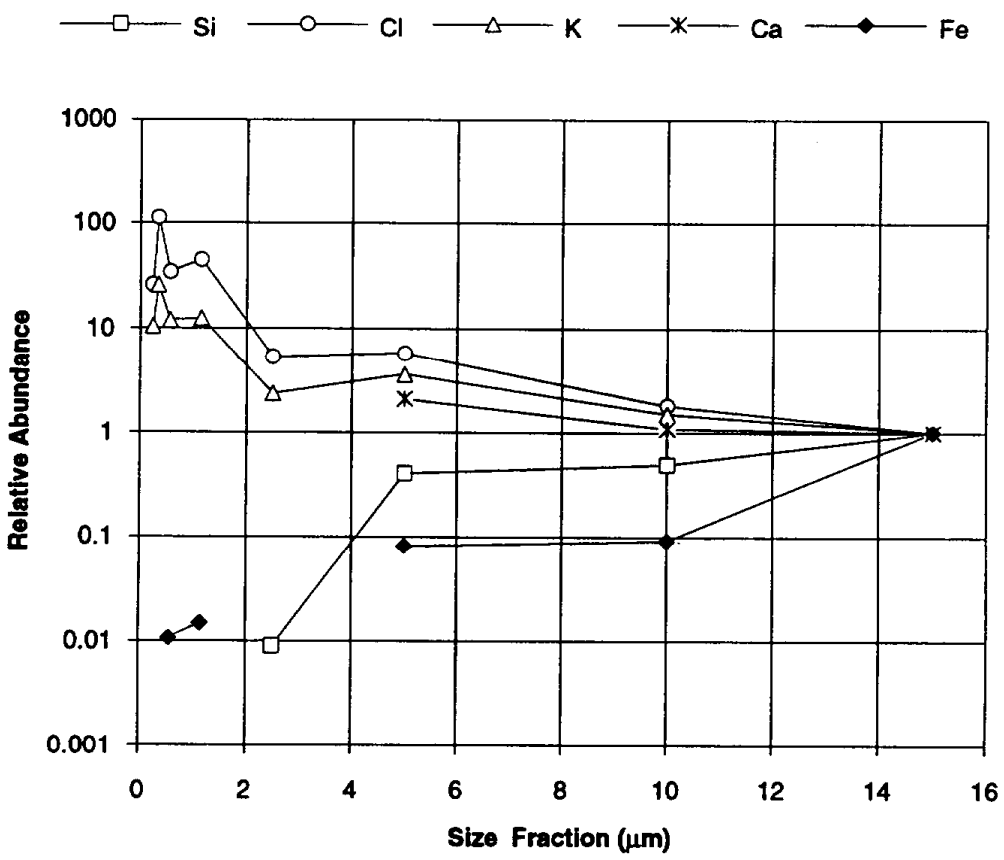

Figure 3.1.8.19. Mass fraction of PAH on primary filter samples, 23 October 1992, rice straw.

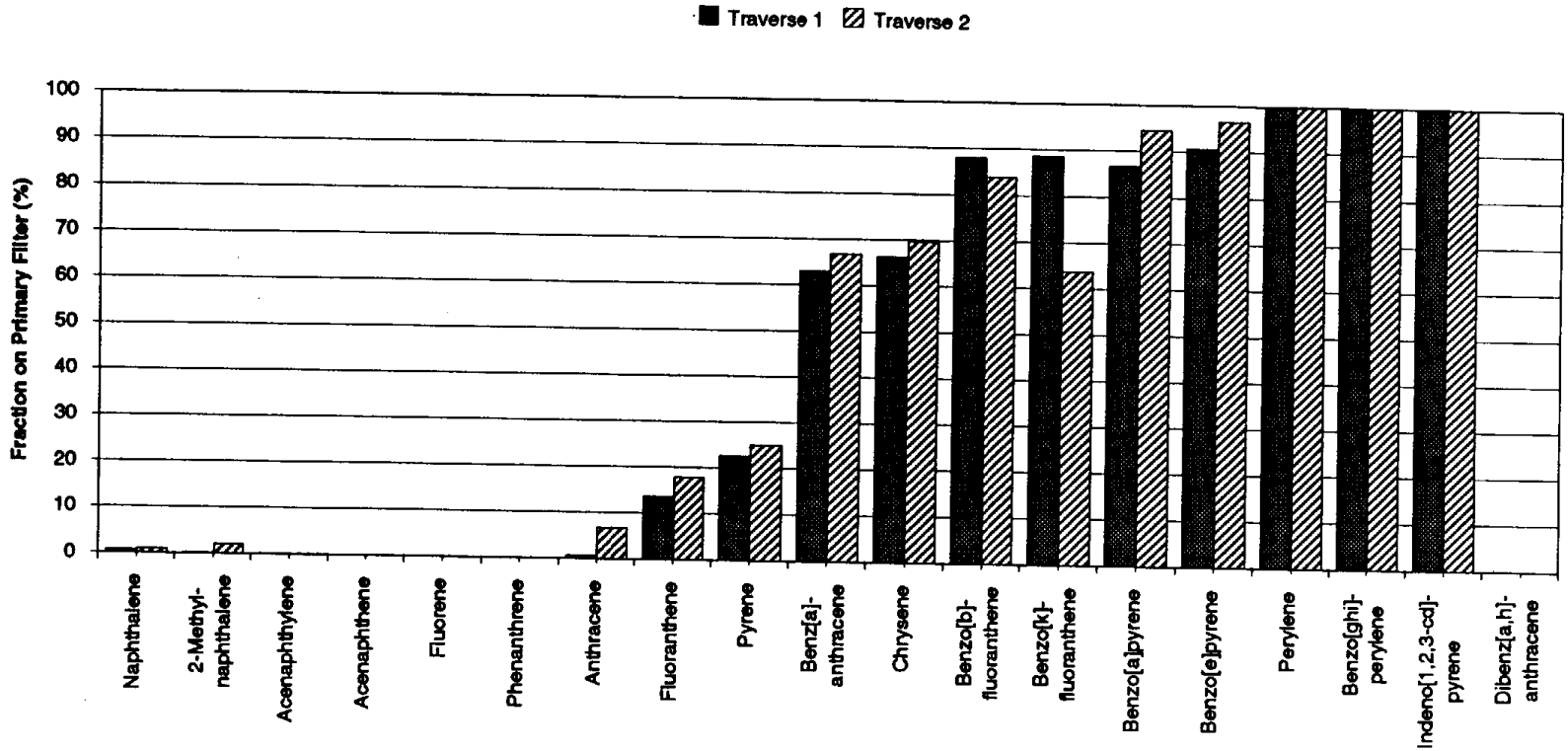

Table 3.2.1.1

Fuel and Ash Analyses

Run Date	11-Aug-92	11-Aug-92
Fuel Type	Wheat Straw	Wheat Straw
Sample Type	Fuel	Ash
Ultimate Analysis		
(% dry weight)		
C	44.71	18.85
H	5.73	1.25
N	0.46	0.36
Elemental Analysis		
(% by weight dry basis)		
N	0.59	0.47
P	0.04	0.20
K	1.90	13.04
Ca	0.16	0.97
Mg	0.12	0.62
Na	0.05	0.36
Cl	0.30	1.04
(mg/kg dry weight)		
S	1,800	6,800
B	5	21
Zn	12	84
Mn	20	152
Fe	285	467
Cu	4	15
Si		
Total (% dry weight)	53.81	37.55
Proximate Analysis		
(% dry weight)		
Ash	9.25	74.92
Volatiles	76.97	18.22
Fixed Carbon	13.78	6.86
Higher Heating Value		
(MJ/kg dry weight)	17.1408	7.2160

Table 3.2.1.2. Operating conditions and concentrations, 11 August 92.

Fuel:	Wheat Straw	Date of Test:	11-Aug-92
		Configuration:	CRNF

Fuel Loading Rate (g/sq.m w.b.):	392
Total Fuel Consumption (kg w.b.)	20.7
Total Ash Recovered (kg w.b.)	2.9
Ash Fraction (w.b.)	0.14

	Traverse 1	Traverse 2
Mean Values		
Air Temperature (°C)	21.17	27.14
Air Relative Humidity (%)	71.39	49.89
Inlet Air Temperature (°C)	26.05	32.32
Stack Temperature (°C)	34.26	42.54
Impinger Outlet Temperature (°C)	13.10	20.69
Fire Spreading Rate (m/min)	0.33	0.42
Stack Gas Velocity (m/s)	2.03	2.15
Gas and PM Concentrations (less background)		
CO (ppmv)	38.61	20.00
NO (ppmv)	0.88	1.31
NOx (ppmv)	1.17	1.68
SO2 (ppmv)	0.18	0.29
THC (ppmv as CH4)	4.87	2.80
HC (ppmv as CH4 by GC)	3.24	1.84
CH4 (ppmv by GC)	0.33	0.98
NMHC (ppmv as CH4)	4.55	1.83
NMHC (ppmv as CH4 by GC)	2.91	0.87
CO2 (ppmv by GC)	666	764
Total S (ppmv as SO2)	0.23	0.35
PM (mg/cu.m)	4.20	4.22
PM10 (mg/cu.m)	4.11	4.14
PM2.5 (mg/cu.m)	3.86	3.95

Table 3.2.1.3. Mass balance, wheat straw, 11 August 92.

Fuel: Wheat Straw | Date of Test: 11-Aug-92 | Configuration: CRNF

Mass Balance

	Traverse 1	Traverse 2
Total Conveyor Travel (m)	15.62	20.05
Fuel Moisture Content (% w.b.)	7.4	7.3
Fuel Loading Rate (g/sq.m d.b.)	363	363
Total Fuel Consumption (g w.b.)	7,457	9,571
Total Fuel Consumption (g d.b.)	6,905	8,872
Residual Ash (g w.b.)	1,052	1,350
Fuel Vaporized (g w.b.)	6,405	8,221
Fuel Consumption Rate (g/s w.b.)	2.59	3.32
Fuel Consumption Rate (g/s d.b.)	2.40	3.08
Ash Generation Rate (g/s w.b.)	0.37	0.47
Fuel Vaporization Rate (g/s w.b.)	2.22	2.85
Stack Gas Density (kg/cu.m)	1.1497	1.1195
Stack Gas Flow Rate (cu.m/s)	3.02	3.20
Stack Gas Mass Flow Rate (kg/s)	3.47	3.58
Inlet Air Mass Flow Rate (kg/s)	3.47	3.58
Overall Air-Fuel Ratio (w.b.)	1339.74	1076.23
Overall Air-Fuel Ratio (d.b.)	1446.80	1160.99

Table 3.2.1.4. Emission factors, wheat straw, 11 August 92.

Fuel:	Wheat Straw	Date of Test:	11-Aug-92
		Configuration:	CRNF

Emission Factors (% of fueldry weight)
Integrated Basis

	Traverse 1	Traverse 2	Average
CO	5.378	2.244	3.811
NO	0.131	0.158	0.144
NOx (as NO2)	0.267	0.310	0.289
SO2	0.057	0.075	0.066
THC (as CH4)	0.387	0.178	0.282
HC (as CH4 by GC)	0.259	0.118	0.188
CH4 (by GC)	0.026	0.063	0.044
NMHC (as CH4)	0.361	0.115	0.238
NMHC (as CH4 by GC)	0.233	0.056	0.144
CO2 (by GC)	146.181	134.747	140.464
Total S (as SO2)	0.074	0.090	0.082
SO2/Total S	0.77	0.83	0.80
PM	0.492	0.408	0.450
PM10	0.482	0.400	0.441
PM2.5	0.453	0.382	0.417
MMAD (μm)	0.143	0.106	0.125
σ	4.543	4.074	

Table 3.2.1.5. Emission factors, wheat straw, 11 August 92.

Fuel:	Wheat Straw	Date of Test:	11-Aug-92
		Configuration:	CRNF

Emission Factors (% of fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Average
CO	5.397	2.244	3.820
NO	0.131	0.157	0.144
NOx (as NO2)	0.269	0.309	0.289
SO2	0.058	0.075	0.066
THC (as CH4)	0.389	0.180	0.285
HC (as CH4 by GC)	0.259	0.118	0.188
CH4 (by GC)	0.026	0.063	0.044
NMHC (as CH4)	0.363	0.117	0.240
NMHC (as CH4 by GC)	0.233	0.056	0.144
CO2 (by GC)	146.181	134.747	140.464
Total S (as SO2)	0.075	0.090	0.082
SO2/Total S	0.77	0.83	0.81
PM	0.492	0.408	0.450
PM10	0.482	0.400	0.441
PM2.5	0.453	0.382	0.417
MMAD (μm)	0.143	0.106	0.125
σ	4.543	4.074	

Table 3.2.1.6. Carbon balance.

Date of Test:	11-Aug-92	11-Aug-92
Fuel	Wheat Straw Traverse 1	Wheat Straw Traverse 2
Carbon Balance		
Dry Fuel Consumption Rate (g/s)	2.40	3.08
Ash Generation Rate (g/s)	0.37	0.47
Ash Fraction (% dry basis)	15.42	15.26
Fuel Carbon Concentration (%)	44.71	44.71
Residual Ash Carbon Concentration (%)	18.85	18.85
Carbon released to stack (g/s)	1.00	1.29
Maximum CO2 emission factor (%)	153.28	153.39
Stack Gas Density (kg/cubic meter)	1.15	1.12
Average CO2 concentration (ppmv)	666	764
Average CO concentration (ppmv)	38.61	20.00
Average THC concentration (ppmv as CH4)	4.87	2.80
PM Concentration (mg/cubic meter)	4.20	4.22
PM Carbon Concentration (%)	41.56	41.56
PM Carbon (mg/cubic meter)	1.75	1.75
Stack Gas Temperature (°C)	34.26	42.54
Impinger Temperature (°C)	13.10	20.69
PM molar concentration (ppm)	3.42	3.52
Estimated Average Stack Gas Velocity (m/s)	1.99	2.37
Emission Factors (% Average Basis):		
CO2	146.181	134.747
CO	5.397	2.244
THC (as CH4)	0.389	0.180
PM	0.492	0.408
Emission Factors (% Integrated Basis):		
CO2	146.181	134.747
CO	5.378	2.244
THC (as CH4)	0.387	0.178
PM	0.492	0.408
Closure (% Average Basis)	102	91
Closure (% Integrated Basis)	102	90

Table 3.2.1.7. Nitrogen balance

Date of Test:	11-Aug-92	11-Aug-92
Fuel	Wheat Straw Traverse 1	Wheat Straw Traverse 2
Nitrogen Balance		
Fuel Nitrogen Concentration (% dry weight)	0.59	0.59
Ash Nitrogen Concentration (% weight)	0.20	0.20
Emission Factors (% Average Basis):		
NOx (as NO2)	0.269	0.309
PM	0.492	0.408
Emission Factors (% Integrated Basis):		
NOx (as NO2)	0.267	0.310
NO3- Concentration of PM (% weight)	0.305	0.305
NH4+ Concentration of PM (% weight)	4.797	4.797
Nitrogen Concentration of PM (%)	3.800	3.800
Fuel Nitrogen (mg/s)	14.16	18.17
Ash Nitrogen (mg/s)	0.74	0.94
Nitrogen as NOx (mg/s Average Basis)	1.96	2.90
Nitrogen as NOx (mg/s Integrated Basis)	1.95	2.91
Nitrogen as PM (mg/s Average Basis)	0.45	0.48
Nitrogen as NOx+PM (mg/s Average Basis)	2.41	3.37
Nitrogen as NOx+PM (mg/s Integrated Basis)	2.40	3.38
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.170	0.186
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.169	0.186
Ash Nitrogen/Fuel Nitrogen	0.052	0.052
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.223	0.237
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.222	0.238

Table 3.2.1.8. Sulfur balance.

Date of Test:	11-Aug-92	11-Aug-92
Fuel	Wheat Straw Traverse 1	Wheat Straw Traverse 2
Sulfur Balance		
Fuel Sulfur Concentration (mg/kg dry weight)	1,800	1,800
Ash Sulfur Concentration (mg/kg weight)	6,800	6,800
Emission Factors (% Average Basis)		
SO2	0.058	0.075
PM	0.492	0.408
Emission Factors (% Integrated Basis)		
SO2	0.057	0.075
Sulfur Concentration of PM (% weight)	2.407	2.407
Fuel Sulfur (mg/s)	4.32	5.54
Ash Sulfur (mg/s)	2.52	3.20
Sulfur as SO2 (mg/s Average Basis)	0.70	1.16
Sulfur as SO2 (mg/s Integrated Basis)	0.68	1.16
Sulfur as PM (mg/s Average Basis)	0.28	0.30
Sulfur as SO2+PM (mg/s Average Basis)	0.98	1.46
Sulfur as SO2+PM (mg/s Integrated Basis)	0.97	1.46
SO2+PM Sulfur/Fuel Sulfur (Average Basis)	0.227	0.263
SO2+PM Sulfur/Fuel Sulfur (Integrated Basis)	0.224	0.263
Ash Sulfur/Fuel Sulfur	0.582	0.576
Closure (% Average Basis)	81	84
Closure (% Integrated Basis)	81	84

Table 3.2.1.9. Water balance.

Estimated Stack Humidity

Fuel	Wheat Straw
Configuration	CRNF
Date of Test	11-Aug-92

	Traverse 1	Traverse 2
Ambient Air Temperature °C)	21	27
Ambient Air Relative Humidity (%)	71	50
Air Temperature (K)	294	300
Saturation Pressure (Pa)	2,514	3,597
Vapor Pressure (Pa)	1,795	1,794
Air Dew Point Temperature (°C)	15.8	15.8
Ambient Volume Fraction Water Vapor	0.0177	0.0177
Ambient Mass Fraction Water Vapor	0.0110	0.0110
Fuel Burning Rate (g/s wet basis)	2.59	3.32
Fuel Moisture Content (%)	7.4	7.3
Ash Fraction (wet basis)	0.14	0.14
Fuel Hydrogen Content (%)	5.73	5.73
Ash Hydrogen Content (%)	1.25	1.25
Moisture Evaporated (g/s)	0.19	0.24
Water of Combustion (g/s)	1.20	1.53
Total Fuel Water Added (g/s)	1.39	1.78
Inlet Air Mass Flowrate (g/s)	3,470	3,580
Inlet Air Water Vapor Flowrate (g/s)	38	39
Total Stack Water Vapor Flowrate (g/s)	40	41
Stack Gas Mass Flowrate (g/s)	3,472	3,583
Mass Fraction Water Vapor in Stack	0.0114	0.0115
Volume Fraction Water Vapor in Stack	0.0183	0.0185
Stack Vapor Pressure (Pa)	1,859	1,874
Stack Temperature (°C)	34	43
Stack Temperature (K)	307	316
Stack Saturation Pressure (Pa)	5,402	8,444
Stack Relative Humidity (%)	34	22
Stack Dew Point Temperature (°C)	16.4	16.5
Impinger Outlet Temperature (°C)	13.1	20.7
Volume Stack Gas Sampled for PM (L)	548	521
Estimated Impinger/Desiccant Weight Gain (g)	7.7	7.2

Totals:

	Estimated	Measured
Total Impinger/Desiccant Weight Gain (g)	14.9	13.7
Estimated/Measured Weight Gain	1.09	

Table 3.2.1.10. Power balance.

Date of Test:	11-Aug-92	11-Aug-92
Fuel	Wheat Straw Traverse 1	Wheat Straw Traverse 2
Power Balance		
Fuel Heating Value (MJ/kg dry weight)	17.1408	17.1408
Ash Heating Value (MJ/kg dry weight)	7.2160	7.2160
Average Energy Release Rate (kW)	38.5	49.4
Products of Incomplete Combustion (kW)		
CO	1.3	0.7
THC (as CH4)	0.5	0.3
PM	0.2	0.2
Heat Release Rate (kW)	36.5	48.2
Fireline Intensity (kW/m)	29.9	39.6
Stack Gas Flow (kg/s)	3.47	3.58
Stack Gas Temperature (°C)	34.26	42.54
Inlet Temperature (°C)	26.05	32.32
Sensible Power at Top of Stack (kW)	28.7	36.8
Tunnel Dissipation (kW)	7.8	11.4

Table 3.2.1.11. Mass concentrations (%) from DRI filter samples

Date	11-Aug-92		11-Aug-92		
Fuel	Wheat Straw CRNF		Wheat Straw CRNF		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT022		ABTT023		
Quartz Filter ID	ABTQ022		ABTQ023		
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)	3,080	162	3,150	166	
	Concentration (%)	±Uncertainty	Concentration (%)	±Uncertainty	PM2.5/PM10
Cl-	28.8338	2.4262	28.1295	2.3649	1.03
NO3-	0.2857	0.0793	0.3048	0.0780	0.94
SO4=	6.3011	0.4784	6.3579	0.7041	0.99
NH4+	4.9388	0.3733	4.7970	0.3622	1.03
Na+	0.3377	0.0439	0.3882	0.0465	0.87
K+	21.6000	1.6629	21.6857	1.6677	1.00
C(org)	25.4715	2.7293	26.3975	2.8030	0.96
C(oht)	24.8025	4.0219	25.8280	4.1688	0.96
C(e)	14.3398	1.3831	15.1640	1.4622	0.95
C(eht)	0.6277	0.4054	0.9735	0.6116	0.64
C	39.8113		41.5615		0.96
Al	0.2107	0.0447	0.2354	0.0477	0.90
Si	0.1487	0.0730	0.4138	0.0802	0.36
P	0.0413	0.2428	0.0590	0.2663	0.70
S	2.1675	0.1911	2.4070	0.2111	0.90
Cl	21.8205	1.5893	23.9494	1.7420	0.91
K	18.9545	1.3788	21.2007	1.5402	0.89
Ca	0.0368	0.2728	0.0791	0.3047	0.47
Ti	0.0017	0.0729	0.0056	0.0671	0.30
V	0.0028	0.0317	0.0042	0.0292	0.67
Cr	0.0011	0.0069	0.0023	0.0065	0.48
Mn	0.0023	0.0048	0.0045	0.0032	0.51
Fe	0.0113	0.0127	0.0786	0.0137	0.14
Co	0.0008	0.0029	0.0007	0.0031	1.14
Ni	0.0005	0.0032	0.0013	0.0030	0.38
Cu	0.0022	0.0034	0.0015	0.0031	1.47
Zn	0.0128	0.0026	0.0139	0.0025	0.92
Ga	0.0000	0.0059	0.0000	0.0054	
As	0.0000	0.0068	0.0000	0.0063	
Se	0.0000	0.0037	0.0008	0.0035	0.00
Br	0.0896	0.0071	0.1018	0.0079	0.88
Rb	0.0090	0.0025	0.0082	0.0025	1.10
Sr	0.0000	0.0034	0.0021	0.0032	0.00
Y	0.0008	0.0043	0.0010	0.0039	0.80
Zr	0.0000	0.0052	0.0002	0.0047	0.00
Mo	0.0010	0.0088	0.0026	0.0080	0.38
Pd	0.0000	0.0323	0.0000	0.0309	
Ag	0.0190	0.0373	0.0175	0.0355	1.09
Cd	0.0000	0.0394	0.0167	0.0378	0.00
In	0.0000	0.0440	0.0000	0.0418	
Sn	0.0006	0.0560	0.0000	0.0527	
Sb	0.0000	0.0636	0.0112	0.0603	0.00
Ba	0.0000	0.2195	0.0371	0.2045	0.00
La	0.0000	0.2931	0.0000	0.2757	
Au	0.0000	0.0097	0.0038	0.0091	0.00
Hg	0.0051	0.0082	0.0016	0.0074	3.19
Tl	0.0000	0.0077	0.0000	0.0070	
Pb	0.0000	0.0101	0.0024	0.0093	0.00
U	0.0002	0.0080	0.0003	0.0074	0.67
Sum of measured species	88.9143	3.7773	95.7159	3.9868	0.93

Table 3.2.1.12. Element ratios from DRI filter samples.

Date	11-Aug-92	11-Aug-92	
Fuel	Wheat Straw	Wheat Straw	
Configuration	CRNF	CRNF	
Size Fraction	PM2.5	PM10	PM2.5/PM10
Teflon Filter ID	ABTT022	ABTT023	
Quartz Filter ID	ABTQ022	ABTQ023	
Cl-/Cl	1.32	1.17	1.13
K+/K	1.14	1.02	1.11
Sulfate S/Total S	0.97	0.88	1.10
C(org)/C	0.64	0.64	1.01
Cl/K	1.15	1.13	1.02
Cl-/K+	1.33	1.30	1.03
Cl-/Na+	85.38	72.46	1.18
S/K	0.11	0.11	1.01
S/Na+	6.42	6.20	1.04
Al/Si	1.42	0.57	2.49

Table 3.2.1.13. Emission factors (mg/kg) from DRI filter samples.

Date	11-Aug-92		11-Aug-92		
Fuel	Wheat Straw CRNF		Wheat Straw CRNF		
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT022		ABTT023		
Quartz Filter ID	ABTQ022		ABTQ023		
Start Time	8:11				
Stop Time	8:41				
Start Time					
End Time					
Elapsed Time (minutes)	30				Traverse 1
PM (mg/m^3 by total filter)					4.200
PM10 (by total filter/impactor)					4.110
PM2.5 (by total filter/impactor)					3.860
PM emission factor (%)					0.492
PM10 emission factor (%)					0.482
PM2.5 emission factor (%)					0.453
		±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 (mg/m^3)	3.080	0.162	3.150	0.166	
Teflon mass/Total mass	0.798		0.766		
	Emission (mg/kg)	±Uncertainty	Emission (mg/kg)	±Uncertainty	PM2.5/PM10
Cl-	1469.0226	109.9069	1416.5273	113.9882	1.04
NO3-	14.5558	3.5923	15.3489	3.7596	0.95
SO4=	321.0280	21.6715	320.1671	33.9376	1.00
NH4+	251.6217	16.9105	241.5643	17.4580	1.04
Na+	17.2051	1.9887	19.5487	2.2413	0.88
K+	1100.4754	75.3294	1092.0346	80.3831	1.01
C(org)	1297.7203	123.6373	1329.3084	135.1046	0.98
C(oht)	1263.6362	182.1921	1300.6299	200.9362	0.97
C(e)	730.5832	62.6544	763.6190	70.4780	0.96
C(eht)	31.9800	18.3646	49.0229	29.4791	0.65
C	2028.3035	0.0000	2092.9274	0.0000	0.97
Al	10.7347	2.0249	11.8541	2.2991	0.91
Si	7.5760	3.3069	20.8379	3.8656	0.36
P	2.1041	10.9988	2.9711	12.8357	0.71
S	110.4296	8.6568	121.2102	10.1750	0.91
Cl	1111.7094	71.9953	1206.0285	83.9644	0.92
K	965.6926	62.4596	1067.6113	74.2376	0.90
Ca	1.8749	12.3578	3.9833	14.6865	0.47
Ti	0.0866	3.3024	0.2820	3.2342	0.31
V	0.1427	1.4360	0.2115	1.4074	0.67
Cr	0.0560	0.3126	0.1158	0.3133	0.48
Mn	0.1172	0.2174	0.2266	0.1542	0.52
Fe	0.5757	0.5753	3.9581	0.6603	0.15
Co	0.0408	0.1314	0.0353	0.1494	1.16
Ni	0.0255	0.1450	0.0655	0.1446	0.39
Cu	0.1121	0.1540	0.0755	0.1494	1.48
Zn	0.6521	0.1178	0.7000	0.1205	0.93
Ga	0.0000	0.2673	0.0000	0.2603	
As	0.0000	0.3080	0.0000	0.3037	
Se	0.0000	0.1676	0.0403	0.1687	0.00
Br	4.5649	0.3216	5.1264	0.3808	0.89
Rb	0.4585	0.1133	0.4129	0.1205	1.11
Sr	0.0000	0.1540	0.1058	0.1542	0.00
Y	0.0408	0.1948	0.0504	0.1880	0.81
Zr	0.0000	0.2356	0.0101	0.2265	0.00
Mo	0.0509	0.3986	0.1309	0.3856	0.39
Pd	0.0000	1.4632	0.0000	1.4894	
Ag	0.9680	1.6897	0.8813	1.7111	1.10
Cd	0.0000	1.7848	0.8410	1.8220	0.00
In	0.0000	1.9932	0.0000	2.0148	
Sn	0.0306	2.5368	0.0000	2.5401	
Sb	0.0000	2.8811	0.5640	2.9065	0.00
Ba	0.0000	9.9434	1.8683	9.8569	0.00
La	0.0000	13.2774	0.0000	13.2887	
Au	0.0000	0.4394	0.1914	0.4386	0.00
Hg	0.2598	0.3715	0.0806	0.3567	3.22
Tl	0.0000	0.3488	0.0000	0.3374	
Pb	0.0000	0.4575	0.1209	0.4483	0.00
U	0.0102	0.3624	0.0151	0.3567	0.67
Sum of measured species	4,530	171	4,820	181	0.94

Table 3.2.1.14. Element concentrations (ng/m^3) from CNL filter samples.

Fuel:	Wheat
Date:	11-Aug-92
Time:	9:20
Filter ID:	AG-31

Element	Concentration	±Uncertainty
	ng/m^3	
H	35,230	7,800
Na	24,920	15,800
Mg	20,120	5,100
Al	23,520	8,300
Si	12,240	4,400
P		
S	32,590	2,700
Cl	402,810	21,000
K	476,960	24,500
Ca		
Ti	1,060	400
V		
Cr		
Mn		
Fe	5,930	500
Ni		
Cu	1,030	200
Zn		
As		
Pb		
Se		
Br	2,130	300
Rb		
Sr		
Zr		

Table 3.2.1.15. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Wheat
Date:	11-Aug-92
Time:	9:20
Filter ID:	AG-31
Fuel rate (g/s)	3.08
Stack gas flow rate (m^3/s)	3.20
Stack Temperature (°C)	42.54
Ambient Temperature (°C)	27.14

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	34.8	7.7
Na	24.6	15.6
Mg	19.9	5.0
Al	23.2	8.2
Si	12.1	4.3
P		
S	32.2	2.7
Cl	398.1	20.8
K	471.4	24.2
Ca		
Ti	1.0	0.4
V		
Cr		
Mn		
Fe	5.9	0.5
Ni		
Cu	1.0	0.2
Zn		
As		
Pb		
Se		
Br	2.1	0.3
Rb		
Sr		
Zr		

Table 3.2.1.16. Relative element concentrations by stage from DRUM impactor.

Stage 1: 10 - 15 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	2,256.25	157.17	7.6723	1
S	222.44	33.52	0.7564	1
Cl				
K	294.08	41.35	1.0000	1
Ca				
Ti	48.14	15.39	0.1637	1
V	64.45	19.04	0.2192	1
Cr				
Mn				
Fe				
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.2.1.17. Relative element concentrations by stage from DRUM impactor.

Stage 2: 5 - 10 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	827.27	75.39	3.3432	0.3667
S	143.92	35.87	0.5816	0.6470
Cl				
K	247.45	38.61	1.0000	0.8414
Ca	199.21	39.39	0.8051	
Ti			0.0000	
V			0.0000	
Cr	38.87	15.13	0.1571	
Mn	55.07	13.04	0.2226	
Fe	215.53	24.26	0.8710	
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.2.1.18. Relative element concentrations by stage from DRUM impactor.

Stage 3: 2.5 - 5 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	366.23	51.52		0.1628
S	137.32	35.48		0.6173
Cl	65.88	22.04		
K				
Ca				
Ti	135.38	37.17		2.8120
V	52.27	19.04		0.8110
Cr	51.68	12.26		
Mn	43.19	11.09		
Fe	419.40	39.26		
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.2.1.19. Relative element concentrations by stage from DRUM impactor.

Stage 4: 1.15 - 2.5 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	407.02	64.7	2.1622	
Na				
Mg				
Al				
Si				
S	89.39	27.78	0.4748	0.4018
Cl	154.42	32.35	0.8203	
K	188.24	44.09	1.0000	0.6401
Ca	73.25	24.52	0.3891	
Ti				
V	144.50	27.91	0.7676	2.2421
Cr	49.34	15.91	0.2621	
Mn	87.27	21.65	0.4636	
Fe	100.79	24.91	0.5354	
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.2.1.20. Relative element concentrations by stage from DRUM impactor.

Stage 5: 0.56 - 1.15 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	227.99	57.39	0.6913	0.1010
S				
Cl	339.55	70.83	1.0295	
K	329.82	40.83	1.0000	1.1215
Ca				
Ti				
V	75.72	18.13	0.2296	1.1749
Cr				
Mn	37.60	9.52	0.1140	
Fe	101.80	26.09	0.3087	
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.2.1.21. Relative element concentrations by stage from DRUM impactor.

Stage 6: 0.34 - 0.56 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	1,134.55	143.87	0.1270	
Na				
Mg				
Al	124.13	36.39	0.0139	
Si				
S				
Cl	6,543.77	365.09	0.7322	
K	8,936.71	483.65	1.0000	30.3889
Ca				
Ti				
V				
Cr				
Mn	50.86	12.39	0.0057	
Fe				
Ni				
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb	104.53	30.00	0.0117	

Table 3.2.1.22. Relative element concentrations by stage from DRUM impactor.

Stage 7: 0.24 - 0.34 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	716.73	277.83		
Na				
Mg				
Al				
Si				
S				
Cl	207.86	48.78		
K				
Ca	84.12	28.30		
Ti				
V				
Cr	84.99	18.52		
Mn				
Fe	29.06	7.83		
Ni	24.67	8.09		
Cu				
Zn				
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.2.1.23. Relative element concentrations by stage from DRUM impactor.

Stage 8: < 0.24 μm

	11-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H	1,324.42	286.70	0.3823	
Na				
Mg				
Al				
Si	73.70	29.74	0.0213	0.0327
S				
Cl	2,488.10	160.83	0.7182	
K	3,464.13	209.48	1.0000	11.7796
Ca				
Ti				
V				
Cr	35.41	15.00	0.0102	
Mn	16.59	9.13	0.0048	
Fe	49.84	11.09	0.0144	
Ni			0.0000	
Cu	581.57	42.26	0.1679	
Zn	371.07	34.43	0.1071	
As				
Se				
Br				
Rb				
Sr				
Pb				

Table 3.2.1.24
VOC Concentrations (ppbv)

Date	11-Aug-92	11-Aug-92
Fuel	Wheat Straw	Wheat Straw
Traverse	Traverse 1	Traverse 2
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	33.7	24.5
Dimethylbutane		
Hexane		
Phenol	12.1	2.3
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	9.7	7.9
Benzonitrile		
Benzaldehyde	6.9	2.2
Methylphenol (hydroxy toluene)		
Styrene	17.5	20.2
Xylene	9.2	5
Trimethylpentane		
Benzofuran	3.4	1.1
Methoxymethylphenol (creosol)		
Naphthalene	11.7	1.1
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)	14.8	6.3

Table 3.2.1.25
VOC Emission Factors (mg/kg)

Date	11-Aug-92	11-Aug-92
Fuel	Wheat Straw	Wheat Straw
Traverse	Traverse 1	Traverse 2
Fuel Consumption Rate (g/s d.b)	2.40	3.08
Stack Gas Mass Flow Rate (kg/s)	3.47	3.58
Acetic acid		
Propanone (acetone)		
Methyl ester acetic acid (methylacetate)		
Butane		
Dimethyloxirane		
Pentene		
Methylbutanone (isopropylmethyl ketone)		
Furancarboxaldehyde (furfural)		
Benzene	131	77
Dimethylbutane		
Hexane		
Phenol	57	9
Dimethylfuran		
2-methyl 2-cyclopenten-1-one		
2-chloro phenol		
Toluene	45	29
Benzonitrile		
Benzaldehyde	37	9
Methylphenol (hydroxy toluene)		
Styrene	91	84
Xylene	49	21
Trimethylpentane		
Benzofuran	20	5
Methoxymethylphenol (creosol)		
Naphthalene	75	6
Unknown		
Alpha-pinene		
Camphene		
Δ3-Carene		
Limonene		

Table 3.2.1.26. PAH emission factors, wheat straw, 11 August 1992 (zero indicates not detected).

	Traverse 1 Filter	Traverse 2 Filter	Trap/Tubing	Traverse 1 Sorbent	Traverse 2 Sorbent	Impinger Rinsate	Total Traverse 1	Total Traverse 2	Total Average
					µg/kg dry fuel				
Naphthalene	49	95	37	669,189	26,498	36	669,311	26,666	347,988
2-Methyl-naphthalene	10	32	0	493	942	6	508	981	745
Acenaphthylene	28	85	0	3,542	531	2	3,572	618	2,095
Acenaphthene	0	21	0	0	6	0	0	27	13
Fluorene	4	7	0	533	95	13	551	115	333
Phenanthrene	246	276	48	2,920	2,100	158	3,372	2,582	2,977
Anthracene	55	63	0	987	540	47	1,090	650	870
Fluoranthene	532	434	55	669	549	58	1,314	1,095	1,205
Pyrene	464	377	75	509	496	74	1,121	1,022	1,071
Benz[a]-anthracene	285	274	0	0	72	12	297	358	327
Chrysene	400	252	0	0	77	47	447	377	412
Benzo[b]-fluoranthene	506	124	0	0	12	0	506	136	321
Benzo[k]-fluoranthene	274	326	0	0	0	0	274	326	300
Benzo[a]pyrene	237	78	0	0	0	0	237	78	158
Benzo[e]pyrene	144	221	0	0	0	0	144	221	182
Perylene	0	16	0	0	0	0	0	16	8
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	3,236	2,681	215	678,843	31,918	453	682,746	35,266	359,006

Figure 3.2.1.1. Ambient air conditions, 11 August 92.

Fuel Type: Wheat Straw
Configuration: CRNF

Test Date 11-Aug-92

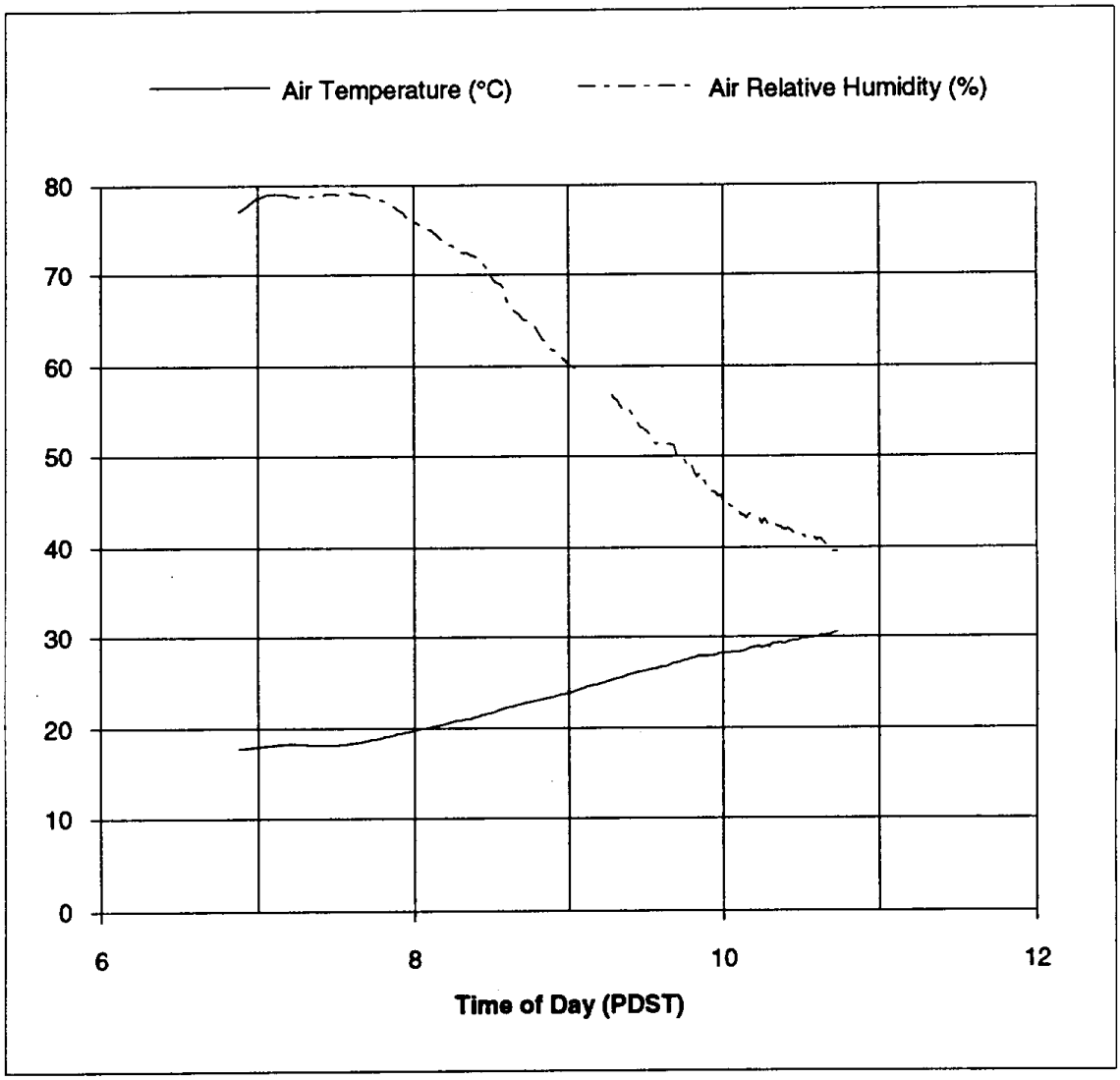

Figure 3.2.1.2. Air temperature and relative humidity from CIMIS station.

Fuel: Wheat Straw Date of Test: 11-Aug-92

Configuration: CRNF

Hourly Average CIMIS Data for Davis, California

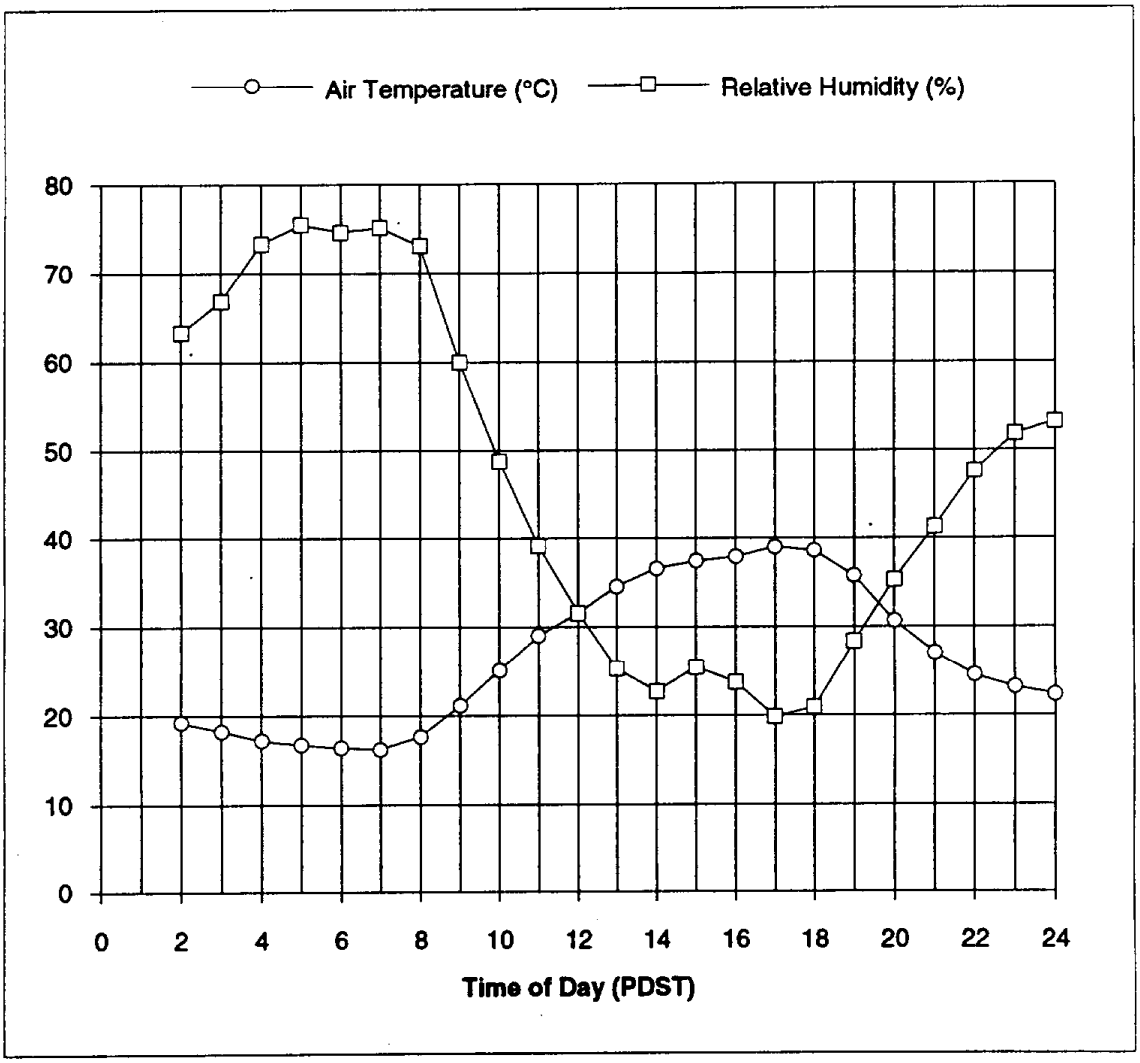

Figure 3.2.1.3. Wind speed from CIMIS station.

Fuel: Wheat Straw Date of Test: 11-Aug-92

Configuration: CRNF

Hourly Average CIMIS Data for Davis, California

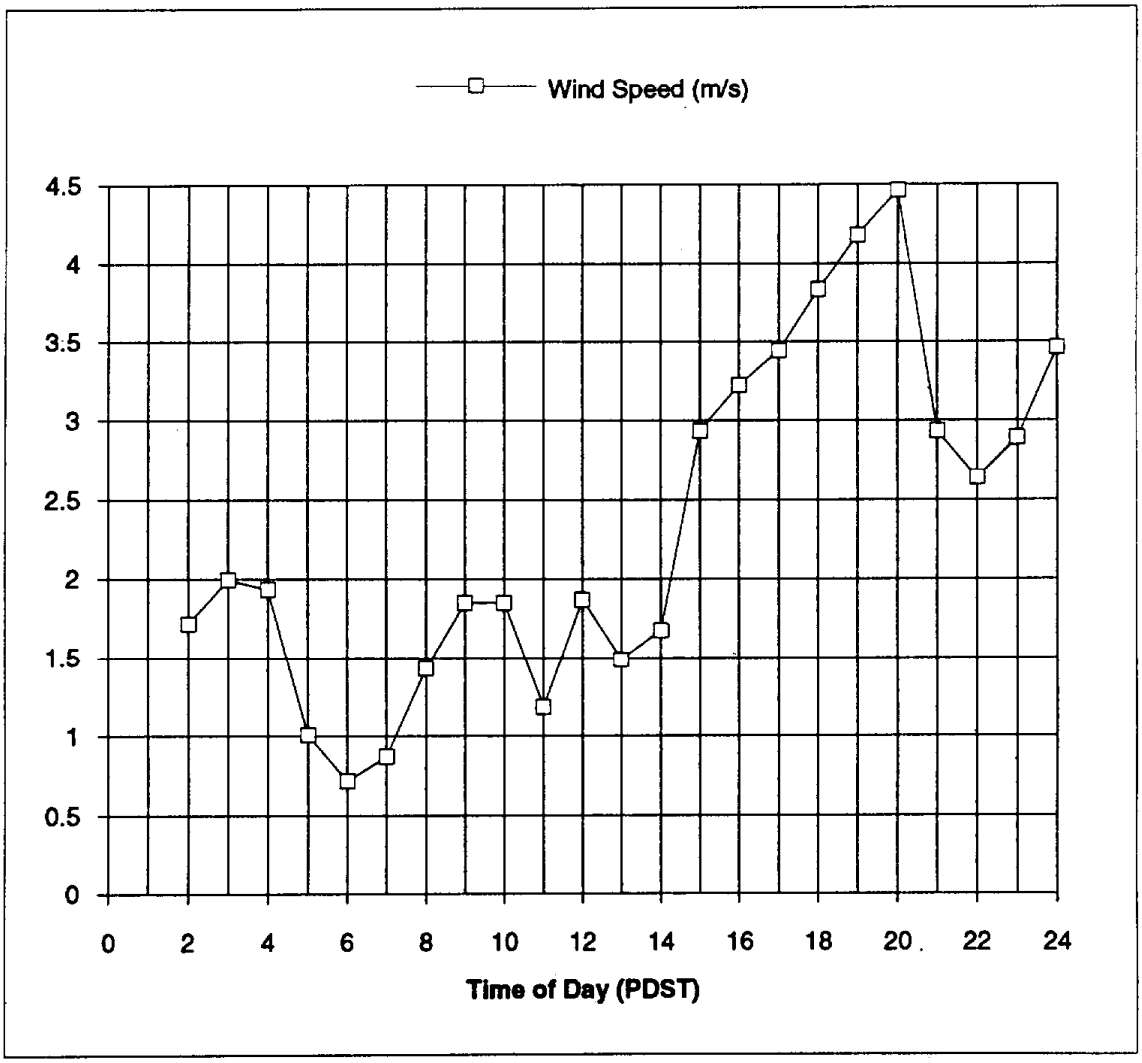

Figure 3.2.1.4. Wind direction and solar radiation from CIMIS station.

Fuel: Wheat Straw Date of Test: 11-Aug-92

Configuration: CRNF

Hourly Average CIMIS Data for Davis, California

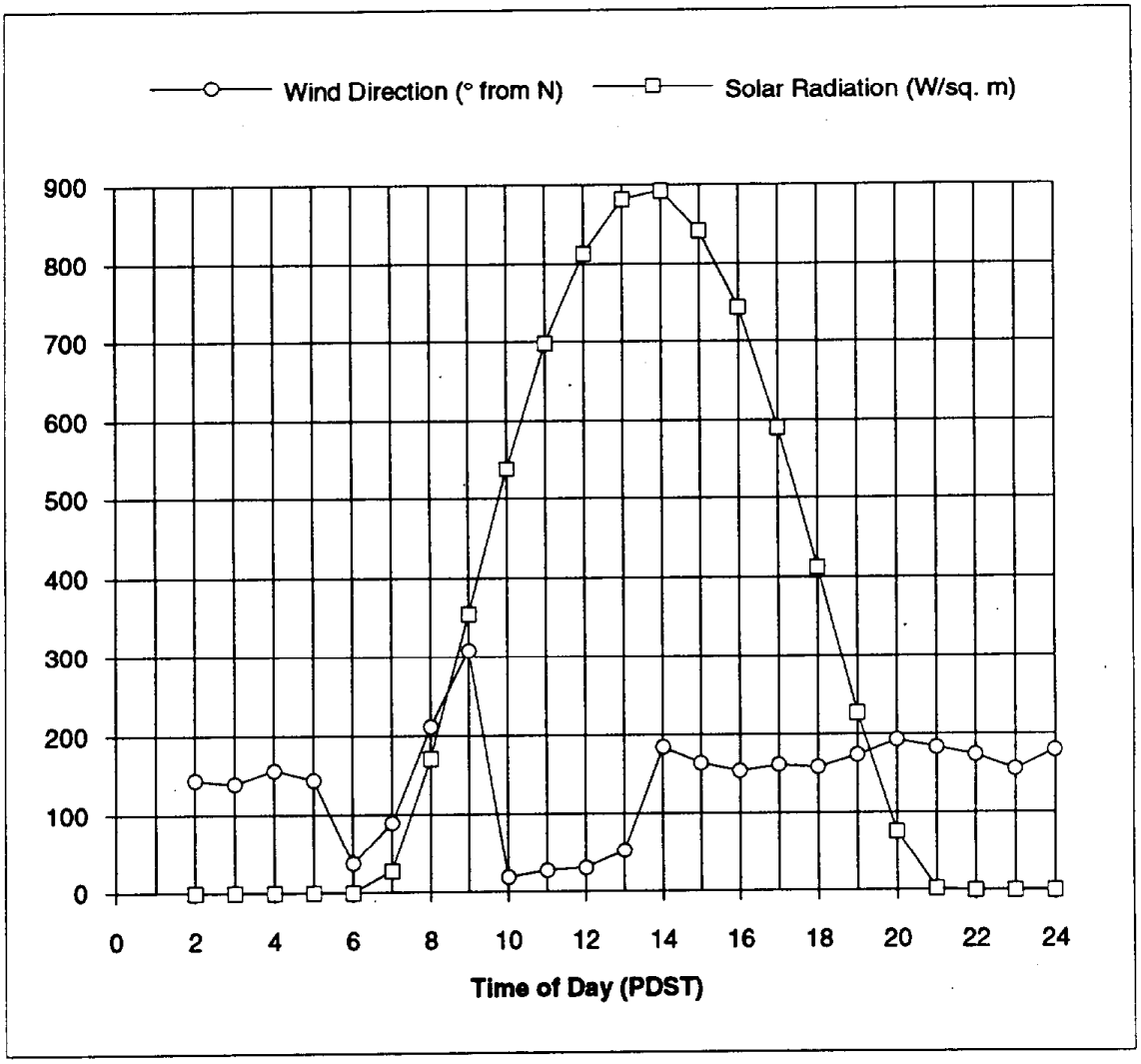

Figure 3.2.1.5. Inlet air, stack gas, and impinger temperatures, 11 August 92.

Fuel Type:	Wheat Straw	Test Date	11-Aug-92
Configuration:	CRNF		

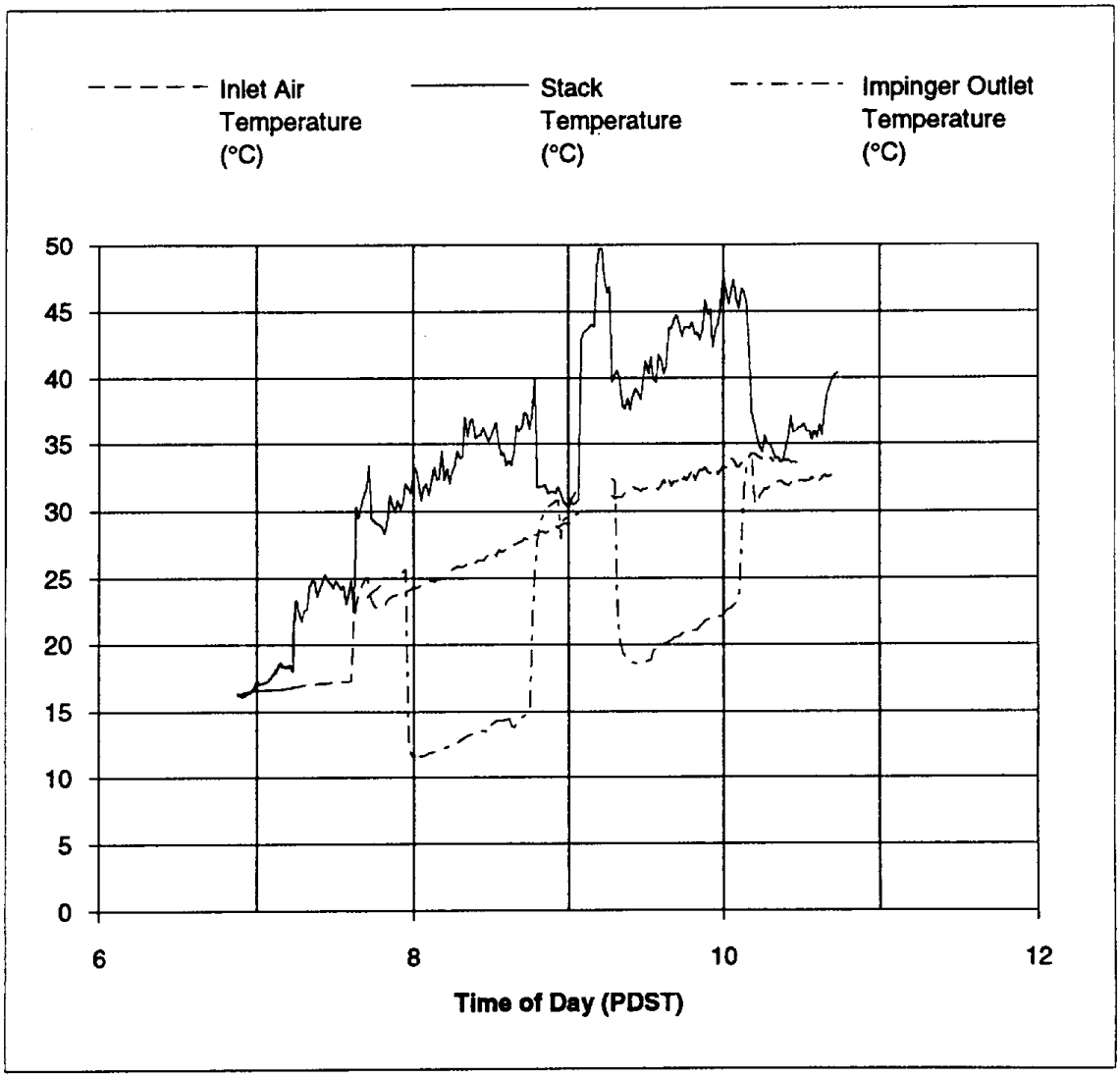

Figure 3.2.1.6. Conveyor speed and stack gas velocity, 11 August 92.

Fuel Type:	Wheat Straw	Test Date	11-Aug-92
Configuration:	CRNF		

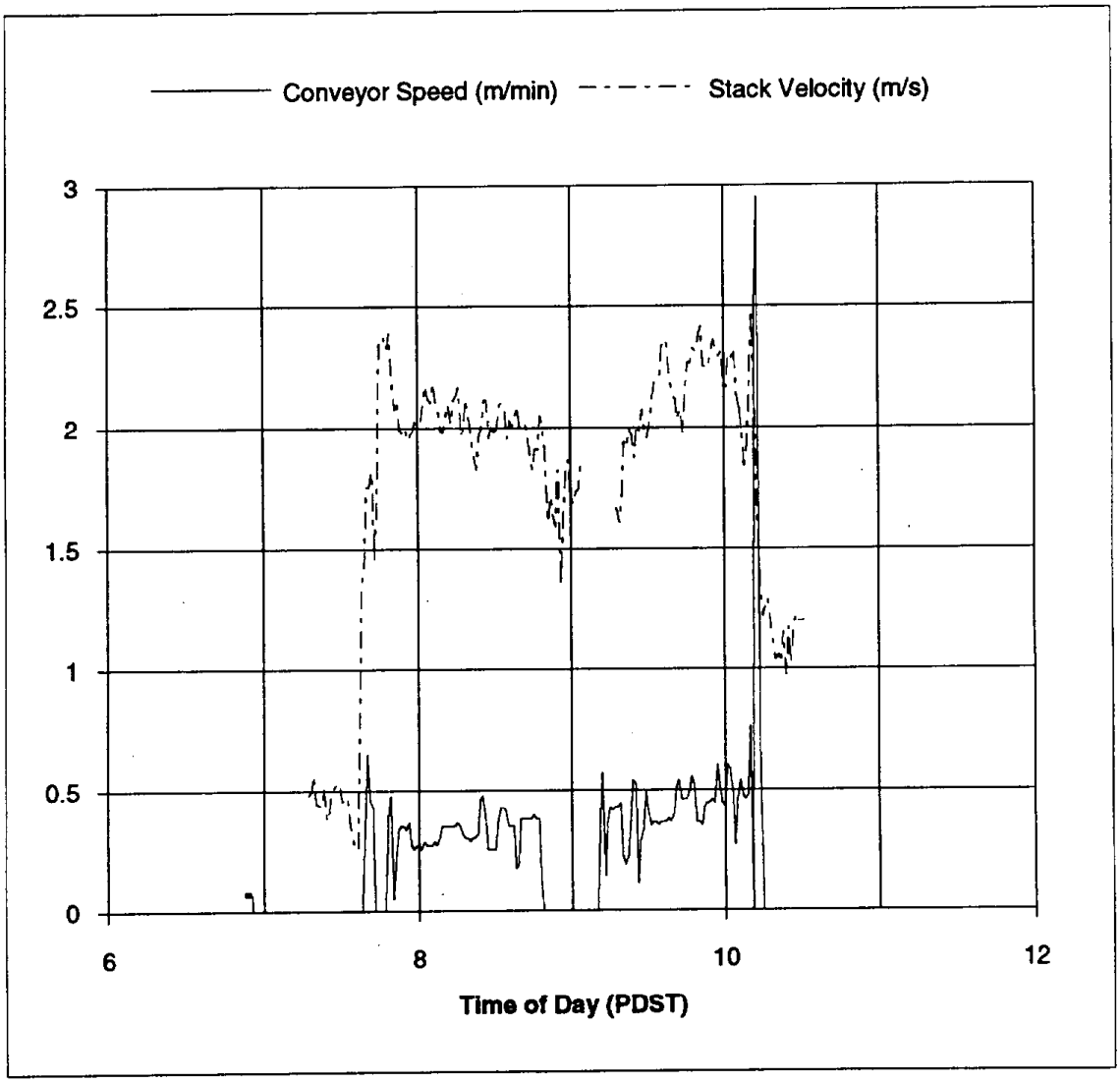

Figure 3.2.1.7. Conveyor speed with 10 min moving average, 11 August 92.

Fuel Type:	Wheat Straw	Test Date	11-Aug-92
Configuration:	CRNF		

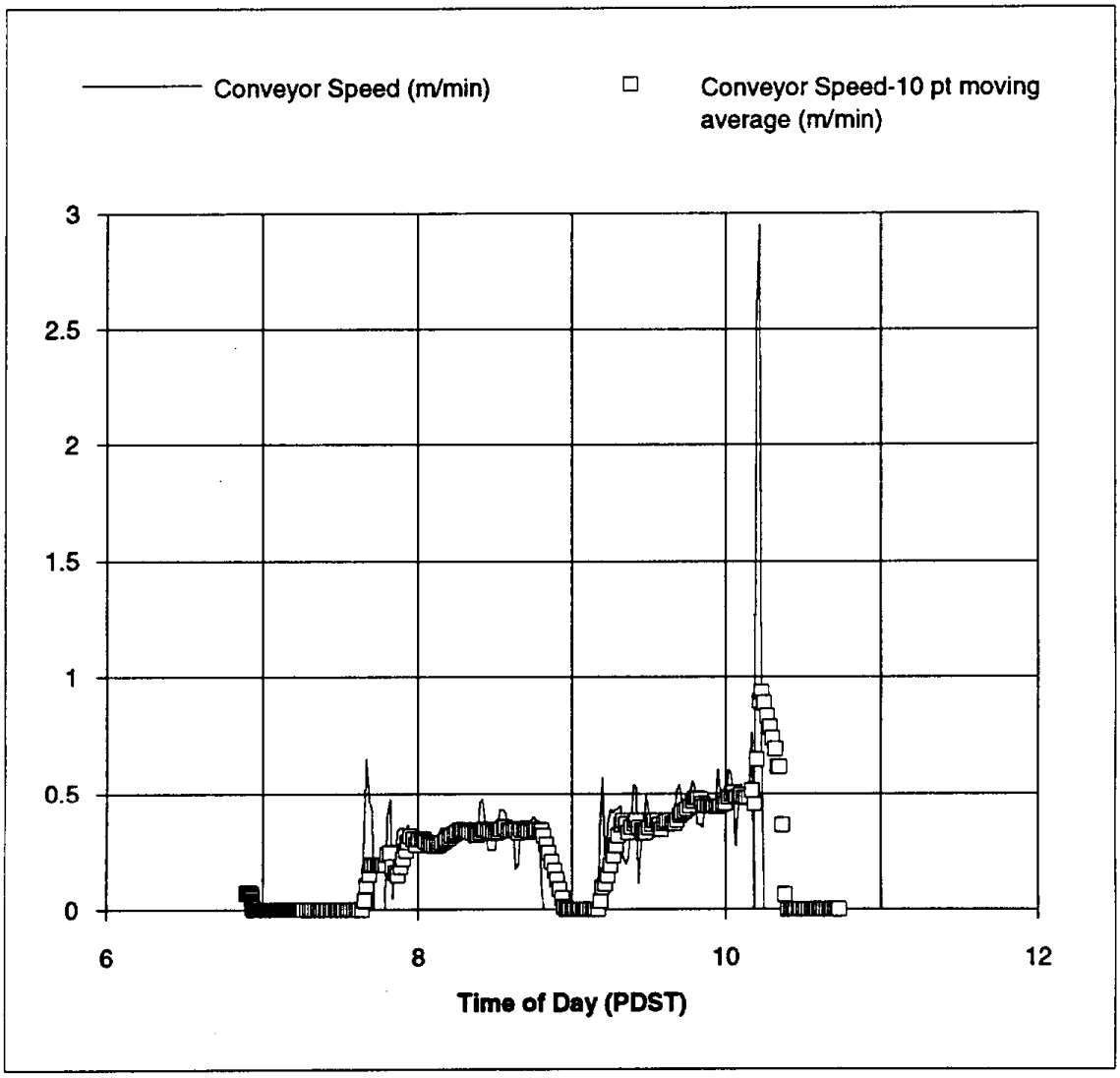

Figure 3.2.1.8. Conveyor travel, 11 August 92

Fuel Type: Wheat Straw
Configuration: CRNF

Test Date 11-Aug-92

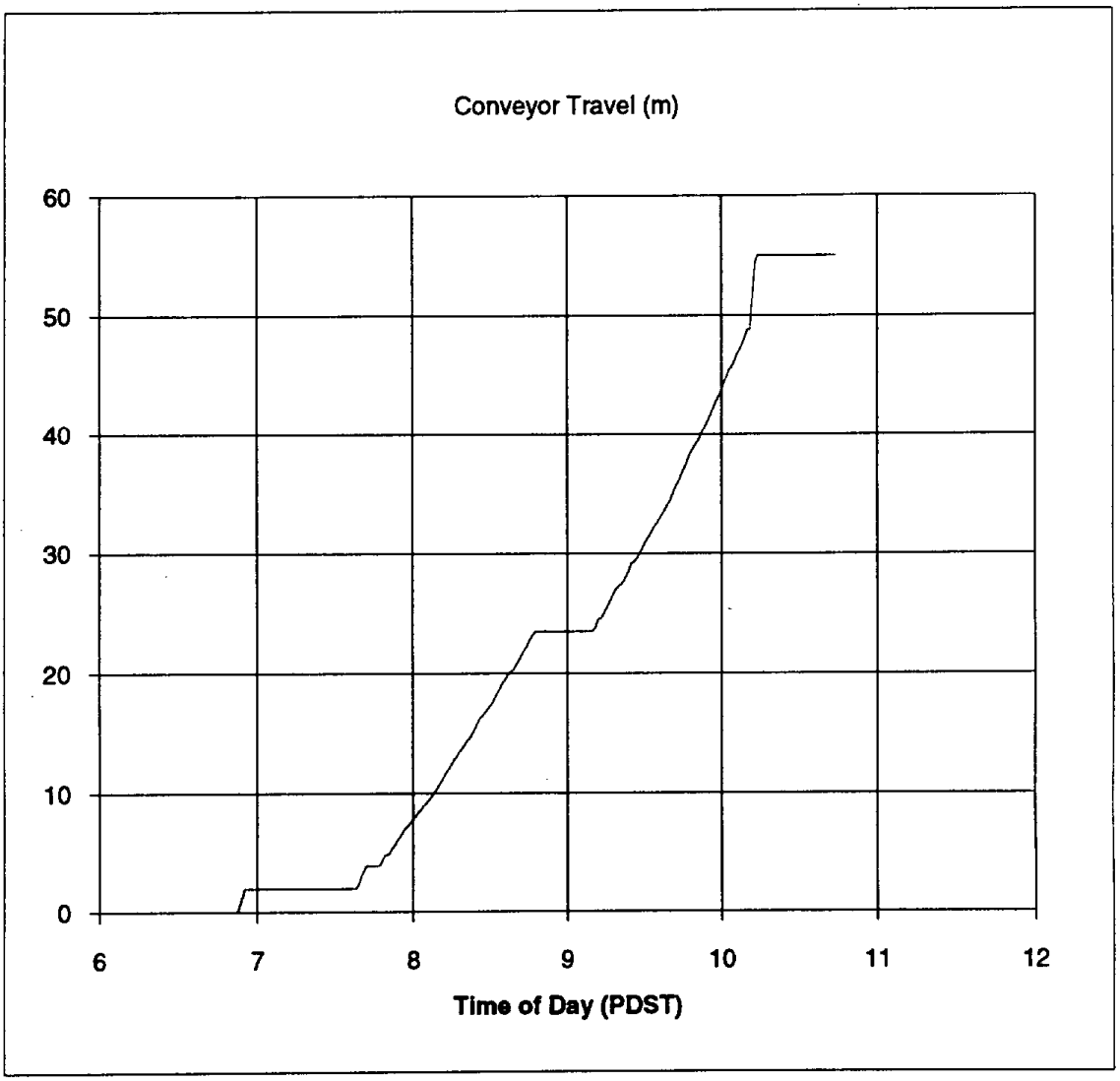

Figure 3.2.1.9. CO concentration in stack gas, 11 August 92.

Fuel Type: Wheat Straw
Configuration: CRNF

Test Date 11-Aug-92

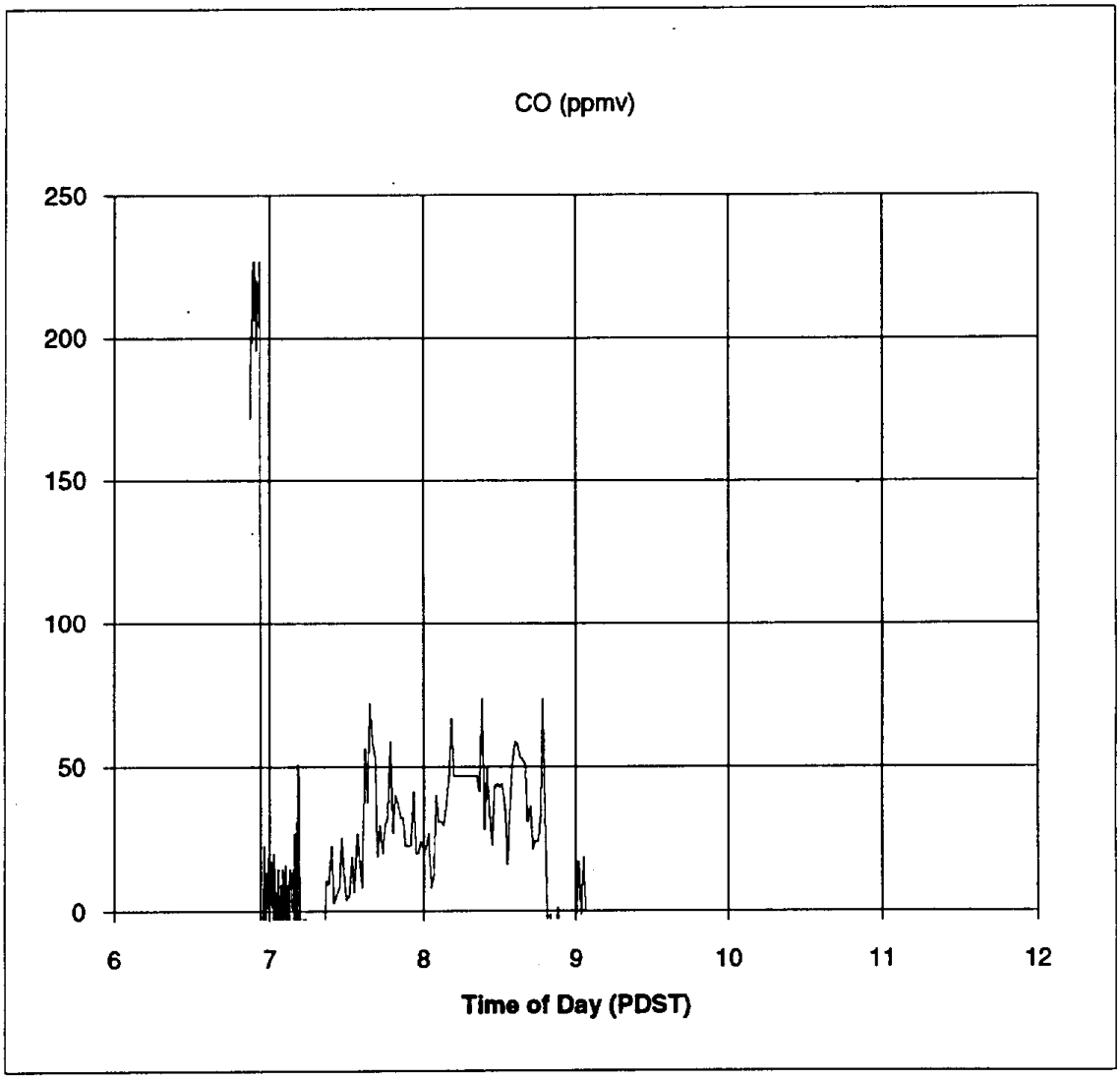

Figure 3.2.1.10. NO and NOx concentrations in stack gas, 11 August 92.

Fuel Type: Wheat Straw
Configuration: CRNF

Test Date 11-Aug-92

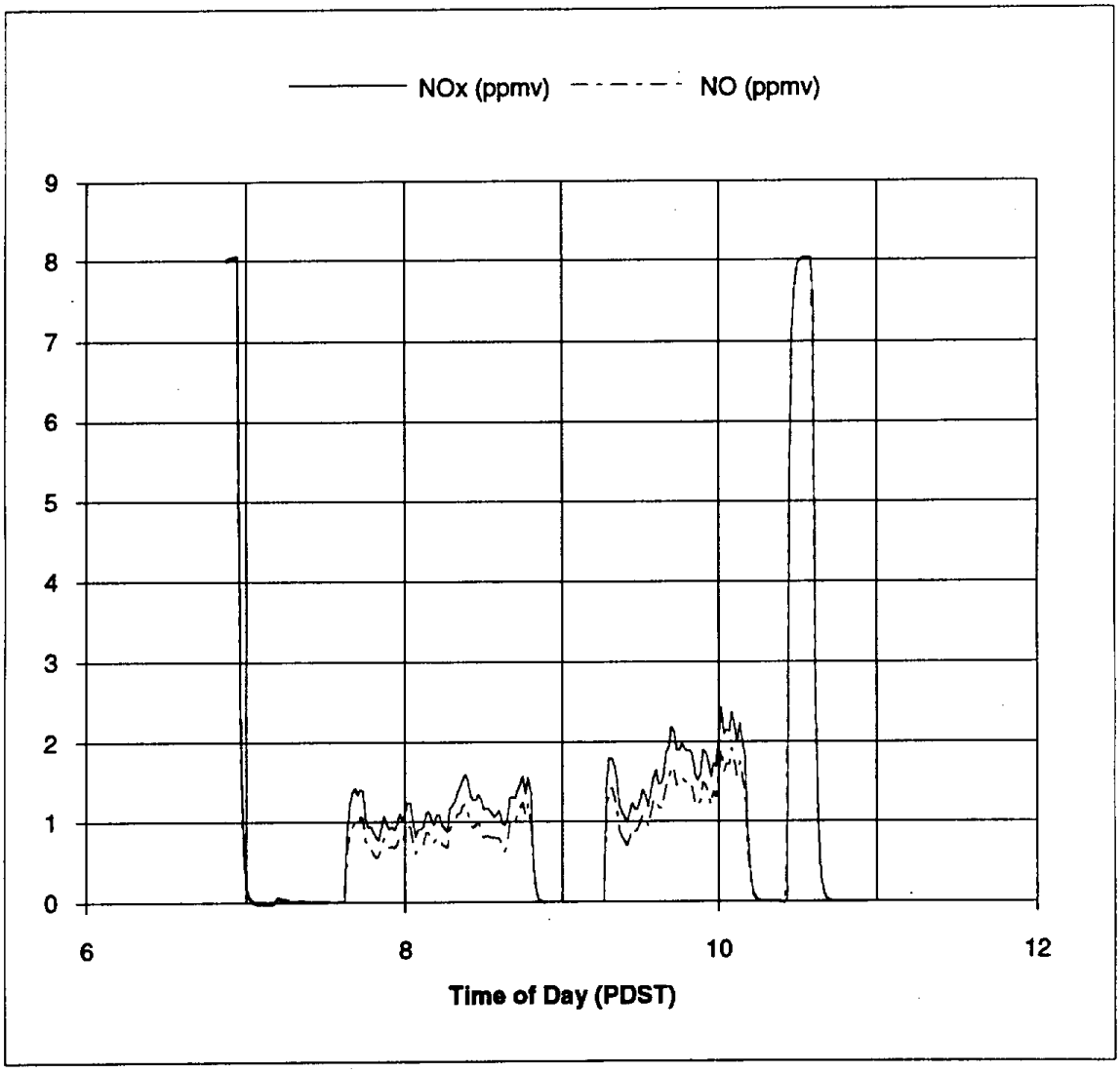

Figure 3.2.1.11. SO2 concentration in stack gas, 11 August 92.

Fuel Type:	Wheat Straw	Test Date	11-Aug-92
Configuration:	CRNF		

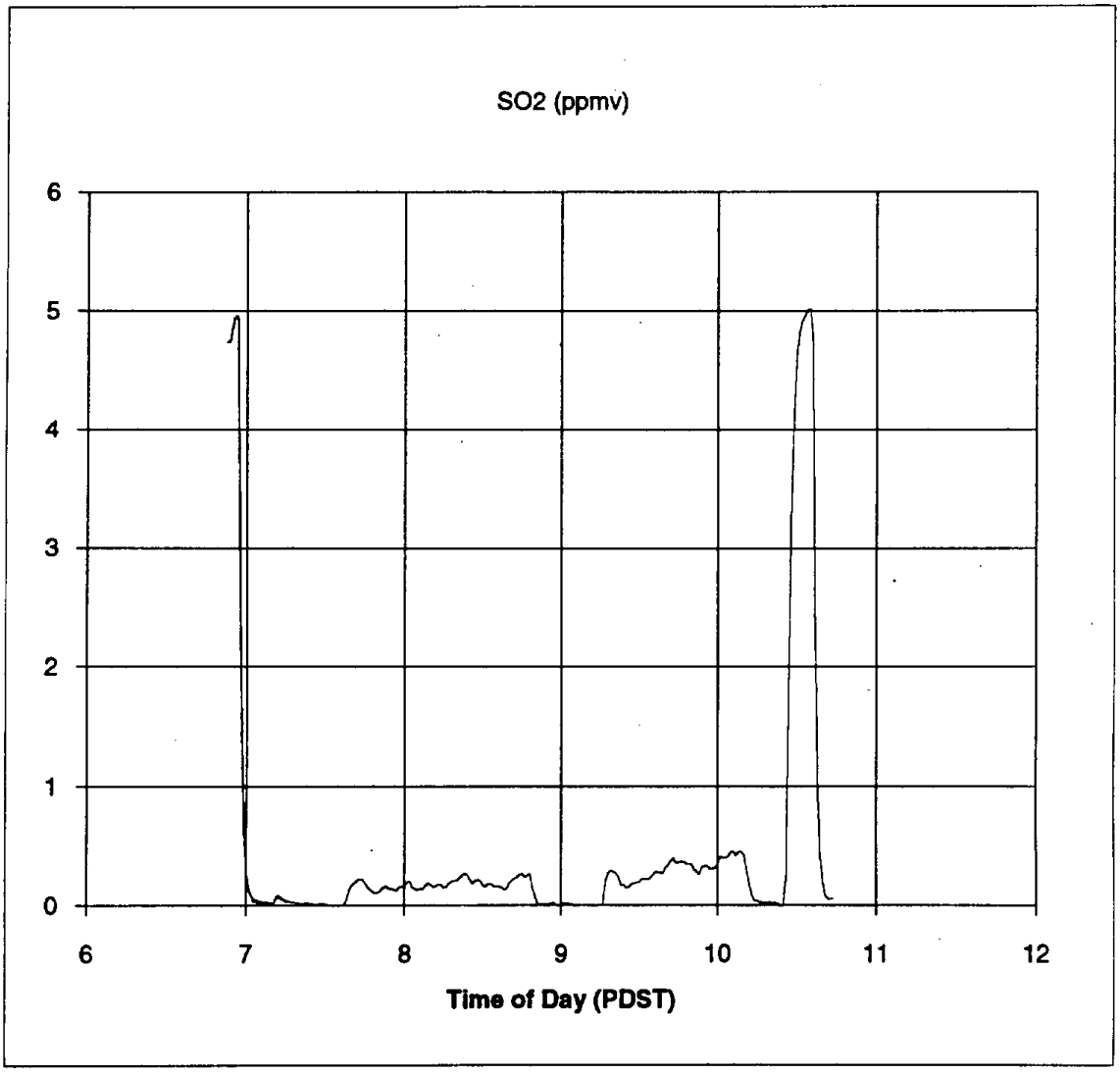

Figure 3.2.1.12. Total sulfur concentration in stack gas, 11 August 92.

Fuel Type:	Wheat Straw	Test Date	11-Aug-92
Configuration:	CRNF		

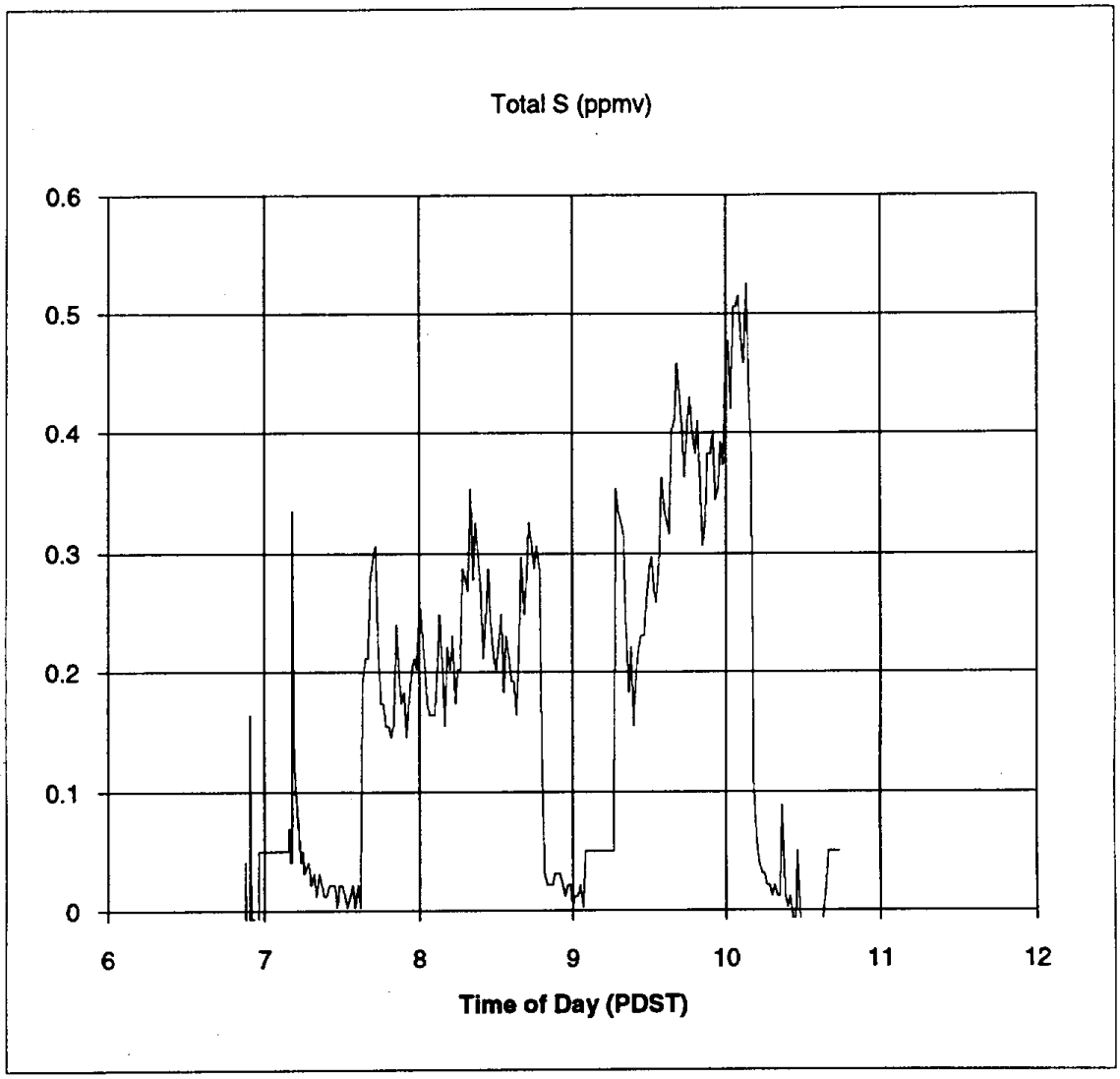

Figure 3.2.1.13. THC concentration in stack gas, 11 August 92.

Fuel Type:	Wheat Straw	Test Date	11-Aug-92
Configuration:	CRNF		

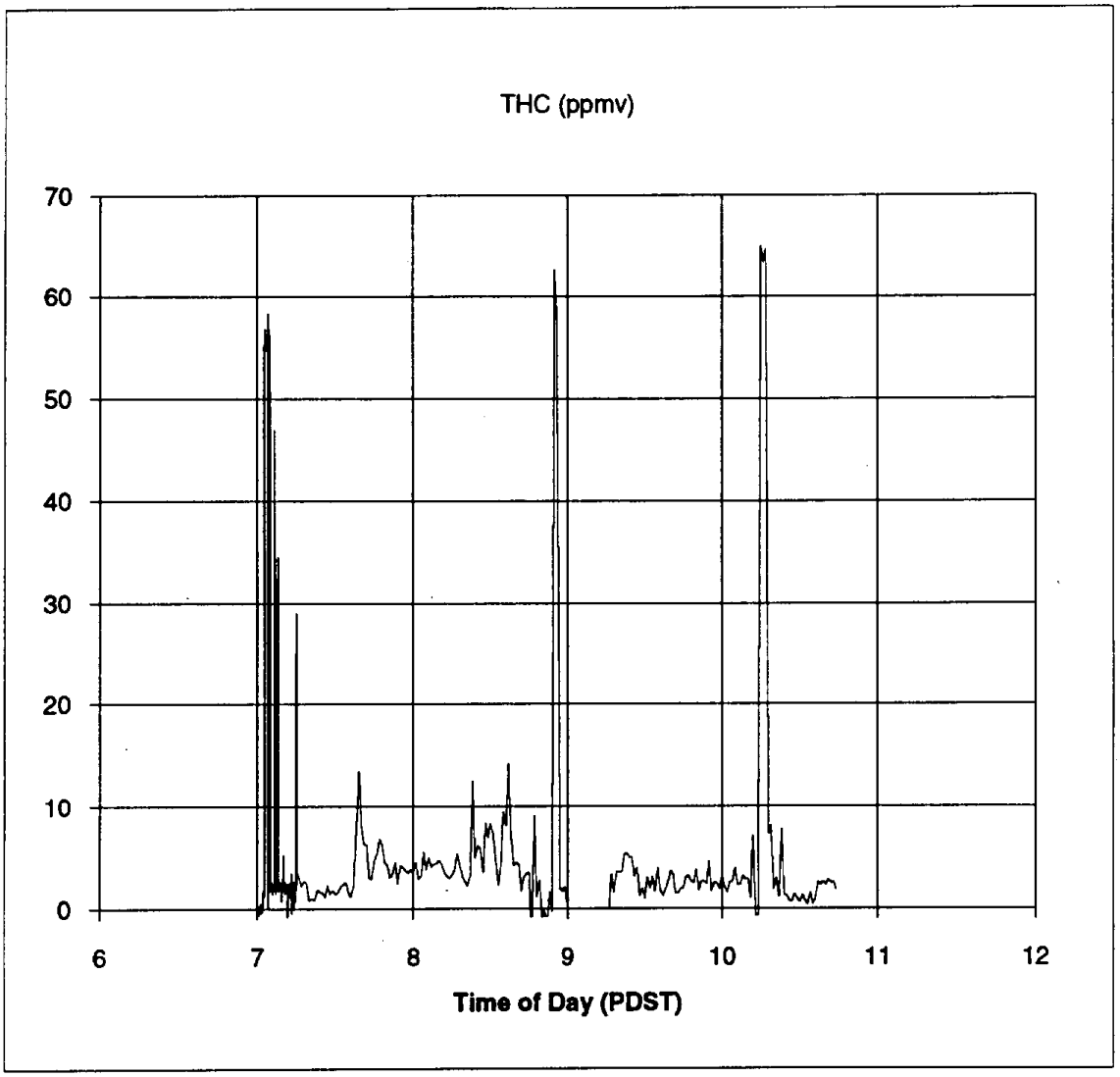

Figure 3.2.1.14. Particle size distribution, traverse 1, 11 August 92.

Fuel: Wheat Straw

Date of Test: 11-Aug-92
Configuration: CRNF

Particle Size Distribution
Traverse 1:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.47	0.1	3.6	1.000
2	7.55	0.1	3.5	0.972
3	4.02	0.1	3.4	0.944
4	2.13	0.1	3.3	0.917
5	1.22	0.1	3.2	0.889
6	0.72	0.3	3.1	0.861
7	0.38	0.4	2.8	0.778
filter	0.00	2.4	2.4	0.667

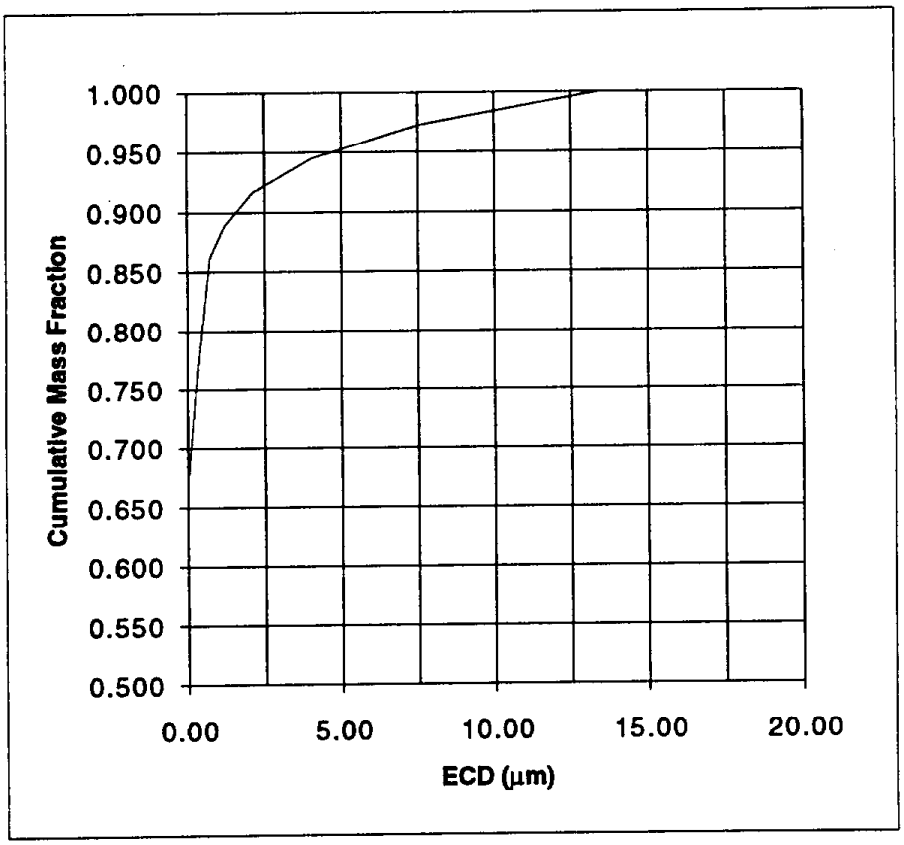

Figure 3.2.1.15. Particle size distribution, traverse 2, 11 August 92.

Fuel: Wheat Straw

Date of Test: 11-Aug-92
Configuration: CRNF

Particle Size Distribution
Traverse 2:

Stage	ECD (μm)	Weight (mg)	Cum. Wt (mg)	Cum. Fraction
1	13.28	0.1	4.2	1.000
2	7.44	0.1	4.1	0.976
3	3.97	0.1	4.0	0.952
4	2.10	0.2	3.9	0.929
5	1.21	0.1	3.7	0.881
6	0.71	0.3	3.6	0.857
7	0.37	0.3	3.3	0.786
filter	0.00	3.0	3.0	0.714

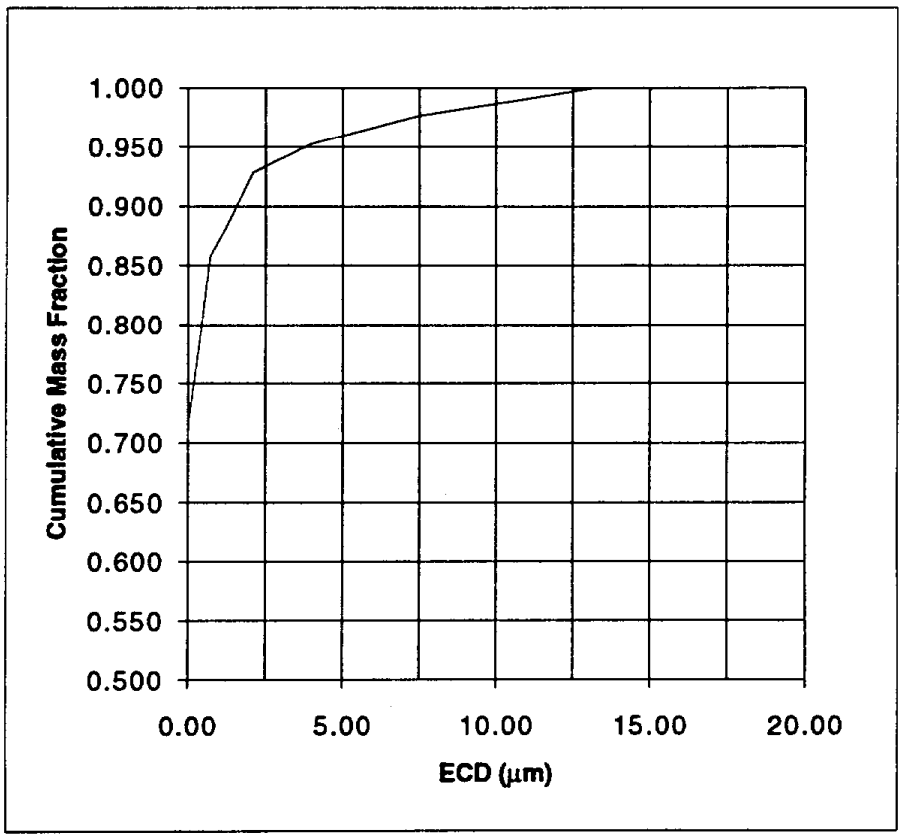

Figure 3.2.1.16. Nitrogen balance.
Date of Test: 11-Aug-92
Fuel Wheat Straw

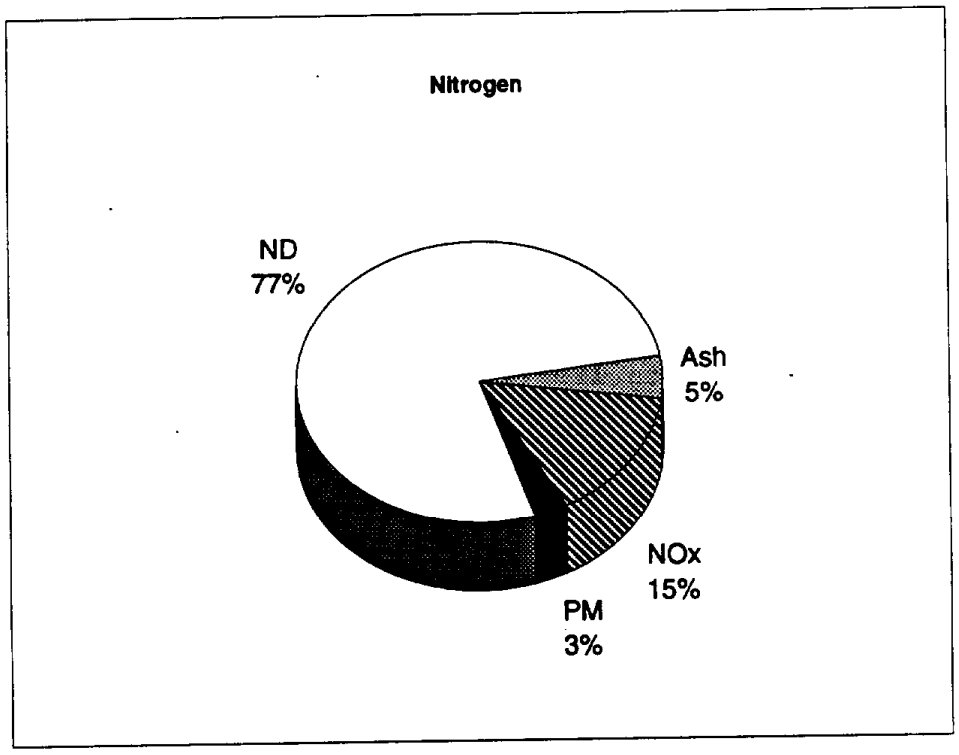

Figure 3.2.1.17. Sulfur balance.
Date of Test: 11-Aug-92
Fuel Wheat Straw

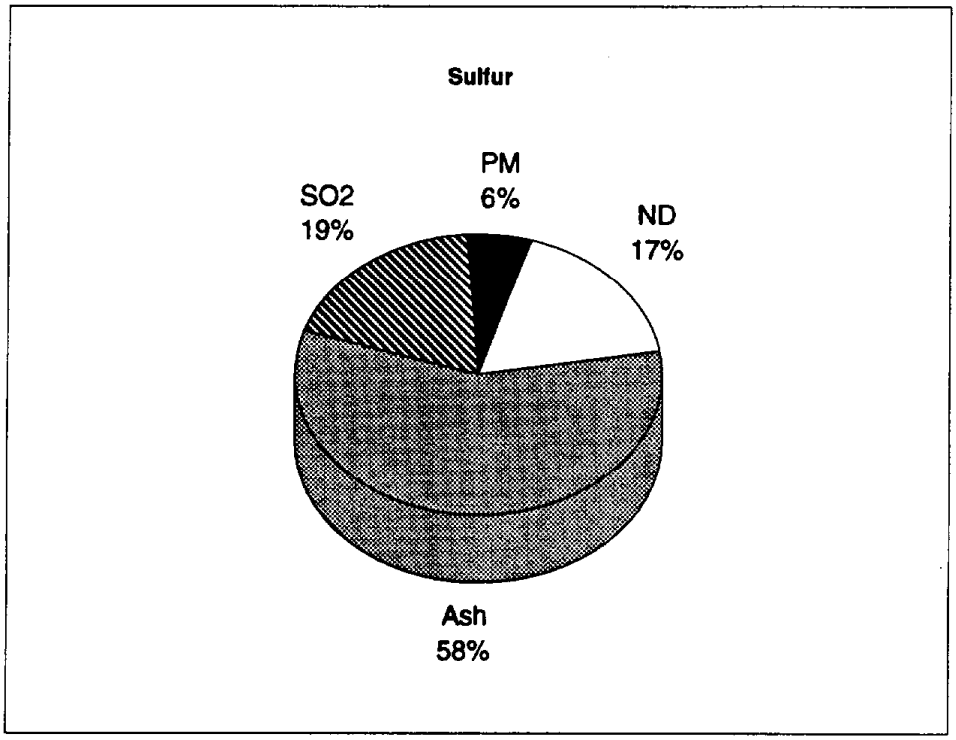

Figure 3.2.1.18. Relative abundance of major elements from DRUM impactor, Wheat Straw, 11 August 92, (CRNF).

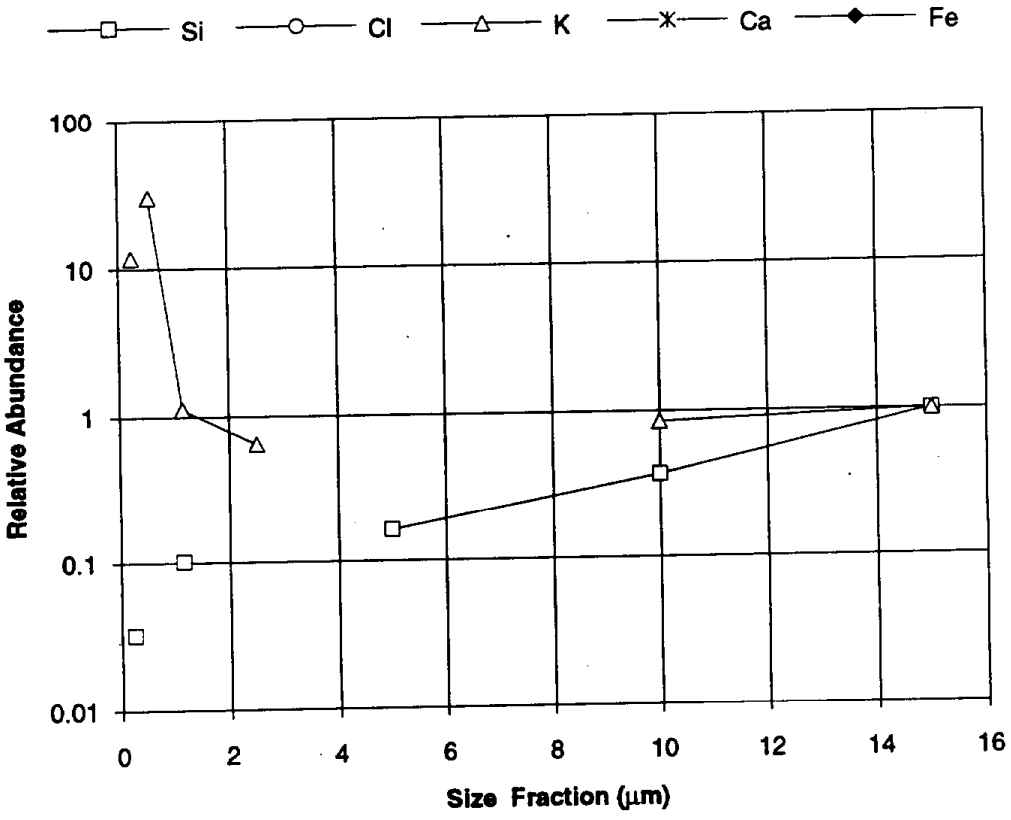

Figure 3.2.1.19. Mass fraction of PAH on primary filter samples, 11 August 1992, wheat straw.

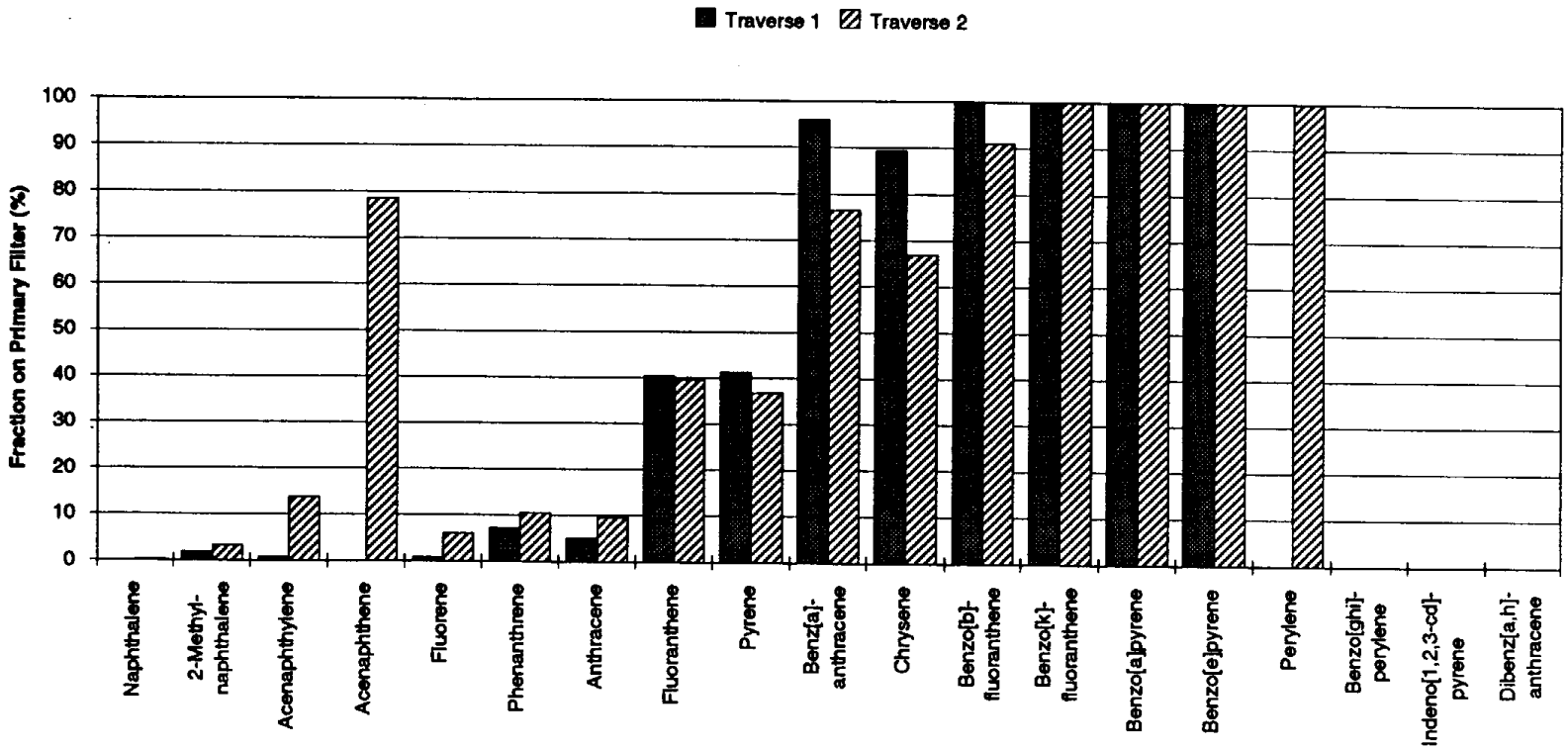

Table 3.2.2.1

Fuel and Ash Analyses

Run Date	13-Aug-92	13-Aug-92
Fuel Type	Wheat Straw	Wheat Straw
Sample Type	Fuel	Ash
Ultimate Analysis		
(% dry weight)		
C	43.84	17.06
H	5.80	0.92
N	0.52	0.36
Elemental Analysis		
(% by weight dry basis)		
N	0.66	0.46
P	0.05	0.23
K	1.87	14.97
Ca	0.06	0.37
Mg	0.10	0.30
Na	0.06	0.25
Cl	0.27	1.08
(mg/kg dry weight)		
S	1,870	6,690
B	6	39
Zn	15	51
Mn	23	88
Fe	217	768
Cu	1	11
Si		
Total (% dry weight)	52.92	36.41
Proximate Analysis		
(% dry weight)		
Ash	9.51	80.21
Volatiles	75.50	14.86
Fixed Carbon	14.98	4.92
Higher Heating Value		
(MJ/kg dry weight)	17.5369	5.3845

Table 3.2.2.2. Operating conditions and concentrations, 13 August 92.

Fuel:	Wheat Straw	Date of Test:	13-Aug-92
		Configuration:	CEWF

Fuel Loading Rate (g/sq.m w.b.):	389
Total Fuel Consumption (kg w.b.)	25.1
Total Ash Recovered (kg w.b.)	2.9
Ash Fraction (w.b.)	0.11

	Traverse 1	Traverse 2
Mean Values		
Air Temperature (°C)	23.03	24.30
Air Relative Humidity (%)	80.92	68.95
Inlet Air Temperature (°C)	23.76	27.05
Stack Temperature (°C)	26.37	31.40
Impinger Outlet Temperature (°C)	15.59	19.63
Fire Spreading Rate (m/min)	0.24	0.31
Stack Gas Velocity (m/s)	3.02	2.68
Gas and PM Concentrations (less background)		
CO (ppmv)	36.84	38.79
NO (ppmv)	0.25	0.30
NOx (ppmv)	0.39	0.48
SO2 (ppmv)	0.04	0.05
THC (ppmv as CH4)	8.76	6.98
HC (ppmv as CH4 by GC)	5.18	5.98
CH4 (ppmv by GC)	2.13	2.56
NMHC (ppmv as CH4)	6.63	4.42
NMHC (ppmv as CH4 by GC)	3.05	3.42
CO2 (ppmv by GC)	245	277
Total S (ppmv as SO2)	0.05	0.06
PM (mg/cu.m)	3.44	3.47
PM10 (mg/cu.m)	3.44	3.38
PM2.5 (mg/cu.m)	3.23	3.26

Table 3.2.2.3. Mass balance, wheat straw, 13 August 92.

Fuel: Wheat Straw

Date of Test: 13-Aug-92

Configuration: CEWF

Mass Balance

	Traverse 1	Traverse 2
Total Conveyor Travel (m)	11.64	14.72
Fuel Moisture Content (% w.b.)	7.0	7.4
Fuel Loading Rate (g/sq.m d.b.)	362	361
Total Fuel Consumption (g w.b.)	5,525	6,987
Total Fuel Consumption (g d.b.)	5,138	6,470
Residual Ash (g w.b.)	635	803
Fuel Vaporized (g w.b.)	4,890	6,184
Fuel Consumption Rate (g/s w.b.)	1.92	2.43
Fuel Consumption Rate (g/s d.b.)	1.78	2.25
Ash Generation Rate (g/s w.b.)	0.22	0.28
Fuel Vaporization Rate (g/s w.b.)	1.70	2.15
Stack Gas Density (kg/cu.m)	1.1800	1.1605
Stack Gas Flow Rate (cu.m/s)	4.49	3.98
Stack Gas Mass Flow Rate (kg/s)	5.30	4.62
Inlet Air Mass Flow Rate (kg/s)	5.30	4.62
Overall Air-Fuel Ratio (w.b.)	2763.31	1904.53
Overall Air-Fuel Ratio (d.b.)	2971.30	2056.72

Table 3.2.2.4. Emission factors, wheat straw, 13 August 92 (integrated basis).

Fuel: Wheat Straw | Date of Test: 13-Aug-92 | Configuration: CEWF

Emission Factors (% fuel dry weight)

Integrated Basis

	Traverse 1	Traverse 2	Average
CO	10.576	8.479	9.527
NO	0.078	0.071	0.074
NOx (as NO2)	0.182	0.171	0.177
SO2	0.029	0.026	0.027
THC (as CH4)	1.432	0.899	1.165
HC (as CH4 by GC)	0.850	0.679	0.764
CH4 (by GC)	0.349	0.291	0.320
NMHC (as CH4)	1.082	0.608	0.845
NMHC (as CH4 by GC)	0.501	0.388	0.444
CO2 (by GC)	110.418	86.604	98.511
Total S (as SO2)	0.031	0.029	0.030
SO2/Total S	0.93	0.89	0.91
PM	0.835	0.591	0.713
PM10	0.835	0.577	0.706
PM2.5	0.785	0.556	0.671
MMAD (μm)	0.203	0.226	0.215
σ	5.358	3.331	

Table 3.2.2.5. Emission factors, wheat straw, 13 August 92 (average basis).

Fuel:	Wheat Straw	Date of Test:	13-Aug-92
		Configuration:	CEWF

Emission Factors (% fuel dry weight)

Average Basis

	Traverse 1	Traverse 2	Average
CO	10.572	7.707	9.140
NO	0.078	0.065	0.071
NOx (as NO2)	0.182	0.157	0.169
SO2	0.028	0.024	0.026
THC (as CH4)	1.436	0.792	1.114
HC (as CH4 by GC)	0.850	0.679	0.764
CH4 (by GC)	0.349	0.291	0.320
NMHC (as CH4)	1.087	0.502	0.794
NMHC (as CH4 by GC)	0.501	0.388	0.444
CO2 (by GC)	110.418	86.604	98.511
Total S (as SO2)	0.031	0.027	0.029
SO2/Total S	0.91	0.89	0.90
PM	0.835	0.591	0.713
PM10	0.835	0.577	0.706
PM2.5	0.785	0.556	0.671
MMAD (μm)	0.203	0.226	0.215
σ	5.358	3.331	

Table 3.2.2.6. Carbon balance.

Date of Test:	13-Aug-92	13-Aug-92
Fuel	Wheat Straw Traverse 1	Wheat Straw Traverse 2
Carbon Balance		
Dry Fuel Consumption Rate (g/s)	1.78	2.25
Ash Generation Rate (g/s)	0.22	0.28
Ash Fraction (% dry basis)	12.36	12.44
Fuel Carbon Concentration (%)	43.84	43.84
Residual Ash Carbon Concentration (%)	17.06	17.06
Carbon released to stack (g/s)	0.74	0.94
Maximum CO2 emission factor (%)	153.02	152.96
Stack Gas Density (kg/cubic meter)	1.18	1.16
Average CO2 concentration (ppmv)	245	277
Average CO concentration (ppmv)	36.84	38.79
Average THC concentration (ppmv as CH4)	8.76	6.98
PM Concentration (mg/cubic meter)	3.44	3.47
PM Carbon Concentration (%)	62.88	62.88
PM Carbon (mg/cubic meter)	2.16	2.18
Stack Gas Temperature (°C)	26.37	31.40
Impinger Temperature (°C)	15.59	19.63
PM molar concentration (ppm)	4.27	4.37
Estimated Average Stack Gas Velocity (m/s)	3.47	4.02
Emission Factors (% Average Basis):		
CO2	110.418	86.604
CO	10.572	7.707
THC (as CH4)	1.436	0.792
PM	0.835	0.591
Emission Factors (% Integrated Basis):		
CO2	110.418	86.604
CO	10.576	8.479
THC (as CH4)	1.432	0.899
PM	0.835	0.591
Closure (% Average Basis)	87	67
Closure (% Integrated Basis)	86	67

Table 3.2.2.7. Nitrogen balance

Date of Test:	13-Aug-92	13-Aug-92
Fuel	Wheat Straw Traverse 1	Wheat Straw Traverse 2
Nitrogen Balance		
Fuel Nitrogen Concentration (% dry weight)	0.66	0.66
Ash Nitrogen Concentration (% weight)	0.46	0.46
Emission Factors (% Average Basis):		
NOx (as NO2)	0.182	0.157
PM	0.835	0.591
Emission Factors (% Integrated Basis):		
NOx (as NO2)	0.182	0.171
NO3- Concentration of PM (% weight)	0.406	0.406
NH4+ Concentration of PM (% weight)	2.083	2.083
Nitrogen Concentration of PM (%)	1.712	1.712
Fuel Nitrogen (mg/s)	11.75	14.85
Ash Nitrogen (mg/s)	1.01	1.29
Nitrogen as NOx (mg/s Average Basis)	0.99	1.08
Nitrogen as NOx (mg/s Integrated Basis)	0.99	1.17
Nitrogen as PM (mg/s Average Basis)	0.25	0.23
Nitrogen as NOx+PM (mg/s Average Basis)	1.24	1.30
Nitrogen as NOx+PM (mg/s Integrated Basis)	1.24	1.40
NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.106	0.088
NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.106	0.094
Ash Nitrogen/Fuel Nitrogen	0.086	0.087
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Average)	0.192	0.174
Ash+NOx+PM Nitrogen/Fuel Nitrogen (Integrated)	0.192	0.181

Table 3.2.2.8. Sulfur balance.

Date of Test:	13-Aug-92	13-Aug-92
Fuel	Wheat Straw Traverse 1	Wheat Straw Traverse 2
Sulfur Balance		
Fuel Sulfur Concentration (mg/kg dry weight)	1,870	1,870
Ash Sulfur Concentration (mg/kg weight)	6,690	6,690
Emission Factors (% Average Basis)		
SO2	0.028	0.024
PM	0.835	0.591
Emission Factors (% Integrated Basis)		
SO2	0.029	0.026
Sulfur Concentration of PM (% weight)	1.310	1.310
Fuel Sulfur (mg/s)	3.33	4.21
Ash Sulfur (mg/s)	1.47	1.87
Sulfur as SO2 (mg/s Average Basis)	0.25	0.27
Sulfur as SO2 (mg/s Integrated Basis)	0.26	0.29
Sulfur as PM (mg/s Average Basis)	0.19	0.17
Sulfur as SO2+PM (mg/s Average Basis)	0.44	0.44
Sulfur as SO2+PM (mg/s Integrated Basis)	0.45	0.47
SO2+PM Sulfur/Fuel Sulfur (Average Basis)	0.133	0.106
SO2+PM Sulfur/Fuel Sulfur (Integrated Basis)	0.136	0.111
Ash Sulfur/Fuel Sulfur	0.442	0.445
Closure (% Average Basis)	58	55
Closure (% Integrated Basis)	58	56

Table 3.2.2.9. Water balance.

Estimated Stack Humidity

Fuel	Wheat Straw
Configuration	CEWF
Date of Test	13-Aug-92

	Traverse 1	Traverse 2
Ambient Air Temperature °C)	23	24
Ambient Air Relative Humidity (%)	81	69
Air Temperature (K)	296	297
Saturation Pressure (Pa)	2,816	3,039
Vapor Pressure (Pa)	2,278	2,096
Air Dew Point Temperature (°C)	19.6	18.3
Ambient Volume Fraction Water Vapor	0.0225	0.0207
Ambient Mass Fraction Water Vapor	0.0140	0.0128
Fuel Burning Rate (g/s wet basis)	1.92	2.43
Fuel Moisture Content (%)	7.0	7.4
Ash Fraction (wet basis)	0.11	0.11
Fuel Hydrogen Content (%)	5.80	5.80
Ash Hydrogen Content (%)	0.92	0.92
Moisture Evaporated (g/s)	0.13	0.18
Water of Combustion (g/s)	0.91	1.15
Total Fuel Water Added (g/s)	1.05	1.33
Inlet Air Mass Flowrate (g/s)	5,300	4,620
Inlet Air Water Vapor Flowrate (g/s)	74	59
Total Stack Water Vapor Flowrate (g/s)	75	61
Stack Gas Mass Flowrate (g/s)	5,302	4,622
Mass Fraction Water Vapor in Stack	0.0141	0.0131
Volume Fraction Water Vapor in Stack	0.0228	0.0211
Stack Vapor Pressure (Pa)	2,310	2,142
Stack Temperature (°C)	26	31
Stack Temperature (K)	300	305
Stack Saturation Pressure (Pa)	3,437	4,599
Stack Relative Humidity (%)	67	47
Stack Dew Point Temperature (°C)	19.8	18.6
Impinger Outlet Temperature (°C)	15.6	19.6
Volume Stack Gas Sampled for PM (L)	669	662
Estimated Impinger/Desiccant Weight Gain (g)	11.6	10.5

Totals:

	Estimated	Measured
Total Impinger/Desiccant Weight Gain (g)	22.1	24.1
Estimated/Measured Weight Gain	0.92	

Table 3.2.2.10. Power balance.

Date of Test: Fuel	13-Aug-92 Wheat Straw Traverse 1	13-Aug-92 Wheat Straw Traverse 2
Power Balance		
Fuel Heating Value (MJ/kg dry weight)	17.5369	17.5369
Ash Heating Value (MJ/kg dry weight)	7.2160	7.2160
Average Energy Release Rate (kW)	29.6	37.4
Products of Incomplete Combustion (kW)		
CO	1.9	1.8
THC (as CH4)	1.4	1.0
PM	0.3	0.3
Heat Release Rate (kW)	26.0	34.4
Fireline Intensity (kW/m)	21.3	28.2
Stack Gas Flow (kg/s)	5.30	4.62
Stack Gas Temperature (°C)	26.37	31.40
Inlet Temperature (°C)	23.76	27.05
Sensible Power at Top of Stack (kW)	13.9	20.2
Tunnel Dissipation (kW)	12.1	14.2

Table 3.2.2.11. Mass concentrations (%) from DRI filter samples

Date	13-Aug-92	13-Aug-92
Fuel	Wheat Straw CEWF	Wheat Straw CEWF
Size Fraction	PM2.5	PM10
Teflon Filter ID	ABTT025	ABTT026
Quartz Filter ID	ABTQ025	ABTQ026
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)	0.45	0.02	0.45	0.02
Quartz sample volume (m^3)	0.45	0.02	0.45	0.02
Teflon mass concentration (µg/m^3)	2,289	120	2,347	122

	Concentration (%)	±Uncertainty	Concentration (%)	±Uncertainty	PM2.5/PM10
Cl-	14.4052	1.2091	14.0506	1.1784	1.03
NO3-	0.3990	0.0745	0.4062	0.0731	0.98
SO4=	3.2847	0.2515	3.1214	0.2390	1.05
NH4+	2.2271	0.1751	2.0828	0.1647	1.07
Na+	0.2552	0.0366	0.2436	0.0354	1.05
K+	11.2681	0.8637	10.9906	0.8416	1.03
C(org)	48.8113	4.8718	49.7875	4.9518	0.98
C(oht)	45.8811	7.1393	47.6681	7.3937	0.96
C(e)	13.7379	1.3226	13.0966	1.2604	1.05
C(eht)	0.7379	0.4663	1.7045	1.0464	0.43
C	62.5492		62.8841		0.99
Al	0.1052	0.0291	0.1382	0.0292	0.76
Si	0.1066	0.0573	0.3298	0.0605	0.32
P	0.0518	0.1363	0.0673	0.1320	0.77
S	1.3329	0.1139	1.3098	0.1113	1.02
Cl	12.0523	0.8742	11.6431	0.8436	1.04
K	11.7150	0.8480	11.3426	0.8202	1.03
Ca	0.0330	0.1695	0.0590	0.1642	0.56
Ti	0.0001	0.0631	0.0081	0.0600	0.01
V	0.0000	0.0274	0.0010	0.0261	0.00
Cr	0.0000	0.0060	0.0007	0.0058	0.00
Mn	0.0010	0.0042	0.0040	0.0029	0.25
Fe	0.0133	0.0114	0.1050	0.0135	0.13
Co	0.0000	0.0025	0.0000	0.0031	
Ni	0.0000	0.0028	0.0006	0.0027	0.00
Cu	0.0000	0.0029	0.0011	0.0028	0.00
Zn	0.0053	0.0022	0.0067	0.0021	0.79
Ga	0.0000	0.0051	0.0009	0.0049	0.00
As	0.0000	0.0059	0.0002	0.0056	0.00
Se	0.0000	0.0032	0.0000	0.0031	
Br	0.0502	0.0043	0.0458	0.0040	1.10
Rb	0.0038	0.0020	0.0033	0.0020	1.15
Sr	0.0000	0.0030	0.0005	0.0028	0.00
Y	0.0000	0.0037	0.0008	0.0035	0.00
Zr	0.0000	0.0045	0.0003	0.0042	0.00
Mo	0.0000	0.0076	0.0010	0.0072	0.00
Pd	0.0000	0.0274	0.0126	0.0268	0.00
Ag	0.0092	0.0317	0.0026	0.0304	3.54
Cd	0.0016	0.0340	0.0143	0.0327	0.11
In	0.0016	0.0388	0.0043	0.0363	0.37
Sn	0.0000	0.0481	0.0084	0.0466	0.00
Sb	0.0000	0.0544	0.0000	0.0527	
Ba	0.0000	0.1914	0.0000	0.1828	
La	0.0000	0.2562	0.0221	0.2473	0.00
Au	0.0000	0.0084	0.0010	0.0080	0.00
Hg	0.0000	0.0070	0.0031	0.0067	0.00
Tl	0.0000	0.0067	0.0000	0.0063	
Pb	0.0000	0.0087	0.0015	0.0083	0.00
U	0.0000	0.0067	0.0000	0.0063	
Sum of measured species	90.9133	5.2141	90.7568	5.2628	1.00

Table 3.2.2.12. Element ratios from DRI filter samples.

Date	13-Aug-92	13-Aug-92	
Fuel	Wheat Straw	Wheat Straw	
Configuration	CEWF	CEWF	
Size Fraction	PM2.5	PM10	PM2.5/PM10
Teflon Filter ID	ABTT025	ABTT026	
Quartz Filter ID	ABTQ025	ABTQ026	
Cl-/Cl	1.20	1.21	0.99
K+/K	0.96	0.97	0.99
Sulfate S/Total S	0.82	0.79	1.03
C(org)/C	0.78	0.79	0.99
Cl/K	1.03	1.03	1.00
Cl-/K+	1.28	1.28	1.00
Cl-/Na+	56.45	57.68	0.98
S/K	0.11	0.12	0.99
S/Na+	5.22	5.38	0.97
Al/Si	0.99	0.42	2.36

Table 3.2.2.13. Emission factors (mg/kg) from DRI filter samples.

Date		13-Aug-92		13-Aug-92	
Fuel		Wheat Straw CEWF		Wheat Straw CEWF	
Size Fraction	PM2.5		PM10		
Teflon Filter ID	ABTT025		ABTT026		
Quartz Filter ID	ABTQ025		ABTQ026		
Start Time	9:18				
Stop Time	10:03				
Start Time					
End Time					
Elapsed Time (minutes)	45				Traverse 2
PM (mg/m^3 by total filter)					3.470
PM10 (by total filter/impactor)					3.380
PM2.5 (by total filter/impactor)					3.260
PM emission factor (%)					0.591
PM10 emission factor (%)					0.577
PM2.5 emission factor (%)					0.556
		±Uncertainty		±Uncertainty	
Teflon sample volume (m^3)	0.45	0.02	0.45	0.02	
Quartz sample volume (m^3)	0.45	0.02	0.45	0.02	
Teflon mass concentration (mg/m^3)	2.289	0.120	2.347	0.122	
Teflon mass/Total mass	0.702		0.694		
	Emission (mg/kg)	±Uncertainty	Emission (mg/kg)	±Uncertainty	PM2.5/PM10
Cl-	880.9812	67.2260	893.2880	67.9937	0.99
NO3-	24.4017	4.1422	25.8248	4.2179	0.94
SO4=	200.8830	13.9834	198.4477	13.7903	1.01
NH4+	136.2031	9.7356	132.4171	9.5032	1.03
Na+	15.6073	2.0350	15.4872	2.0426	1.01
K+	689.1251	48.0217	698.7439	48.5603	0.99
C(org)	2985.1609	270.8721	3165.3152	285.7189	0.94
C(oht)	2805.9582	396.9451	3030.5711	426.6165	0.93
C(e)	840.1711	73.5366	832.6360	72.7251	1.01
C(eht)	45.1279	25.9263	108.3661	60.3773	0.42
C	3825.3320	0.0000	3997.9512	0.0000	0.96
Al	6.4337	1.6180	8.7863	1.6848	0.73
Si	6.5194	3.1859	20.9675	3.4909	0.31
P	3.1679	7.5783	4.2787	7.6164	0.74
S	81.5164	6.3328	83.2725	6.4220	0.98
Cl	737.0845	48.6055	740.2276	48.6757	1.00
K	716.4562	47.1488	721.1228	47.3255	0.99
Ca	2.0182	9.4242	3.7510	9.4743	0.54
Ti	0.0061	3.5084	0.5150	3.4620	0.01
V	0.0000	1.5234	0.0636	1.5060	0.00
Cr	0.0000	0.3336	0.0445	0.3347	0.00
Mn	0.0612	0.2335	0.2543	0.1673	0.24
Fe	0.8134	0.6338	6.6755	0.7790	0.12
Co	0.0000	0.1390	0.0000	0.1789	
Ni	0.0000	0.1557	0.0381	0.1558	0.00
Cu	0.0000	0.1612	0.0699	0.1616	0.00
Zn	0.3241	0.1223	0.4260	0.1212	0.76
Ga	0.0000	0.2836	0.0572	0.2827	0.00
As	0.0000	0.3280	0.0127	0.3231	0.00
Se	0.0000	0.1779	0.0000	0.1789	
Br	3.0701	0.2391	2.9118	0.2308	1.05
Rb	0.2324	0.1112	0.2098	0.1154	1.11
Sr	0.0000	0.1668	0.0318	0.1616	0.00
Y	0.0000	0.2057	0.0509	0.2020	0.00
Zr	0.0000	0.2502	0.0191	0.2423	0.00
Mo	0.0000	0.4226	0.0636	0.4154	0.00
Pd	0.0000	1.5234	0.8011	1.5464	0.00
Ag	0.5626	1.7625	0.1653	1.7541	3.40
Cd	0.0979	1.8904	0.9091	1.8868	0.11
In	0.0979	2.1573	0.2734	2.0945	0.36
Sn	0.0000	2.6744	0.5340	2.6888	0.00
Sb	0.0000	3.0246	0.0000	3.0408	
Ba	0.0000	10.6418	0.0000	10.5476	
La	0.0000	14.2447	1.4050	14.2692	0.00
Au	0.0000	0.4670	0.0636	0.4616	0.00
Hg	0.0000	0.3892	0.1971	0.3866	0.00
Tl	0.0000	0.3725	0.0000	0.3635	
Pb	0.0000	0.4837	0.0954	0.4789	0.00
U	0.0000	0.3725	0.0000	0.3635	
Sum of measured species	5,560	290	5,770	293	0.96

Table 3.2.2.14. Element concentrations (ng/m^3) from CNL filter samples.

Fuel:	Wheat
Date:	13-Aug-92
Time:	8:20
Filter ID:	AG-32

Element	Concentration	±Uncertainty
	ng/m^3	
H	86,800	7,800
Na		
Mg	10,390	2,700
Al		
Si	17,790	1,500
P		
S	30,730	2,300
Cl	427,590	21,700
K	412,500	20,900
Ca		
Ti		
V	190	100
Cr		
Mn	380	100
Fe	4,880	300
Ni	210	100
Cu	190	100
Zn		
As		
Pb		
Se		
Br	1,390	100
Rb		
Sr		
Zr		

Table 3.2.2.15. Element emission factors (mg/kg) from CNL filter samples.

Fuel:	Wheat	
Date:	13-Aug-92	
Time:	8:20	
Filter ID:	AG-32	
Fuel rate (g/s)		1.78
Stack gas flow rate (m^3/s)		4.49
Stack Temperature (°C)		26.37
Ambient Temperature (°C)		23.03

Element	Emission factor (mg/kg)	±Uncertainty (mg/kg)
H	216.5	19.5
Na		
Mg	25.9	6.7
Al		
Si	44.4	3.7
P		
S	76.7	5.7
Cl	1,066.6	54.1
K	1,028.9	52.1
Ca		
Ti		
V	0.5	0.2
Cr		
Mn	0.9	0.2
Fe	12.2	0.7
Ni	0.5	0.2
Cu	0.5	0.2
Zn		
As		
Pb		
Se		
Br	3.5	0.2
Rb		
Sr		
Zr		

Table 3.2.2.16. Relative element concentrations by stage from DRUM impactor.

Stage 1: 10 - 15 μm

	13-Aug-92 Concentration (relative)	±Uncertainty	Abundance Relative to Potassium (-)	Abundance Relative to Stage 1 (-)
H				
Na				
Mg				
Al				
Si	10,675.87	581.09	7.9860	1
S	200.15	55.45	0.1497	1
Cl	537.58	97.64	0.4021	1
K	1,336.82	124.73	1.0000	1
Ca	2,596.55	212.55	1.9423	1
Ti	107.25	36.91	0.0802	1
V				
Cr				
Mn	226.13	25.09	0.1692	1
Fe	1,843.35	112.91	1.3789	1
Ni	17.91	8.18	0.0134	1
Cu	248.51	27.45	0.1859	1
Zn	327.91	28.00	0.2453	1
As				
Se				
Br				
Rb				
Sr				
Pb				